



WHITE PAPER

Leveraging Warehousing Technology
for India's Deeper Integration into
Global Supply Chains

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2. Glossary:

3PL	Third-Party Logistics	ML	Machine Learning
AI	Artificial Intelligence	MMT	Million metric tonnes
AMR	Autonomous Mobile Robots	NBHC	National Bulk Handling Corporation
API	Active Pharmaceutical Ingredient	NCML	National Commodities Services Management Limited
BIS	Bureau of Indian Standards	NCR	National Capital Region
C&F	Clearance and Forwarding	PEB	Pre-Engineered Building
CAGR	Compound Annual Growth Rate	PLI	Production Linked Incentive
CFS	Container Freight Stations	RCC	Reinforced Cement Concrete
COD	Cash on Delivery	RFP	Request for Proposal
CWC	Central Warehousing Corporation	RO/RO	Roll-On Roll-Off
DC	Distribution Centre	SaaS	Software as a Service
FDI	Foreign Direct Investments	SKU	Stock Keeping Unit
FMCG	Fast Moving Consumer Goods	SWC	State Warehousing Corporation
FTWZ	Free Trade Warehouse Zones	TCI	Transport Corporation of India
GST	Goods and Services Tax	TMS	Transportation Management System
IBEF	Indian Brand Equity Foundation	ULB	Urban Local Body
ICD	Inland Container Depots	WMS	Warehouse Management Systems
IPO	Initial Public Offering		
JIT	Just-in-Time		

3. Introduction:

In recent times, the Indian government has made significant efforts to enhance the logistics and warehousing sectors. Flagship programmes of the Indian government such as 'Make in India' and 'Atmanirbhar Bharat' schemes seek to catalyse domestic manufacturing in India not only for the domestic market but to facilitate exports as well.

Indeed, India is ideally positioned between the 'east' and 'west', with significant potential to position itself as a global logistics hub.

However, to achieve this objective, several challenges and shortcomings need to be addressed. According to various estimates, logistics costs account for as much as 14% of GDP in India, well above the 8-10% seen in advanced economies.

While this figure may be substantially lower than the 20% of GDP seen in some South-East Asian countries, these higher costs undoubtedly have an impact on the ability of India to become a regional and global logistics hub.

This challenge is further compounded by issues related to the lack of standardized guidelines in line with international frameworks for warehousing space, transit transport and automation in the sector, as well as the lack of a coordinated and detailed National Logistics Policy.

However, with the logistics sector being granted 'infrastructure status' in India in 2017, this has led to eased financing for projects; and moreover, the National Logistics Policy together with the newly launched Gati Shakti National Master Plan for multimodal connectivity have significant potential to transform the entire logistics sector in India.

The continued rise of the e-commerce sector and the main players therein, as well as increasing competition between suppliers and retailers along with increased expectations and price sensitivity of end-consumers, are likely factors in the increased adoption of automation, technologies and digitization in the sector.

This White Paper seeks to provide an overview of the present state of warehousing in India, the factors contributing to current and expected changes, the level of automation and technological adoption in this space in India, profiles of key players, as well as an overview of potential technologies and solutions that could be adapted to- and adopted by- the sector in India.

4. Introduction to the Warehousing Industry in India:

4.a. Overview:

With a population now nearing 1.4 billion, India is one of the largest consumer markets in the world. Transportation and warehousing are critical links in the supply chain that connect manufacturers to end-consumers. Today's warehouses not only provide storage but also a variety of value-added services such as packaging, labelling, grading, sorting, kitting, processing and more. Warehouses are increasingly becoming a nodal part of the supply chain linking goods from producers to consumers.

In comparison to industrialised economies, India's per capita warehouse space remains low. India carries a per capita warehousing space of only 0.02 square metres, compared to 4.4 square metres in the United States, 1.09 square metres in the United Kingdom, and 0.8 square metres in China.

In terms of transaction volumes, the industrial and warehousing industry in the United States transacted 20.4 million square metres (220 million square feet) in 2020, more than seven times that of India in FY 2021.

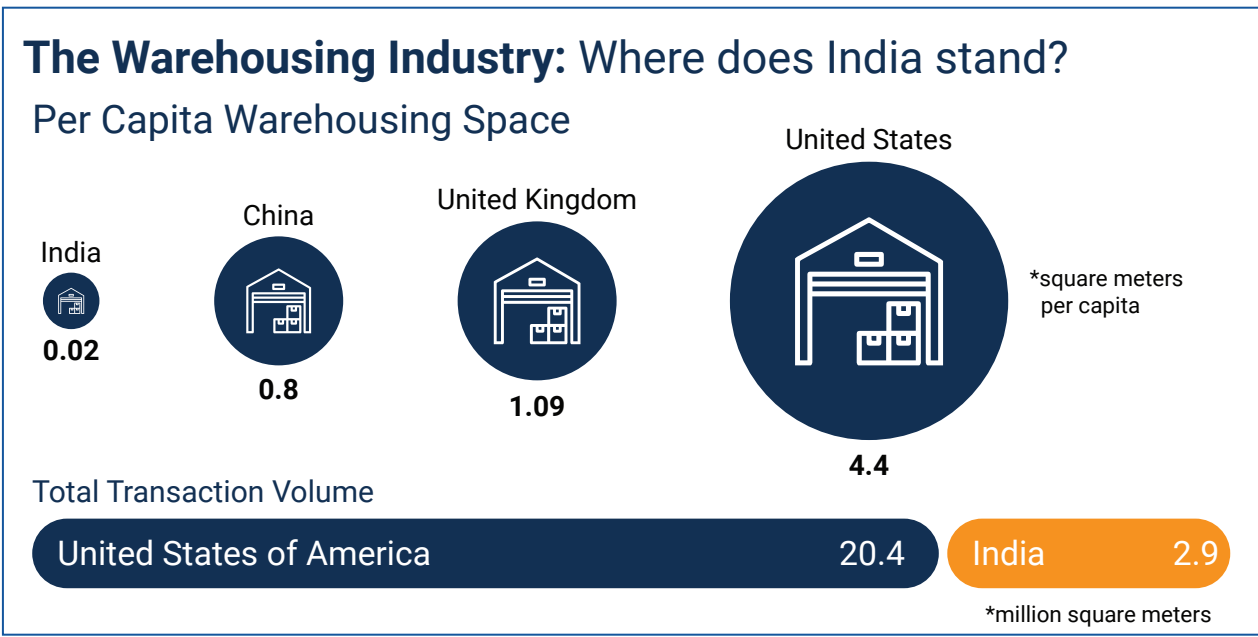
Broadly categorized, Indian warehousing can be divided into two segments: agricultural and industrial warehousing.

4.a.i. Agriculture Warehousing

Agriculture warehousing accounts for more than half of the warehousing space in India. The Food Corporation of India (FCI) is the nodal agency in charge of storing all food grains across the country.

The Central Warehousing Corporation (CWC), a government-owned entity, operates 422 warehouses (with a combined a storage capacity of 9.98 MMT) as of 2019.

“Across India, there are 19 State Warehousing Corporations (SWC) consisting of 2,145 centres, with an operating network capacity of 34 MMT as on March 31, 2019. Though government agencies have traditionally dominated this sector, several new private players have emerged, including Star Agri, Shubham, NBHC, and NCML.”



4.a.ii. Industrial Warehousing

Warehousing of industrial products is primarily supplied by private sector players. The following is a broad classification of warehousing in India.

