CONNECTED TRANSACTIONS: EXPLORING THE PAYMENT CARD, IOT RFID, AND ESIM MARKETS

Innovations Driving Seamless Transactions and Intelligent Connectivity

Frost & Sullivan
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1. GLOBAL AND INDIAN ECONOMIC LANDSCAPE

1.1 Global Macro economic Outlook

The global economy in 2025 is steady but slow, with industrial and emerging market leadership balancing softness in mature economies. The IMF has moderately upgraded its 2025 growth forecast, citing resilience in the face of trade uncertainty and uneven macro conditions. Global real GDP growth is projected at 3.0% in 2025, up from 2.8% in April 2025, and is expected to reach 3.1% in 2026. Emerging and developing economies are forecasted to grow at 4.1% in 2025, moderating slightly to 4.0% in 2026.

While global growth remains below pre-pandemic norms, the upgrade reflects improved financial conditions, reduced tariff tensions, and fiscal support in select economies. Growth disparities persist—the strongest outlook is in Emerging Markets, especially China and India, while advanced economies remain sluggish. Policy uncertainty, trade disruptions, fiscal constraints, and geopolitical instability pose tangible downside risks to the baseline outlook. Despite modest upward revisions in global growth forecasts to 3.0% in 2025 and 3.1% in 2026, the recovery remains fragile and exposed to significant geopolitical and environmental headwinds.

Geopolitical conflicts, trade disputes, and tariff escalations are disrupting supply chains, dampening investment sentiment, and contributing to global economic fragmentation. Heightened U.S. - China trade frictions, regional conflicts in Eastern Europe and the Middle East, and rising defense expenditures have further strained fiscal resources and increased uncertainty across markets.

Simultaneously, environmental challenges—including the intensification of climate-related disasters such as floods, droughts, and wildfires—are imposing significant economic costs, especially on climate-vulnerable nations. These events are exacerbating food and energy price volatility, damaging infrastructure, and heightening fiscal pressures in emerging and low-income economies. The uneven pace of the green energy transition and inadequate climate adaptation investments add further risk to long-term global stability.

Together, these intertwined geopolitical and environmental pressures are amplifying inflationary risks, distorting trade and investment flows, and threatening to derail the fragile recovery. The IMF underscores the urgent need for coordinated global policies to strengthen resilience through climate adaptation financing, trade diversification, and conflict mitigation efforts to sustain economic stability.

Inflation continues to play a critical role in shaping global economic dynamics in 2025, even as headline rates moderate. While global inflation is projected to decline to 4.2% in 2025 (IMF), it remains above pre-pandemic levels in many economies, with uneven regional impacts. High inflation reduces real incomes, particularly in lower-income households, curbing consumer spending, which is a key driver of economic growth. Persistent food and energy price pressures disproportionately affect emerging markets and vulnerable populations. To control inflation, major central banks (e.g., U.S. Federal Reserve, ECB) have maintained tight monetary policies, including higher interest rates. This has raised borrowing costs globally, slowing investment, credit growth, and housing markets.

While the IMF expects inflation to gradually ease, sticky core inflation in major economies (e.g., U.S., Eurozone) keeps monetary policy restrictive. Emerging economies must balance inflation control with growth needs, as over-tightening risks deepening slowdowns. Structural factors—geopolitical

conflicts, climate shocks, and supply chain fragmentation—continue to inject inflationary pressures globally.