- **Private Warehouses:** These warehouses are held by private companies or individuals and are generally used for storage of goods belonging to various business organizations.
- **Public Warehouses:** These warehouses are owned by government agencies like CWC and licensed by them to private entities to store goods for various business organizations.
- **Bonded Warehouses:** These are special warehouses that Indian Customs has granted permission to keep imported goods till the customs tariff is paid.
- **Container freight stations (CFS) and Inland container depots (ICDs):** CFSs/ICDs are Export-Import (EXIM) gateway warehouses where export and import cargo is consolidated and deconsolidated.
- **Cold Storage:** These are temperature-controlled storage areas for perishable products in the agriculture, dairy, pharmaceutical, and food industries.

“Modern” Indian storage began a little more than a decade ago, when logistics corporations began constructing state-of-the-art warehouses in the country. Though there are no official classifications, new modern warehouses are sometimes categorised as Grade A and conventional warehousing as Grade B in India.

For more information on the qualification of [modern and traditional warehouses in India](#), see [here](#).

Presently, the warehouse market in India is highly fragmented. Unlike developed countries, the

average size of warehouse space is very small, at around 10,000 sq. ft.

Unorganized sector players, control nearly 90% of the storage sector. The existence of a considerable number of Reinforced Cement Concrete (RCC) structures in the Indian warehousing industry, as opposed to mostly Pre-Engineered Building (PEB) constructions around the world, is another distinguishing feature.

A [SWOT analysis of the warehousing sector in India](#) can be found in Annexure II.

4.b. Value Chain for Warehousing in India:

The warehousing sector in India is made up of warehouse developers, warehousing service providers, and warehousing service users. In this section, we take a closer look at these key components.

4.b.i. Warehouse Developers

Developers design and develop their own warehousing infrastructure. They invest in land, build warehousing structures, and potentially lease warehouses to 3PL companies. Traditionally, warehouses in India are owned by unorganised sector players.

However, in recent years, several private equity players have made large investments in the logistics sector, and in particular, warehousing.

4.b.ii. Warehouse Service Providers - 3PL Players

3PL players are providers of logistics services, including the provision of warehousing services. They own warehouses, or rent them from developers, and operate them with material handling equipment, technology, labour, and management expertise in order to provide warehousing services to the user industry.

Unorganised players, commonly referred to as clearance and forwarding (C&F) agents, dominated the 3PL market in the past. Such enterprises usually operate in a single state or region.

However, many organised 3PL players have entered India in the last decade. Several multinational 3PL businesses, including Schenker, DHL, Kuehne + Nagel (K&N), Yusen and LF Logistics are now present in India.

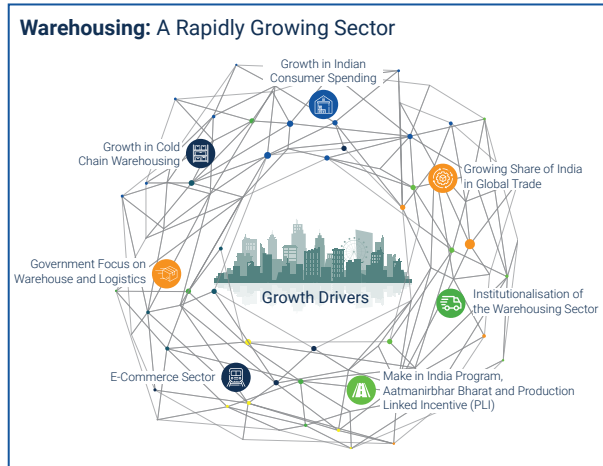
Several organised Indian businesses have also entered the 3PL space. They include Mahindra, TVS, FutureGroup, and Reliance, and pure play logistics providers such as TCI and Allcargo. Players in the express and transportation industries, such as Gati and Safexpress, have also integrated into the 3PL market. Several start-ups have also recently emerged in this segment.

4.b.iii. Warehouse Service Users

Traditionally, FMCG and consumer durables used to be the largest consumers of warehousing services. However, with the advent of modern retail and e-commerce in the last decade, they too have become one of the key users of warehousing services in India.

Paints, auto ancillaries, chemicals, tyres, pharmaceuticals, and cement are the other large users of industrial warehousing services in India.

4.c. Warehousing Growth Drivers:



The Indian warehousing sector is growing swiftly. The following are some of the factors that are fuelling this growth:

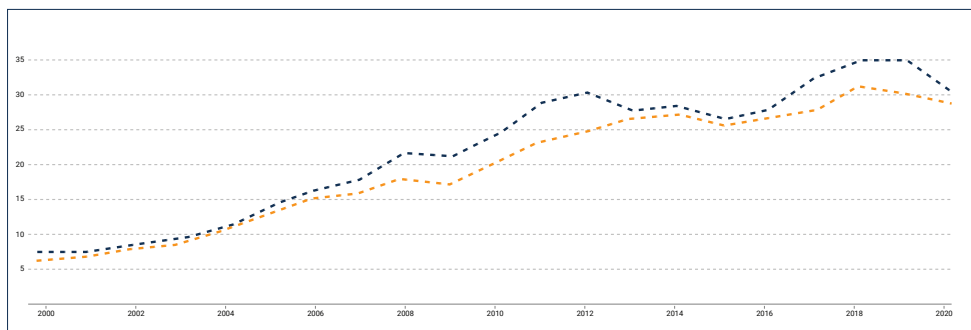
Growth in Indian Consumer Spending

The last three decades have brought about a general betterment of livelihoods across the Indian population. Greater personal disposable incomes and increased internet access have also led to a transformation of Indian retail and e-commerce sectors.

Growing Share of India in the Global Trade

India's growth trajectory has been extraordinary, particularly since the turn of the century. Over the

India: Rising Share in Global Trade



Source: World Bank

Global Share

Imports

0.7%

1.7%

Exports

0.7%

2.4%

last 25 years, Indian exports have grown 17 times while imports have increased 19 times. India's part of global merchandise exports increased from 0.6 percent in the early 1990s to 1.7 percent in 2016, while its percentage of imports increased from 0.6 percent to 2.4 percent during the same time period.

The rise in imports reflects rising Indian consumption and warehousing requirements. Demand for container freight stations and multimodal logistics parks are also expected to increase, particularly due to increased export volumes.

Institutionalisation of the Warehousing Sector

A growing economy, and an outsized consumption base, is attracting large investments into the Indian warehousing industry. The Indian warehouse sector is slowly, but surely, moving away from being an unorganised to becoming an organised sector, attracting investment from private equity firms, known for their expectations of high returns.

Larger, organised players - both Indian and international - are increasingly managing warehouses that are closer to international warehousing norms and standards.

Make in India Program, Aatmanirbhar Bharat and Production Linked Incentive (PLI)

The Indian government's flagship 'Make in India' programme on domestic manufacturing has propelled domestic manufacturing for domestic consumption and exports. In a complementary approach, the government has also launched several policies, such as the 'Aatmanirbhar Bharat' scheme to significantly enhance domestic manufacturing.

The PLI scheme is currently active in more than ten sectors, including semiconductors, electronics manufacturing, food processing, battery storage, automobile components, and specialty steel, and several more schemes for other industries are expected. The increase in manufacturing activities is also driving the growth of the warehousing sector on the production side of warehousing.

The E-Commerce Sector

Over the last five years, the e-commerce sector has emerged as one of the most important drivers of warehousing growth in India.

According to IBEF, the e-commerce market in India is expected to reach USD 200 billion by 2026 from USD 38.5 billion in 2017.

According to estimates, e-commerce warehousing absorption in FY 2019-20 stood at 8.5 million square feet, growing at a CAGR of 55% during the period FY 2017-20.

Even though e-commerce adoption has expanded manifold in recent years, India's proportion of overall trade in e-commerce is still minimal in comparison with other developing nations. In 2019, e-commerce penetration as a share of total retail was only 4.7% in India as compared to 15.9% in China and 19.2% in the United Kingdom. E-commerce is expected to continue to expand, with a corresponding impact on the Indian warehousing sector.