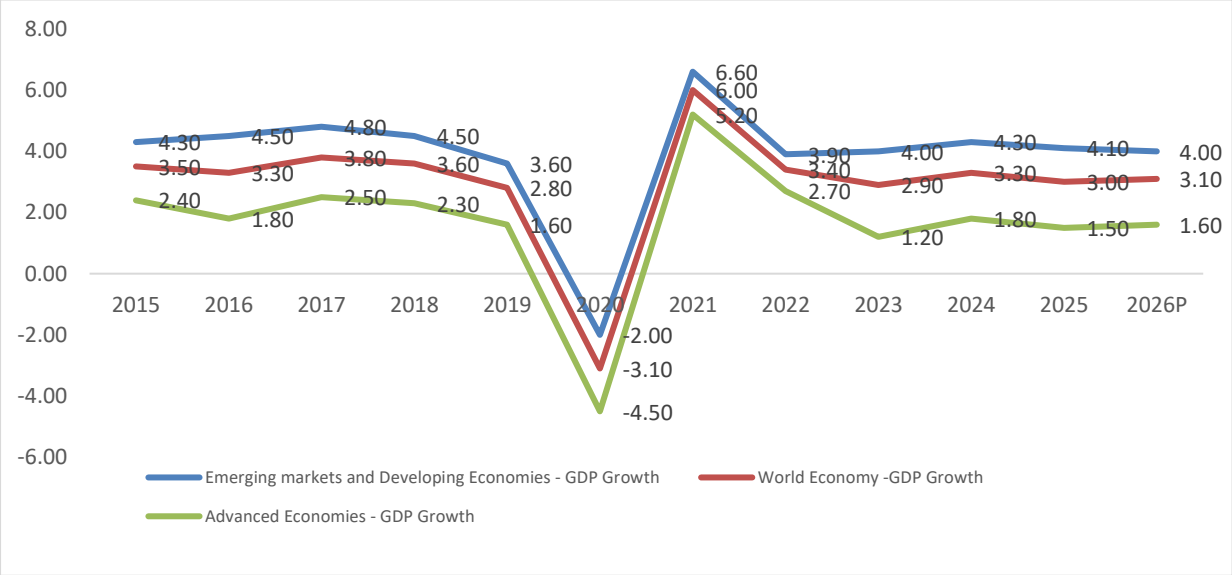
1.1.1 Global GDP Growth

The IMF's July 2025 growth forecast projects global GDP growth at 3.0% in 2025 (up from April 2025's projections of 2.8%) and 3.1% in 2026, supported by front-loaded trade activity, improved financial conditions, and fiscal support in key economies.

Global growth for 2024 had been approximately 3.3%, which the IMF notes is still stronger than the current year's projection but set the baseline for moderation into 2025

Advanced economies are expected to grow at 1.5% in 2025 and 1.6% in 2026, with the United States upgraded to 1.9% and 2.0% for 2025 & 2026, driven by tax stimulus and strong domestic demand, while the Euro Area is forecast at 1.0% and 1.2% amid easing energy pressures. Emerging and developing economies remain the primary growth engines, expanding 4.1% in 2025 and 4.0% in 2026, led by China (raised to 4.8% in 2025, moderating to ~4.2% in 2026) and India, the fastest-growing major economy, at 6.4% in both years on robust domestic demand and infrastructure investment.

Exhibit 1: Global GDP Growth, CY 2015-26 (in %)



Note: Advanced economies include regions such as United States, Germany, France, Italy, Spain, Japan, United Kingdom
Emerging economies include regions such as China, India, ASEAN-5, Russia, Brazil, Mexico, Saudi Arabia, Nigeria, South Africa
Source: IMF, World Economic Outlook (WEO), July 2025

Global inflation is expected to ease to 4.2% in 2025 and 3.6% in 2026, though it remains above pre-pandemic levels, while global trade growth is forecast at 2.6% in 2025, before slowing to 1.9% in 2026 amid tariff uncertainty and fragmentation. The IMF cautions that risks from geopolitical tensions, trade disputes, climate-related disruptions, and persistent core inflation could undermine this fragile recovery, highlighting the need for coordinated policies to support stability and resilience.

Advanced economies : The IMF's latest update signals slightly improved prospects for advanced economies, but growth remains modest and well below pre-pandemic averages. As part of its World Economic Outlook Update, the IMF projects growth for advanced economies to reach 1.5% in 2025