Amazon, Flipkart, and Reliance JioMart are actively looking for warehousing space to grow their operations across major cities. According to industry estimates, e-commerce companies like Flipkart and Amazon have leased over a quarter of India's entire warehouse capacity in the last two years. According to Colliers, leasing in Grade A industrial and warehousing premises in the top five Indian cities of Bengaluru, Chennai, Delhi NCR, Mumbai, and Pune totalled 10.1 million square feet in H1 2021.

Indian Government's focus on Logistics and Warehousing

The Indian government is increasingly focused on the logistics sector, including the warehousing sector, through various actions such as granting the logistics sector "infrastructure status". This allows for 100 percent FDI in warehousing, setting up a Logistics Department within the Ministry of Commerce, the enactment of the Warehousing (Development and Regulation) Act, 2007, and the designing of two policies (still to be tabled) on National Logistics and Warehousing, and the

announcement in the latest Union Budget on February 01, 2022 on the establishment of multimodal logistic parks and free trade warehouse zones (FTWZs).

Growth in Cold Chain Warehousing

The expansion of the organised food industry and e-commerce is the primary driver of expected growth in India's cold chain business. Food retailing has matured, and the country's increasing penetration of organised food retail is necessitating the establishment of efficient cold chain storage management.

The pharmaceutical industry is yet another major demand generator for temperature-controlled storage and distribution. COVID-19 vaccines and API medicinal formulations, in particular, will necessitate substantial expansions in India's cold chain warehousing capacity.

4.d. Geographical Distribution:

Warehousing stock in India is growing at a rapid pace. As per the 'India Real Estate Outlook – A new growth cycle' report by JLL, India's total warehousing stock stands at 238 million sq. ft. in 2020 with top 8 cities, which includes, NCR Delhi, Mumbai, Bengaluru, Chennai, Pune, Kolkata, Hyderabad and Ahmedabad accounting for almost two thirds of the space.

Growth in warehousing space in India between 2016 – 2020 can be seen in Annexure III.

Nearly 60% of India's Grade A warehouse stock is concentrated in just six cities: Bengaluru, Chennai, Ahmedabad, Mumbai, NCR, and Pune, with Kolkata and Hyderabad rounding out the top six.

This is driven by the concentration of manufacturing activity and the existence of a significant urban population in the vicinity of these clusters. This trend is expected to continue in these areas, due to factors such as infrastructure quality and labour availability.

Analysis of the warehousing sector in India can be seen in Annexure IV.

Aside from these major metropolitan centres,

there are tier-II cities which are emerging as new hubs for warehousing in India.

These include 'frontrunners', such as the National Capital Region of Delhi, Mumbai, Chennai, Bengaluru and Hyderabad; 'challengers', such as Surat, Vishakhapatnam, Nagpur and Chandigarh; and 'newcomers', such as Vijayawada, Coimbatore and Jamshedpur.

Classification of warehousing potential across India can be seen in Annexure V.

4.e. Technology and Automation in Warehousing:

In comparison to industrialised countries, in India, the adoption of automation and other technology including warehouse management systems is still low. Due to high initial expenses, perceived long payback periods, substantially smaller labour rates, insufficient connectivity, lack of awareness of options and possibilities, and a host of other challenges, warehouse operators have been sluggish to adopt automation in warehouses. This is covered in greater detail in Section 7 of this paper.

There is still a dominance of ground storage over racked storage within the overall Indian warehousing industry, and the use of racking-in is still hampered by a lack of standardized flooring specifications of warehouses, perceived high racking costs, and a lack of a long-term perspective.

Due to its substantially greater service delivery requirements, e-commerce, as a key occupier segment, has been at the forefront of technology use in warehousing in India. Other segments too, mainly high-volume products, are now slowly moving in this direction.

For optimal results, technology adoption happens at an early stage of design, rather than retrofitting at a later stage. Increased long-term agreements between the users and the 3PL companies is expected to allow 3PL players to invest in technology and automation. The necessity for warehouse operators to manage large numbers of SKUs and handle rapid cargo movement has created and increased the need for technology.

5. Macro Trends and Developments in the Warehousing Industry:

There have been several recent policy adoptions by the Government of India that impact the logistics and warehousing sectors.

Indeed, the government's emphasis on increasing the country's "Ease of Doing Business" rankings, while at the same time, its recognition of the need for a made-to-order National Logistics Policy, are expected to accelerate the growth of the wider logistics sector in India.

Furthermore, the growth of cities and Urban Local Bodies (ULBs) across the country, as well as the increased adoption of e-commerce during the COVID-19 pandemic, is expected to substantially increase the need for standardised, efficient and digitized warehousing, supply chains and logistics.

5.a. Impact of Policy Changes:

India has achieved great progress by constructing logistics infrastructure and implementing key legislative and structural changes the last few years. Various programs, such as, the [Pradhan Mantri Gram Sadak Yojna](#), Industrial & Dedicated Freight Corridors, [Bharatmala](#) and [Sagarmala](#) projects, and [Jal Marg Vikas](#) have contributed to the development of logistics infrastructure. A scheme to create an Integrated Cold Chain and Value Addition Infrastructure is underway by the Ministry of Food Processing Industries, under the [Pradhan Mantri Kisan Sampada Yojana](#) scheme.

In recent times, the government has implemented several major policy decisions with regard to the logistics sector. These include the [Pradhan Mantri Gram Sadak Yojna](#), Industrial & Dedicated Freight Corridors, the [Bharatmala](#) and [Sagarmala](#) projects, and [Jal Marg Vikas](#) scheme. Lately, the government has also introduced the [PM Gati Shakti Master Plan](#) for Multi-Modal Connectivity. This seeks to provide integrated and seamless connectivity for movement of people, goods, and services from one mode of transport to another.

These policy changes are aimed at substantially

reducing logistics costs, which are approximately 14% -16% of GDP, substantially higher than the 8% -10% in China and 12% -13% in the United States, but lower than the near 20% seen in some South-East Asian markets .

Under the Warehouse Development and Regulatory Authority, the Indian government has also announced plans for geo-tagging of goods and the development of modern warehouses for the logistics sector .

The guidelines laid by this Authority, farmers and self-help groups will be given incentives to construct modern warehouses to enable storage at the local/regional level, with an eye to prevent food wastage and loss.

These policies could provide an impetus to increase warehousing supply while simultaneously providing opportunities to both domestic and foreign players to expand their presence in the Indian warehousing segment.

Prior to the implementation of the goods and services tax (GST), inventory considerations dictated the location and number of warehouses, the implementation of GST has provided businesses with additional leeway in establishing their warehouses across India.

As we have seen before, in-house logistics providers formed the foundation of supply chain activities before the advent of GST. However, 3PL players' specialized storage and distribution services have grown at a CAGR of about 8% , and are poised to account for a majority of warehouse demand in recent years.

According to data, the warehousing and logistics sectors received approximately USD 100 million between FY 2005-16. However, since the implementation of GST in 2017, the segment has witnessed substantial new investments - receiving over USD 2.14 billion in funding during the period 2017 to H1 2021.

5.b. Emergence of e-commerce players:

As we have seen in Section 4, increased competition amongst e-commerce players in India, particularly with regards to expedited deliveries and rising pricing wars, is driving developments in the warehousing and logistics sectors. It can be expected that this will push businesses to opt for in-city warehousing, which can not only reduce delivery times, but also reduce inventory levels of perishable items, thereby reducing wastage.

In-city warehousing is becoming more widely recognized as a critical infrastructure requirement, particularly in major consumption centres in cities and ULBs.

E-commerce has forced warehouses to shift their focus from massive bulk purchases to tiny batches and even single items. Consequently, there is expected to be a shift from container loads or cartons of individual products picking, and shipping individual products.

To accommodate these developments, warehouse managers must increasingly consider investing in warehouse solutions such as slotting optimization systems, inventory management systems, and warehouse mobility to efficiently process smaller and more frequent orders.

In this sector, warehouses' abilities to properly manage returns is crucial. Consumers expect not just to receive their purchases swiftly but also to have a simple and expedited return process.

Returning items necessitates more time and expenditures and a significant quantity of warehouse space. With the growing expansion of e-commerce, learning to manage returns promptly and efficiently has become essential.

5.c. Pricing Models – Recent Trends:

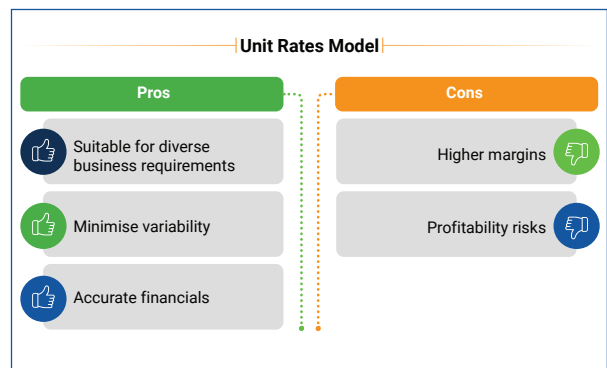
As the logistics sector continues to grow, notably in and around major metropolitan centres in India, the need to ensure that adequate warehousing facilities are located close to the end customer, as well as the limited availability of such locations, is driving-up warehousing costs.

In dense urban areas, such as Singapore, Hong

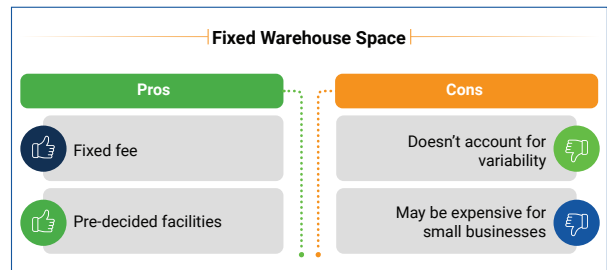
Kong, and Japan, limited land availability has led to the vertical development of multi-story warehouses.

On the other hand, there are multiple warehousing pricing models up on offer to fulfil the needs of different businesses. Transaction or Unit Rates Models accord greater financial control to shippers and protects them from downside variability, but this comes at the expense of a higher margin and profitability risks are high.

Other business models include contracts for fixed warehouse space. In such cases, the price



structure is based on a fixed monthly fee that includes the cost of storage space and infrastructure and any kitting, assembly, picking and packing expenses.

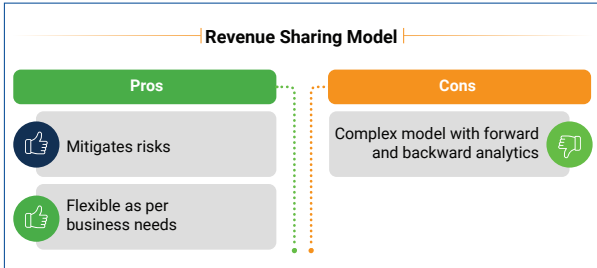


On the other hand, revenue sharing models work through percentage sharing of total sales. This model necessitates a lot of forward and backward-looking analysis and forecasting to maintain accuracy.

5.d. Impact of COVID-19:

The COVID-19 pandemic has had a significant impact on the warehousing sector in India. While on the one hand, the abrupt impact on the global economy halted increased foreign and domestic investments in the sector, the increased demand

for contactless deliveries, digital payments, as well



as reduced footfalls in retail outlets increasing the shift towards e-commerce.

Estimates suggest that the warehousing market will expand to cities and ULBs driven by an increase in local consumption¹¹ of daily requirements.

Although, lean manufacturing is expected to remain important, the ratio of Just-in-Time (JIT) inventory to safety stock is expected to shift. In manufacturing lean philosophies are expected to retain additional inventory (buffer stock) on hand to avoid future inventory shortages and production shutdowns. This is expected to push upwards the demand for warehouse space and capacity.

Brands are likely to decentralize their warehouse locations to achieve same-day or next-day delivery. Being closer to consumers lowers transportation costs and the risk of supply chain disruptions. While some manufacturers may want to construct these decentralized storage facilities in strategic areas, others may wish to collaborate further with established 3PL providers.

5.e. Move Towards Hyperlocal:

The hyperlocal delivery market worldwide is set to grow at a CAGR of 17.9% to reach USD 3.63 billion by 2027 . In India, the trend of hyperlocal deliveries started in 2014 with major restaurant aggregators like Zomato and Swiggy. Hyperlocal logistics providers not only deliver a wide range of products, including groceries, home care, personal care, medicine and food to customers' doorsteps but also empower people to become digitally active.

Hyperlocal delivery models are penetrating beyond urban centers to smaller towns and cities. Hyperlocal delivery provides convenience and are therefore becoming a preferred choice of customers.

Hyperlocal deliveries are backed by advanced technologies that enable single-pick multi-drop, secure payment processing, including Cash-on-Delivery (COD), route and delivery prioritization, and real-time tracking. New age platforms use AI and ML to automate, optimize and make delivery more efficient.

It is expected that hyperlocal logistics will be built on the back of a combination of locally owned warehouses that are integrated with local stores for a robust supply chain framework. Today's retail outlets are expected to transition to micro-fulfilment centers to meet customer demands quickly and cost effectively.

5.f. Digitization:

To meet the increased velocity of the order fulfilment process, automation and robotics usage in material handling and warehousing is likely to



foresee a major increase over the course of the coming years.

In Southeast Asia, autonomous mobile robots (AMRs) and comparable systems being adopted in warehouses. AMRs are small enough to fit into existing warehouse spaces, easy to deploy, and cost-effective. Mobile robotics' flexibility allows them to be readily and swiftly integrated within warehousing facilities. Companies don't require the same height level, floor loadings, or changes to current services that what would normally be the case.

As an example, Indonesia is also benefiting from international investments and trade in warehousing. As a result, warehouse automation in the region is expanding. Just like India, e-commerce is the biggest push, projected to enable the rapid growth of the sector from USD 16 billion in 2019 to USD 62 billion by 2025. With foreign investment, particularly from Australian developer Logos to build the three-level ramp-up Metrolink Logistics Hub for lease to e-commerce firms, the country's warehousing sector is increasingly moving towards automation.

6. Challenges Faced by the Industry:

Challenges in warehouse technologies in India can, in general, be classified on the basis of either resistance to adoption of new technologies or challenges arising due to the regulatory environment.

6.a. Resistance to Adoption of New Technologies:

The table provided below highlights the main issues related to warehouse automation arising due to a general resistance to the adoption of new technologies.

Classification	Context/Impact
Small warehouse sizes	Precludes WMS and racking systems
Cost	Low manpower costs and lack of awareness of cost, time and productivity efficiencies arising from automation
Lack of cost-effective solutions	Razor thin margins of 3PL players and price sensitivity of end consumers
Perceived high maintenance	Need for dedicated maintenance services and fears of disruption
Issues related to Internet continuity	Lack of continuous coverage of internet services in non-urban warehousing areas

One of the most significant challenges associated with the adoption and implementation of automation, technologies, and digital solutions in warehouses in India is the relatively small size of these warehouses. This lack of space stands as an obstacle for the implementation of efficient Warehouse Management Systems (WMS), as well as equipment for the efficient unloading, handling, storage, loading and distribution of materials.

With the rise of larger warehouses catering exclusively to the burgeoning e-commerce sector, time and cost efficiencies, which are crucial to players in this sector, can be expected to accelerate the adoption of such technologies and equipment in India.