and 1.6% in 2026. This represents a modest upgrade of 0.1% point for each year compared to the April 2025 forecast, reflecting a broadly positive but fragile economic environment. For United States growth rates is forecasted to reach 1.9% in 2025 and 2.0% in 2026, up from projections made in April 2025. The revisions are supported by lower-than-expected tariffs, improved financial conditions, currency depreciation, and fiscal stimulus through U.S. tax reforms (One Big Beautiful Bill Act, or OBBBA), estimated to raise output by ~0.5% through 2030. For Euro Area, growth rate has been revised upward to 1.0% growth in 2025 (0.2 % higher than estimates published in April, 2025), and further to 1.2% in 2026. The higher 2025 forecast is largely attributable to a spike in Irish pharmaceutical exports driven by trade front-loading, though Ireland constitutes under 5% of eurozone GDP. For other Advanced Economies (excluding U.S. & Eurozone), growth rates are projected at 1.6% in 2025, rising to 2.1% in 2026. The slower 2025 pace is attributed to currency appreciation and selective tariff hikes (e.g. on autos and steel), though financial conditions remain broadly favorable. Example: South Korea (IMF downgraded its 2025 growth forecast for South Korea to 0.8% which is a 0.2% cut from April, 2025 estimates), but raised its 2026 outlook to 1.8%.

Emerging and developing economies: The IMF projects growth rate of 4.1% in 2025, easing slightly to 4.0% in 2026 for emerging market and developing economies, marking an upward revision from its earlier estimates of 3.7% for 2025. China's growth was upgraded to 4.8% in 2025, down slightly to ~4.2% in 2026, reflecting stronger-than-expected early 2025 activity and a significant reduction in U.S.–China tariffs. India remains the fastest-growing major economy, with 6.4% growth in both CY2025 and CY2026, revised upwards in light of more favorable external conditions. While the forecasts reflect underlying resilience, growth momentum among emerging economies is partly driven by front-loaded trade activity ahead of tariff hikes, which may fade by late 2025. Continued policy uncertainty, tariff volatility, geopolitical friction, and climate-related shocks remain key downside risks, particularly for developing economies with limited fiscal buffers.

Emerging and developing economies continue to be the global growth engine, with a solid baseline forecast of 4.1% in 2025. Gains in the forecast reflect improved external conditions, particularly in China and India. However, much of the near-term resilience stems from shifted trade timing and temporary fiscal or monetary support. As these effects dissipate, these economies may face headwinds from evolving trade policies, fiscal constraints, and environmental or geopolitical disruptions.

U.S. trade tariffs and related uncertainties pose significant threats to global trade and growth. The U.S. has implemented tariffs on selected imports (steel, autos, select electronics) while partially easing others (notably on China), creating volatility in global supply chains. Recent front-loading of imports—as businesses accelerated purchases ahead of scheduled tariff hikes—provided a temporary boost to trade volumes in early 2025 but is expected to fade in H2 2025. The IMF warns that potential tariff escalations or reversals of recent rollbacks could significantly disrupt global trade flows.

While recent partial tariff rollbacks, particularly on China, have provided some short-term relief, selective tariffs on steel, autos, and electronics continue to disrupt supply chains and elevate costs. The front-loading of imports ahead of scheduled tariff hikes temporarily boosted trade volumes in early 2025 but is expected to fade in the second half of the year. Global trade growth has been revised to 2.6% in 2025, slowing to 1.9% in 2026, as tariff-related distortions, supply chain fragmentation, and weaker demand take hold. Persistent uncertainty surrounding U.S. trade policy is dampening cross-border investment, prompting businesses to diversify suppliers and contributing to inflationary

pressures. The IMF warns that further tariff escalation or retaliatory measures by major trading partners such as the EU and China could intensify trade fragmentation and undermine the fragile recovery, emphasizing the urgent need for stable, rules-based trade policies and strengthened multilateral cooperation.

Impact on Global Trade: The IMF revised global trade growth to 2.6% in 2025, slowing to 1.9% in 2026 due to tariff-related distortions and weaker global demand. This is also causing "Supply Chain Fragmentation" as tariff volatility is forcing businesses to diversify suppliers and increase costs, contributing to inflationary pressures. The depreciation of the U.S. dollar (~8% in 2025) has temporarily offset some tariff impacts but also altered trade competitiveness globally.

Risks to global economy: Escalation of U.S. tariffs (particularly after August 2025) could reduce global trade volumes and investment confidence. Retaliatory measures by major partners (e.g., EU, China) risk worsening trade fragmentation. This persistent uncertainty is dampening cross-border investment and complicating global supply chain planning.

1.1.2 GDP growth rate of Key Select Economies, and factors affecting them

The ongoing U.S.-China geopolitical and economic competition remains the most significant global risk in 2025. Despite partial tariff rollbacks earlier in the year, persistent uncertainty surrounding U.S. trade policy continues to disrupt global trade flows and strain supply chains. The tech decoupling, driven by U.S. export controls on semiconductors and AI technologies, has intensified China's efforts toward technological self-sufficiency, further fragmenting global innovation networks. Meanwhile, geopolitical alliances are deepening polarization, with the U.S. advancing its Indo-Pacific strategies and China expanding its Belt and Road Initiative (BRI), compelling other economies to navigate an increasingly divided global landscape.

Russia-Ukraine Conflict and European Security Risks

The Russia-Ukraine war continues to strain Europe's energy markets, disrupt agricultural exports such as grain and fertilizer, and impose heavy fiscal burdens related to defense and humanitarian aid. Despite efforts to diversify away from Russian gas, energy price volatility persists, undermining industrial competitiveness and fueling inflation. At the same time, rising defense spending across NATO countries is diverting resources from social programs and long-term investments, further complicating the region's economic stability and growth prospects.

Middle East Instability : Ongoing tensions involving Iran, Israel, and Gulf states, as well as proxy conflicts, pose risks to global oil markets and maritime trade routes (e.g., the Strait of Hormuz, Red Sea disruptions). Attacks on shipping and regional escalations threaten to raise energy prices and disrupt supply chains, feeding inflation and weakening trade flows globally.

Global Trade Fragmentation : Geopolitical rivalry is driving "friendshoring" and reshoring, leading to parallel trade blocs (U.S.-aligned vs. China-aligned) and reduced efficiency in global value chains. WTO's weakened role limits dispute resolution, and rising protectionism (tariffs, subsidies) further impedes multilateral trade. The IMF estimates trade fragmentation could shave 1.5% off long-term global GDP if current trends persist.

Geopolitical Competition in Technology & Resources : Control over critical minerals (lithium, cobalt, rare earths) needed for green energy and high-tech manufacturing has sparked geopolitical contestation in Africa, South America, and Asia. Competition for dominance in AI, quantum