On the other hand, the competitiveness and razor-thin margins of warehouse space end-users, particularly from the e-commerce segment, as well as the lack of willingness to pass on higher costs to end consumers, pose a significant challenge to the industry. The expected consolidation of warehouse space users in coming years, may provide an opportunity for the increased adoption of automation in warehousing in India.

At the same time, abundant access to a relatively inexpensive manpower base and the perceived higher costs of automation and technologies in warehousing, as well as the perceived attendant higher maintenance costs of such systems, are also longstanding issues being faced by the sector.

As competitiveness between warehouse end-users continue to grow, and consumers continue to expect expedited deliveries and replacement of products, the need for warehouses to stack larger quantities and categories of products, is expected to grow.

6.b. Inefficient Regulatory Environment:

Despite recent policy changes either implemented or proposed by the central and state governments, existing regulatory challenges remain.

While the Indian central government has implemented various policies to enhance the warehousing sector, the absence of a consistent National Logistics Policy has proved to be a lacuna for large-scale investments that can bring about rapid change.

Major regulatory obstacles for warehousing in India are land associated issues. Regulatory policies on the acquisition and reclassification of land differ from state to state and frequently face obstacles in the issuance of permits, environmental clearances and the reclassification

Classification	Context/Impact
Land acquisition issues	Cumbersome regulatory procedures for acquisition of land and delays due to government clearances
Reclassification of land	Red tape associated with reclassification of agricultural land for warehousing; different policies implemented by each state government
Cost of land	Prohibitively expensive prices of land, in particular in metropolitan cities
Title of land	Lack of digital land ownership records and traditional communal family properties result in difficulties in purchase
Lack of uniformity	Lack of clear guidelines in ensuring standardization and uniformity of warehouses; lack of applicable BIS standards
Month-end peaks	Revenue streams and last orders are usually made in the last few days of each month

of agricultural land to industrial usage for warehousing.

At the same time, the classification of the logistics sector as infrastructure is set to substantially facilitate further investments in the sector. Additionally, the National Logistics Policy being considered by the central government and the recently announced Gati Shakti National Master Plan for Multimodal Connectivity, are expected to significantly resolve regulatory issues and enhance incentives in the sector.

The ever-rising migration towards urban metropolitan areas and significant urban infrastructure developments in areas adjoining major cities, make purchasing land for warehousing prohibitively expensive. While this may entail the establishment of warehousing hubs in close proximity to urban centres, as opposed to within major towns and cities, it can be expected that the increased time and cost efficiencies due to automation in these hubs, may significantly catalyze their adoption and implementation in the warehousing sector in India.

The lack of digitization of land records and the traditional communal family ownership of land, particularly in smaller peripheral towns and cities, may also pose an obstacle for the greater development of warehouses in India.

The lack of specific regulations and guidelines for the warehousing sector in India, and particularly with regard to standards related to floor specifications, illumination guidelines, the height of the warehouse, the bay design, plinth height and other parameters, pose significant challenges to enterprises.

The structure of these warehouses may vary from multi-story RCC to a prefab structure. Due to a lack of standardisation, enterprises may need to spend money and effort in upgrading the space and its specifications to support their operations.

Finally, a common challenge with the warehousing industry in India is the 'month-end peak' phenomenon. For a majority of warehouses in India, more than two-thirds of the billing happens during the last three days of the month.

This skew in volumes leads to errors, process inefficiencies, and higher costs. The manpower utilisation is suboptimal due to the variability in the volumes being handled. The cost of transportation also goes up due to the month-end volume surge. Although several companies are trying to mitigate the situation with weekly targets and other solutions, the phenomenon is still very much prevalent.

7. Using Technology and Automation to Resolve Challenges:

7.a. Why Invest:

The warehousing industry in India continues to evolve at a rapid pace. As a result, brands and their partners are now contemplating various warehousing automation and digital solutions to better serve their customers. This is particularly prevalent in the last-mile delivery space.

To keep up with customers' expectations, technology is a must. The conventional approach of adding extra labour is not a solution to derive the necessary speed and accuracy required to meet burgeoning customer demand. On the other hand, adding automation or technology, without changing processes will likely not solve the problem at hand. Therefore, any handpicked solution will need to address both technological capability as well as process improvements as part of the investment.

Investment in technology and automation is now far more accessible than it once was driven by innovation, smaller capital investments, and alternative financing models.

Automating a warehouse was hitherto deemed feasible only if the building was purpose-built for the integration of the technology. The four walls of a warehouse building would essentially be built around a pre-identified automation solution.

However, the flexibility of AMRs and mobile robotics ensures that they can be easily and quickly adopted inside any warehouse configuration. Companies do not necessarily need the height, floor loadings, or upgrades to existing services that was conventionally required. Existing sites with a flat concrete floor can be readily utilised and do not need to be bespoke to the automation solution.

This has democratised automation. Traditional warehouse automation solutions were typically only adopted by larger businesses due to the

high-cost investment and long payback involved.

Mobile robotics are now enabling smaller players to consider integrating automation into their warehouses to better meet growing consumer demands, particularly the fast delivery expected out of e-commerce. Furthermore, with increased competition from other countries, the level of capital needed to automate warehouses using mobile solutions is now comparatively lower, and businesses can also enjoy a shorter return on investment.

This type of mobile automation can also be deployed within months, rather than years, and scaled as a business grows. For newer e-commerce players, whose volumes are growing rapidly, or growth levels are not yet quantified, the mobile robotics solution gives businesses flexibility.

Additional robots can be ordered quickly to cater to fluctuations in growth, and the portability of the solution means that it can also be easily relocated to a new site should a business outgrow its current site.

The same is also true for implementation of software solutions. Software as a Service (SaaS) is now commonplace and being offered by smaller players in the WMS, TMS, and OMS spaces. This implies that there is not a huge capital outlay at the commencement of any software implementation.

These solutions can also be used for more 'off-the-shelf' products, than they once were, and multiple systems can be used in parallel and work seamlessly due to increased linkages in the back end of these systems. This also assists in giving the visibility that is required in modern supply chains to ensure products are tracked throughout the entire journey.

7.b. Automation versus Manpower:

Even with improved accessibility and low-cost options offered by mobile automation and SaaS solutions today, there remain barriers in India in taking those first steps towards automating warehouses. This is mainly due to the relatively low labour costs given the large base of manpower available.

Although automation is known to increase output and reduce time taken to process an order, there is a counter debate that adding more labour can achieve the same at a lower cost than investing in a machine. However, it must be noted that automation does not necessarily mean replacing people or taking significant labour out of their operations, but rather supplementing growth and allowing people to be retrained and upskilled.

The rapid advent of e-commerce and more consumers going online per the "Digital India" drive, demand continues to be at an all-time high. Even hiring an additional 100 people might not be a solution to fulfil customer orders in a timely manner. Evidently, increased usage of technologies, IT solutions and automation in the sector can provide a critical boost to the timeliness and accuracy of orders, which additional manpower may not be able to provide.

7.c. Way Forward:

While having automation solutions in warehouses is needed as part of modernising supply chains, there are important questions that businesses should consider before implementation.

One key element to consider is management of pain points of existing processes and how a future optimal process flow would reshape such existing mechanisms. Having a good understanding of these and mapping them correctly can help ensure that the right type of automation is implemented, be it physical or digital. The last thing that a business would want while implementing a new automation solution is to replicate existing poor processes.

Beyond this, it is also crucial to ensure that employees are willing to embrace change. Implementing solutions that are as transformative as mobile robotics can result in significant changes to workflow, day-to-day operations and the type of skills needed from the workforce. An effective change management plan that seeks to position new automation solutions as further augmenting current employees' work should therefore be established and prioritised when undertaking the automation and digitisation journey.