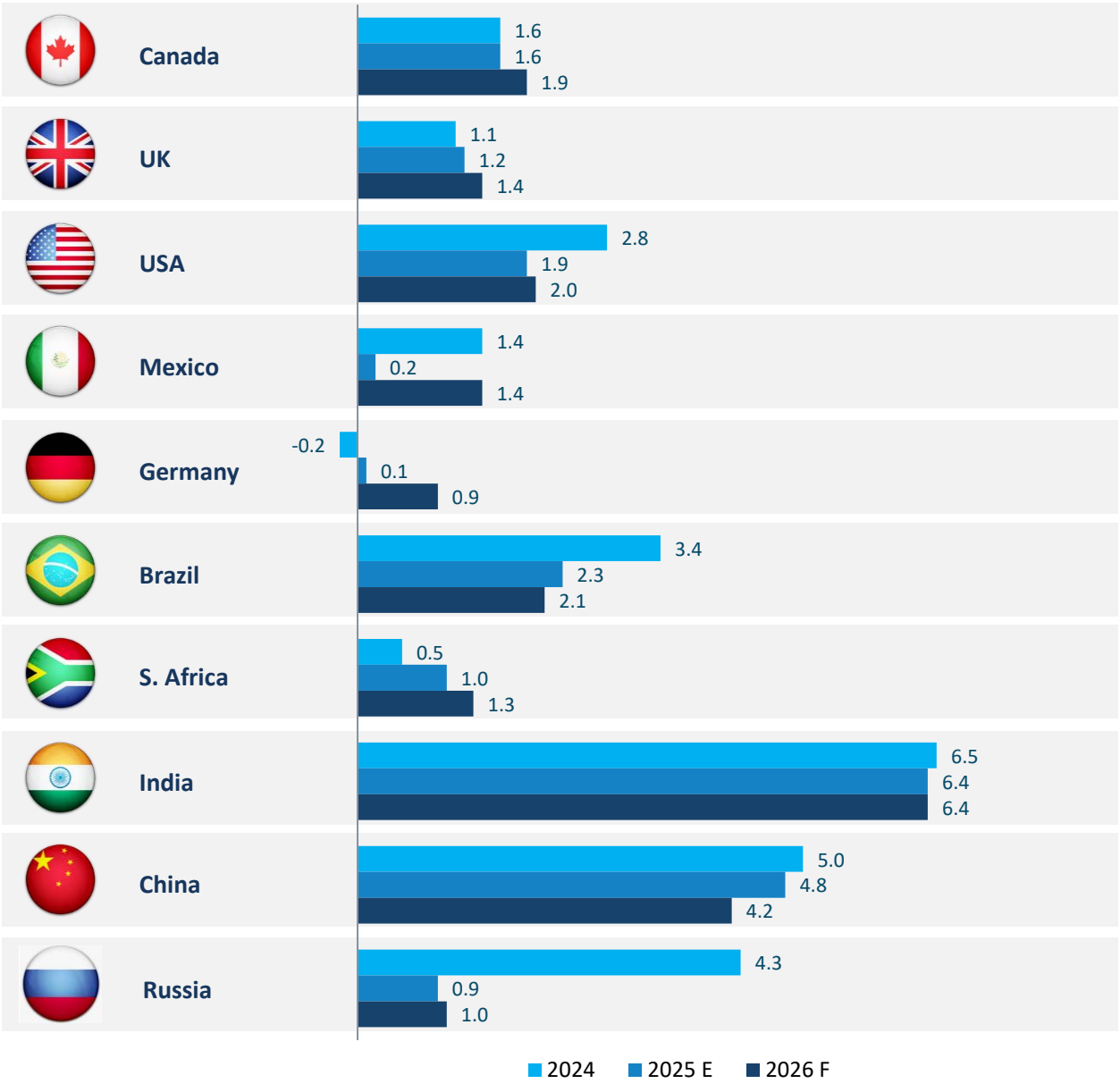
computing, and cybersecurity is intensifying economic nationalism and curbing international collaboration.

Global South* Political and Debt Crisis : Many developing economies face debt distress, exacerbated by tighter global monetary conditions and reliance on external financing. Political instability in parts of Africa, Latin America, and Southeast Asia, often linked to resource nationalism or governance crises, further undermines investor confidence.

*(*Global South refers to a group of developing and emerging economies across Africa, Latin America, parts of Asia, and Oceania)*

The IMF emphasizes that geopolitical tensions are now a core structural risk to the global economy, intertwined with trade fragmentation, technology decoupling, and climate policy. Without coordinated frameworks, these risks could lead to slower global growth (3.0% in 2025) and heightened financial instability. The IMF urges multilateral cooperation, renewed WTO engagement, and targeted support for emerging markets to cushion the economic fallout.

Exhibit 2: GDP Growth, Key Countries, Global (CY 2024, CY 2025E, CY 2026F)



Note: GDP Growth rates are expressed in percentage;
SOURCE: IMF, July, 2025 World Economic Report E- Estimates. F- Forecast

The economic data reflects a spectrum of trends across nations. Australia has maintained moderate growth, stabilizing through 2024–2025 amid steady domestic demand and commodity exports. Brazil has shown steady expansion, supported by agriculture and services, though structural reforms remain essential to sustain momentum. India continues to be one of the fastest-growing major economies, sustaining robust growth of 6.4%, driven by strong domestic consumption and investment. Ireland, after its exceptional growth earlier in the decade, has moderated to more sustainable levels in line with broader Euro Area trends. The United Kingdom has exhibited gradual improvement, with growth projected at 1.1–1.4%, constrained by post-Brexit trade frictions and subdued investment. The United States has maintained positive growth, easing from 2.8% in 2024 to 1.9% in 2025, reflecting tighter monetary policy and cooling domestic demand. These trends underscore the varying pace of recovery across economies and the influence of structural, policy, and external factors on their growth trajectories.