8. Profiles of Key Players:

8.a. Mahindra Logistics Ltd (MLL):



Overview of the company

Mahindra Logistics Limited is a leading integrated logistics and mobility solutions provider in India.

It offers customised end-to-end logistics solutions, including transportation and distribution, warehousing, in-factory logistics, and value-added services.

Its asset-light business model, with solution design capabilities, enables the company to serve over 300 domestic and multinational companies operating in several industry verticals in India, including the automotive, engineering, consumer goods, pharmaceuticals, e-commerce, and bulk

Key clients include the Mahindra Group, Volkswagen, Vodafone Idea, Thermax, JSW Steel, Ashok Leyland, Siemens, Bosch, BMW, 3M, and Mercedes-Benz.

It is a listed organisation with a market capitalisation of around INR 31 billion (approximately USD 410 million).

For the fiscal year 2020–21, its revenue were INR 32.64 billion (approximately USD 435 million) and profit after tax were INR 290 million (approximately USD 4 million).

Warehousing Capabilities

The company manages over 17 million square feet of warehousing space spread over more than 500 locations across the country. These include a mix of built-to-suit, dedicated, and multi-user warehouses.

It offers warehousing services for order management, inventory control, material supply management, kitting, sequencing and line-side delivery, bundling, unbundling, light/sub-assembly, packaging, re-packaging, re-boxing, labelling, sorting, reverse Logistics, returns management and audit support.

It deploys technology in warehousing in the form of WMS, Disha (Dock Management Software to reduce dock congestion), Class (Warehouse Layout Design Software for optimal space utilisation) and Pick to Light Systems.

The Transport Management System (TMS) platform is also used by the company to foster collaboration, visibility, and transparency among stakeholders such as customers, business associates, and freight partners. The company also operates Control Tower Operations (CTO) to keep an eagle's eye on our fleet of vehicles, ensuring smooth and timely delivery.

The company is now building smart warehouses using technology (warehouse management systems, handheld terminals, yard management, virtual reality led training), processes (pick to light, system directed pick up and put away, etc.) and people (training, referrals, salary advances).

8.b. TVS Supply Chain Services Ltd:



Overview

TVS Supply Chain Solutions (TVS SCS) is among India's largest and fastest growing integrated

supply chain solutions providers in India.

It is part of the USD 8.5 billion TVS Group.

An Indian multinational 3PL company with a global footprint, it has a presence in 19 countries with over 17,000 employees. It serves more than 50 of the Fortune Global 500 companies.

Its services include - supply chain consulting, warehousing solutions, transportation and integrated logistics, material handling and management, integrated returnable packaging solution, technology and project logistics, as well as sourcing and procurement management.

Its global operations generate revenue in excess of USD 1 billion. At the end of the fiscal year March 2021, the revenue from Indian operations was estimated to be INR 13.45 billion (approximately USD 180 million).

The company is planning for an Initial Public Offering (IPO) in year 2022.

Warehousing Capabilities

The company manages over 13 million sq. feet of warehousing space spread across 180 plus locations in India.

It serves clients in industries including the automotive, engineering, auto components, FMCG, consumer durables, e-commerce, retail, energy/power, chemical/paints, pharma/medical equipment and telecommunications sectors.

It offers warehousing solutions in the form of in-plant warehousing, after-market warehousing, finished goods warehousing and free-trade warehousing.

It offers specialised solutions for critical parts storage and last-mile delivery.

Its key customers for finished goods warehousing include Titan, Hitachi, Daikin, Panasonic Anchor and Mitsubishi. Its key customers for in-plant and after-market warehousing include Hyundai, Fiat, Saint Gobain, Ford, Apollo Tyres, Daimler, Ashok Leyland, JCG and Cummins.

It operates in-house warehouse management system named Visibility, which allows integration with customer ERP through API-based connectivity.

It operates a control tower to monitor pan-India operations.

8.c. Embassy Group:



Embassy Group

Embassy Group is a privately-held real estate developer operating in verticals including the commercial, residential, hospitality, industrial warehouse spaces, services, retail and education. In May 2021, Blackstone Capital recently acquired the entire Embassy Industrial parks portfolio for INR 52 billion (approximately USD 680 million).

Industrial and Warehousing Development

Embassy Industrial Parks was a 70-30 joint venture between Warburg Pincus and Embassy. It has 22 million sq. feet logistics assets across the country's six major cities including Chennai, Delhi NCR, Hosur, Hyderabad, Pune and Mumbai, covering a total size of around 200 acres. These warehouses are primarily dedicated towards e-commerce and retail players. Currently they have 35 million sq. feet in ongoing/future development work.

The Blackstone Group in Warehousing:

Blackstone entered the Indian warehousing sector in 2019 through a joint venture with a Hiranandani group firm, Greenbase. This 50-50 JV plans to invest over INR 25 billion (approximately USD 330 million) in the upcoming three- or four-year period to develop around 12 million sq. feet assets across India.

So far, it has developed 2 million sq. feet in warehousing space. After Blackstone's second deal in the sector with the Embassy Group, it now has a portfolio of over 40 million sq. feet developed and future assets with its partners Hiranandani and Allcargo.



8.d. CapitaLand India Logistics Fund:

CapitaLand India Logistics Fund

The Singapore based CapitaLand has launched its second SGD 400 million (approximately EUR 270 million) logistics private fund in India. This fund will look at investments in warehousing space in the six major metropolitan areas of Ahmedabad, Bangalore, Chennai, Mumbai, National Capital Region (NCR), and Pune, as well as in emerging markets such as Coimbatore, Guwahati, Jaipur, Kolkata and Lucknow.

The new CapitaLand India Logistics Fund II of 2021, follows the deployment of its first logistics fund, the SGD 400 million (approximately EUR 270 million) Ascendas India Logistics Programme, with an aim to focus on warehousing projects in Bengaluru, Chennai, NCR and Pune in 2018 that had as its objective the creation of 12 million sq. feet of warehousing space.

9. TMX Case Studies:

With e-commerce skyrocketing over the last few years, and consumer demands becoming increasingly discerning, warehouses need to operate efficiently to keep pace with the current marketplace. Robust warehouse technologies and infrastructure are no longer a 'good to have' but a 'must have' in supply chains for businesses looking to improve productivity, overcome barriers, and cut costs.

While today's warehousing technologies present tremendous potential to optimise supply chains, there is no one-size-fits-all solution. Different regions, markets and industries present their own unique challenges and opportunities and require the right warehousing solution to meet their specific needs.

This is especially the case in the dynamic and vibrant Asia-Pacific region. For example, businesses operating in markets that have advanced digital ecosystems like Japan or Singapore have the opportunity to explore more sophisticated automation systems, data analytics, and robotics. Meanwhile, those in emerging markets like India, and many other markets in South and Southeast Asia that are still on the cusp of supply chain modernisation, are looking at warehousing technologies that can make use of their existing infrastructure and workforce, while at the same time provide simple, user-friendly solutions to improve their operations and help them meet the rising demands of e-commerce.

As an Asia-Pacific business transformation consultancy focused on helping businesses optimise their entire supply chain, from top-of-the-funnel demand generation right through to final fulfilment, TMX works with diverse clients with wide ranging needs, budgets, goals, opportunities and constraints.

This experience has given us a deeper knowledge of in-market challenges and opportunities as well as the technological innovations that will help build competitive logistics and supply chain networks across all our markets.

9.a. Constructing the warehouse of the future:

One example of a business that understands the merits of leveraging automation is one of the largest bottlers in Japan. The company recognised the need to optimise its operations, as its existing network was complex and inefficient, leading to greater cost pressures. These costs escalated in the face of barriers such as labour shortages, rising costs, and an increasingly fragmented customer profile.