1.1.3 Impact of Emerging Technologies on the World Economy

Emerging technologies are significantly reshaping the world economy by driving productivity, transforming industries, creating new markets, and influencing labor dynamics. The IMF highlights that emerging technologies are becoming a central driver of global economic transformation, influencing productivity, trade, labor markets, and investment patterns. Advances in AI, automation, and digital platforms are significantly improving efficiency across industries, reducing costs, and creating new markets. Generative AI and advanced analytics are reshaping services and knowledge work, while blockchain, fintech innovations, and digital payments are accelerating the shift toward cashless economies and improving financial inclusion.

In manufacturing and trade, automation, robotics, and 3D printing are transforming global value chains by reducing dependence on low-cost labor markets and promoting regionalized production. Meanwhile, green technologies, including renewable energy, electric vehicles, and energy storage solutions, are driving sustainable investment and reshaping energy markets in response to climate imperatives.

Labor markets are undergoing profound changes as automation displaces routine tasks while creating demand for high-skill digital roles, particularly in emerging economies integrating into the global digital economy. This is fueling a need for widespread reskilling initiatives to prevent widening inequality between digitally advanced economies and those lagging behind.

Furthermore, technological leadership has become a geopolitical determinant, with competition in AI, semiconductors, and green tech influencing trade flows and investment priorities, particularly between the U.S. and China. While emerging technologies are projected to add over $15 trillion to global GDP by 2030, the benefits remain unevenly distributed, emphasizing the importance of digital infrastructure investment, policy support, and international cooperation to ensure inclusive growth in this rapidly evolving landscape.

Some of the key areas where the emerging technologies impact the world are :

Boosting Productivity and Efficiency : AI and Automation streamline manufacturing, logistics, and services, reducing costs and increasing efficiency across sectors. Generative AI is transforming knowledge work (finance, healthcare, legal services), boosting output while reducing routine tasks.

Driving Innovation and New Markets : Technologies like blockchain, quantum computing, and IoT are creating new industries (e.g., Web3, autonomous logistics) and revenue streams. Digital platforms have enabled global e-commerce, fintech, and decentralized finance, broadening access to financial and business services.

Labor Market Transformation : AI-driven automation is displacing routine jobs but creating demand for high-skill roles in tech development, cybersecurity, and data science. There is an increased focus on reskilling and upskilling, especially in emerging economies integrating into the digital economy.

Impact on Trade and Global Value Chains : Advanced manufacturing (3D printing, robotics) reduces reliance on low-cost labor markets, reshaping global supply chains. Digital trade and cross-border data flows are now key components of international trade, making technology a driver of globalization.

Financial Sector and Digital Payments : Fintech, CBDCs (Central Bank Digital Currencies), and blockchain-based systems are redefining payment infrastructure and improving financial inclusion. This shift accelerates the transition toward cashless economies, impacting monetary policy and regulatory frameworks.

Geopolitical and Economic Competition : Technological leadership has become a strategic driver of geopolitical power, with U.S.-China competition in AI, semiconductors, and green tech influencing global trade and investment patterns.

Sustainability and Green Technology : Renewable energy technologies, EVs, and energy storage are reshaping energy markets, reducing fossil fuel dependence, and driving climate-related investment. Climate tech is projected to be a multi-trillion-dollar sector by 2030, aligning sustainability goals with economic growth.

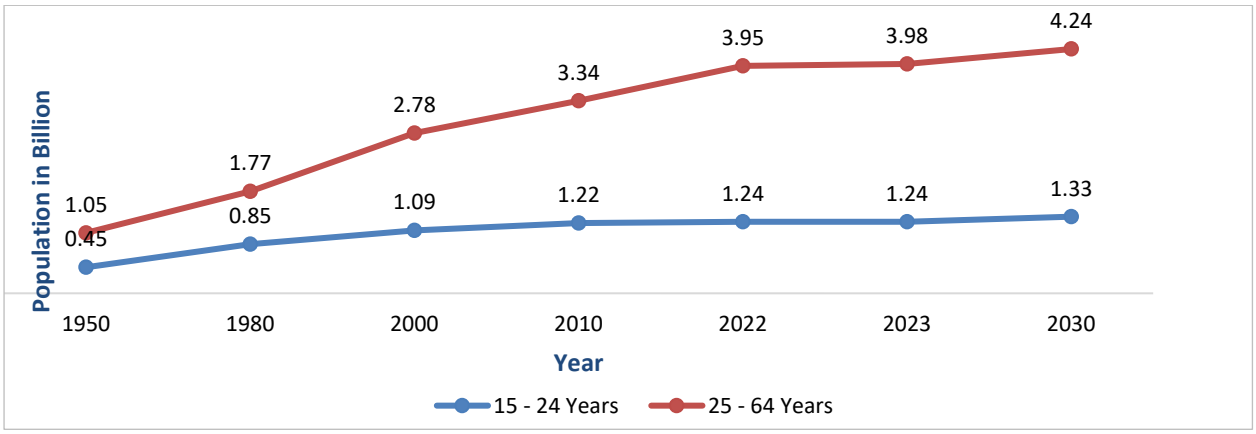
1.1.4 Key Macroeconomic Growth Drivers for Global Economy with specific focus on India

Rising Young Population:

According to United Nations, there are approximately 1.24 billion people globally aged 15-24 years old (CY2023), representing roughly 15% of the total population. An estimated 40% of the global population falls under the age of 25, highlighting the significant size of the younger generation. Due to income limits, the growing population of young people has a tendency towards financial restraint.

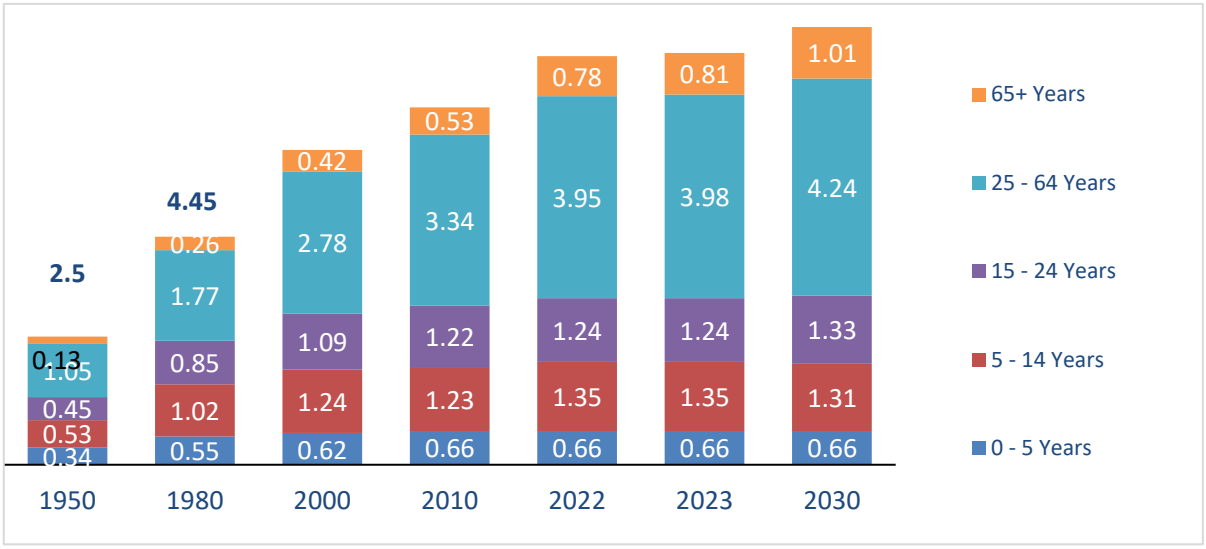
However, estimates show that by 2030, both its sizable population and per capita spending are expected to experience significant rise. With 1.2 billion members worldwide, the youth demographic is the largest generation in history and offers prospects for both labour supply and consumer demand.