Recognising these challenges, the bottling company entrusted TMX as its partner of choice to strengthen its supply chain through advanced end-to-end automation, with the development of its new mega automated distribution centre (DC).

TMX supported this project with the objective of improving its logistics efficiency and streamlining processes, ultimately achieving reduced costs and even stronger customer service. To achieve this, TMX applied its 3-step network strategy methodology, making the end game simpler, safer, and lower-cost.

Consolidating a number of its smaller sales centres, the bottler established a central hub that supported its logistics network and connected its manufacturing and logistics processes. This helped to achieve timely end-to-end deliveries from the production site all the way to end customers.

The hub features an end-to-end automated material handling system:

- **Automated storage systems (AS/RSs)** requiring only half the space of conventional warehouses;
- **Sorting Transfer Vehicles** that ensure efficient movement of goods between processes;
- **Automated case picking shuttles** and **Automated Case Pick (ACP)** for pallet building;

- **RORO (roll-on/roll-off)** stations which reduces loading and unloading times by half, and more.

Automation and robotics clearly play a key role in improving the speed and accuracy of routine operations. For example, palletising robots not only quickly stack cases, crates, and totes of varying sizes, but do so based on the most efficient stacking pattern, which is automatically calculated by the robots' software. A first in Japan, the RORO stations also fully automated the loading and unloading of truckload batches.

In response to the project, the scale of the transformation designed by TMX was recognised by the client as a "once in a generation opportunity for the company", achieving over 10% estimated annual OPEX savings delivered by the strategy. The bottling company was able to address the forecasted labour shortage challenge unique to Japan, and ultimately achieve a scalable, agile solution.

9.b. Strengthening supply chain through automation:

Vietnam is another market that is witnessing burgeoning investment towards state-of-the-art technologies in its industries, and warehouse development is ramping up. The country is well on its way to become one of the most advanced manufacturing hubs in Asia.

TMX worked with the largest retailer in Vietnam, which was facing a number of logistical challenges, namely low productivity, high logistics costs, high inventory and a need to improve services in three ambient DCs and retail stores across Ho Chi Minh City.

Originally brought in to lead a workshop, TMX identified several opportunities to improve cost savings and operational efficiency and was then appointed to lead the retailer's supply chain transformation programme. Working closely with a cross-section of team members from the client side, TMX consultants created a new strategy that helped the business grow and adopt automation in stages, saving millions in the process.

One of the key improvements included planning and developing a new DC, which involved redefining warehouse processes, proposing the right partners, developing land and managing the consenting and building process.

As part of the business transformation, it was evident the capability of the people, processes, and systems were not where they needed to be to support a highly automated DC. To address this, TMX proposed a Business Improvement program to lift its current processes, systems, and people capability in readiness for the proposed automated DC.

This included optimising transportation to reduce costs and improve delivery times, which also involved managing an RFP process to select the best transport provider.

To ensure the operations team was engaged, and team capabilities were lifted to sustain improvement efforts, teams on the retailer's side had direct engagement with TMX team members in upskilling sessions, and CEO and Deputy CEOs were given ownership of change and appointed as advocates of the transformation program.

Other improvements included re-engineering the layout, systems, equipment and manpower across the retailer's sites and reducing excess inventory across DCs and stores to reduce overall supply chain costs. A master plan helped support the client's continued rapid growth and made sure it was ready to handle an influx in ambient, temperature controlled, convenience and online distribution demands.

Notably, TMX also introduced Peak Period Planning to address the retailer's challenges during festivities, which helped to reduce labour costs through improved labour structure, transiting away from vendor-managed labour source.

TMX's transformation project ultimately saved the retailer USD 10 million in capital costs and around USD 500,000 in operational costs.

Overall, the Business Improvement Program achieved 5% transport reductions, 25% in pick productivity, and 12% in inventory reduction. The new DC program achieved 15% footprint savings and saved USD 15 million in capital expenditures. The retailer was able to utilise the gains from the Business Improvement Program to fund the program costs of its new DC and Business Improvement program.

9.c. Conclusion

Warehouse technology and innovation will continue to play an increasingly important role in advancing supply chains, with technological advancements crucial to improving warehouse management processes. These two case studies demonstrate a variety of solutions designed and managed by TMX consultants, which made automation accessible for two very different markets.

10. Conclusion:

The warehousing sector in India presents significant opportunities, specifically in terms of the adoption and implementation of automation, technologies and IT solutions.

However, along with those opportunities, India presents investors with a set of varied challenges.

Whilst the sector is growing at an exponential rate with changes in end-consumer buying patterns and the development of the e-commerce and hyperlocal retail segments, the warehousing space in India remains highly fragmented, with the majority of warehouses still operated by unorganised sector players. The demand pattern change is however driving a consolidation of activities, thereby attracting an increase of both domestic and international investments in the sector driving growth.

This is happening despite the fact that the sector is also to a certain extent constrained by razor-sharp margins amongst the largest group of the users of warehouses: the 3PL players.

The warehousing sector lacks standards and regulations, both of which would further fuel high growth. Large scale adoption of automation, technologies and IT solutions within the warehousing industry in India is happening only at a very slow pace, whereby the sector is experiencing lower than possible efficiencies. More often than not, such capex investments are weighed against fairly easy access to a skilled and relatively low-cost workforce. Indeed, the first actual warehouses that became semi-automated in India recorded swift returns on investment, thereby showing that the hesitation of warehouse

owners to implement such changes, which could dramatically increase their efficiency, can be attributed to the low level of awareness of the benefits of automation and technology.

None the less, the ever increasing presence of new and diverse firms and investments, coupled with the consolidation of major enterprises in this sector, bodes well for a higher uptake of such new automation and technology solutions in both brownfield and greenfield warehousing projects.

The Government understands that efficient logistics, including efficient warehousing, is a pre-requisite for economic growth, and is currently implementing a variety of support measures, including an upcoming National Logistics Policy, a Warehousing policy, and a plan to grant the warehousing sector an industry status nationwide. This will in essence give a further incentive for stakeholders to invest and warehousing sector, boosting both growth and efficiencies.

In conclusion, there is every reason to expect that international best practices, including automation, technologies and IT solutions, will witness a significant uptake within the warehousing sector in India. This shift is happening at an opportune time, with global supply chains in flux and re-designing, so such evolution in domestic supply chains and warehousing standards will enable the better, swifter and customised integration of Indian supply chains into global supply chains.

11. Profile of the Authors:



Prof. Jitamitra Desai is Associate Professor of Operations Research in the Decision Sciences (DS) group at the Indian Institute of Management (IIM) Bangalore. He is also the Chairperson of the Supply Chain Management Centre at IIM Bangalore.

Prof. Desai's research interests are centred around mathematical/computational decision analytics, particularly in developing large-scale (big-data) optimization algorithms and their applications, notably in aviation, transportation and location theory, energy analytics, and wireless communication networks.

Dr. Aditya Gupta is the Chief Operations Officer at the Supply Chain Management Centre of IIM Bangalore.

Prior to his present position, Dr. Gupta has over 24 years in Supply Chain Management, General Management, Finance and Sales in organizations such as TVS Group, Tata Group, Virgin Group, Moser Baer, Jindal Group, Essar Group. Dr. Gupta's areas of expertise include Warehousing, Transportation, Import/Export Management, Planning and Inventory Management.



Mr. James Christopher leads TMX's Asia business, having joined the business in 2013. He has over 20 years of construction and property experience successfully delivering complex, automated and high bay facilities across the region for leading national retailers and logistics companies, including Schneider Electric, the supermarket company Woolworths, retailer Kmart and the national postal services, Australia Post and Singapore Post.

James' expertise lies in managing the design and integration of automation into a building.

Mr. Poul V. Jensen is the Managing Director of the European Business and Technology Centre (EBTC), a project advisory and facilitation organization that seeks to enhance the Europe – India Business Corridor.

Poul holds a Bachelors in International Trade from the Copenhagen Business School, Denmark and a Master's in Business Administration from CASS Business School, London, and is currently Chair of the National Council of Logistics of the Associated Chambers of Commerce and Industry of India (ASSOCHAM).



Annexure I: Modern and Traditional Warehouses in India

Key parameters	Traditional warehouses	Modern warehouses
Size (footprint)	Usually up to 5,000 sq. Ft.	> 10,000 sq. ft.
Height	12~15 ft	>20 ft.
Storage	Floor stacked on pallets	Floor + racking option available
Flooring	Standard paved	Reinforced hi-grade concrete
Structure	Standard brick or RCC structure	Reinforced walls + prefab sheets and bespoke roof design
Material discharge/ loading	Single-point entry/ exit	Multiple docks/ bays with levellers
IT	Limited	Full-fledged warehouse management system
Material handling	Limited material handling equipment usage	Extensive usage of material handling equipment
Value-added services (VAS) capability	Limited	Significant scope for palletization, bar coding, MRP labelling, pick and pack, and shrink wrapping
Cargo safety/ security	Basic	Fire extinguishers, ventilators and CCTV surveillance standard

Annexure II: SWOT Analysis of the Warehousing in India

Strengths

- Large distributed Spread across every State and key production and consumption Markets.
- Rational Warehousing Space Rates.
- Strong interest by new MNC and PE players in Warehousing.
- The development and growth of 3PL and 4PL industry in managing Warehousing.

Weakness

- Lack of Organized players
- Lack of Standardization.
- Lack of Mechanization and Technology in Warehousing
- Challenges in Land Acquisition and conversion.
- Small Box Sizes.
- Too many RCC and Old structures

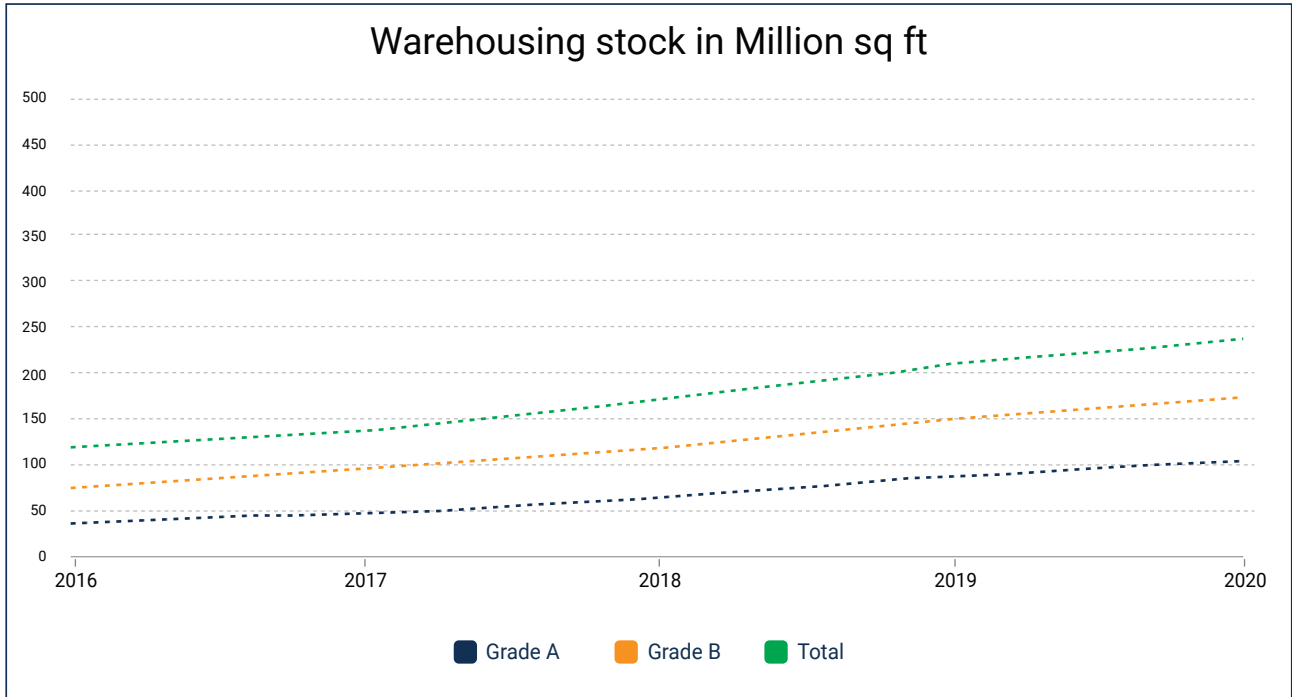
Opportunities

- Large scope for Organized players in Warehouse Space and Management.
- With the GST, consolidation of Warehousing at Strategic Locations.
- Large scope for Vertical Storage and Mechanization and Automation of Warehouses.
- Implementation of Pay-per-use kind of Models with Flexible spaces.

Opportunities

- Warehousing spaces created only with Fiscal considerations may not find takers.
- The rising Minimum wages are pushing up the cost of Warehousing.
- Lack of Formal education and Training in the Warehousing.
- Industries adopting more and more leaner practices and reducing the inventory in the system thus reducing Warehousing requirements.

Annexure III: Growth in warehousing space in India between 2016 – 2020



Source: JLL

Annexure IV: Analysis of the warehousing sector in India

Market	Total warehousing land (Acres)	Total warehousing FSI Potential in mn sq m (mn sq ft)	Existing Stock in mn sq m (mn sq ft)	Vacancy	Development potential in mn sq m (mn sq ft)	Development potential multiple
NCR	4,178	9.3 (100)	5.3 (57)	13.90%	4 (43)	1.75
Chennai	2,361	4.6 (49)	2.2 (24)	14.70%	2.3 (25)	2.02
Bengaluru	2,210	4.5 (48)	2.3 (25)	29.70%	2.1 ((33)	1.89
Pune	1,814	3.9 (42)	2.4 (26)	21.80%	1.5 (16)	1.61
Ahmedabad	1,587	3.4 (37)	1.7(18)	13.20%	1.8 (19)	2.09
Hyderabad	1,291	2.7 (29)	1.2(13)	22.40%	1.5 (16)	2.19
Kolkata	1,098	2.6 (28)	2(21)	20.60%	0.6 (6)	1.29
Total	21,163	46.5 (500)	28.3 (307)	15.50%	18 (193)	1.63

Source: Knight Frank Research

Annexure V: Classification of warehousing potential across India

Category	Characteristics	Locations
Frontrunners	<ul style="list-style-type: none"> Existing logistics hubs Primarily the major metros with a very large consumer base- Excellent connectivity High availability of skilled labour and managerial workforce 	NCR, Mumbai, Chennai, Bengaluru, Ahmedabad, Kolkata, Hyderabad, Pune
Challengers	<ul style="list-style-type: none"> Large cities and towns - connected by existing roads and to be better connected by new corridors Location of major infrastructure projects such as ports - mix of rural and urban consumers Target of consumer products and retail companies Growing pool of skilled, yet less costly workforce 	Surat, Vishakhapatnam, Nagpur, Chandigarh, Guwahati, Kochi
Newcomers	<ul style="list-style-type: none"> Mostly smaller cities and towns High availability of labor but low on managerial workforce Linked to infrastructure projects Promising because of large development initiatives Existing infrastructure is not very conducive to logistics 	Vijayawada, Coimbatore, Jamshedpur, Lucknow

Source: Miebach Research