Exhibit 3: Global Young Population, CY 1950-2030, In Billion



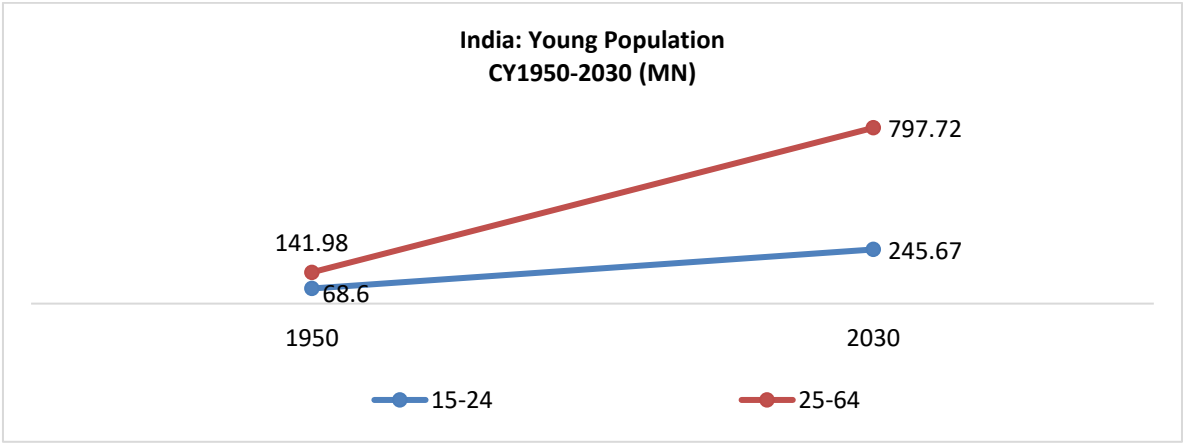
Source: Frost & Sullivan Analysis, ourworldindata.org

Exhibit 4: Global Population Age Structure, CY 1950-2030, In Billion



Source: Frost & Sullivan Analysis, ourworldindata.org

Exhibit 5: Rising Young Population, CY 1950-2030 (MN), India

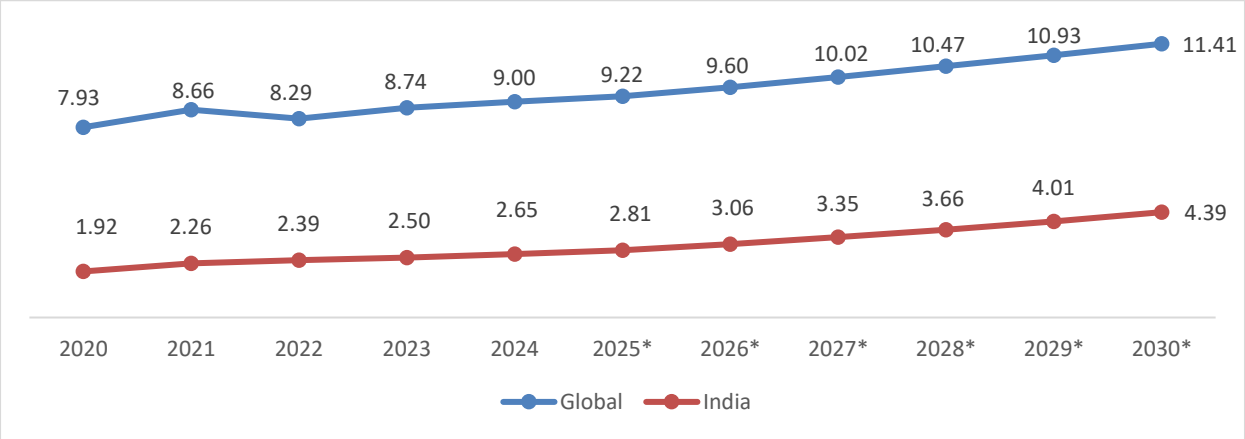


Source: Frost & Sullivan Analysis

The chart shows India's young and working-age populations expanding sharply from 1950 to 2030: ages 15–24 rise from ~69mn to ~246mn (~3.6×), while age group 25–64 jump from ~142mn to ~798mn (~5.6×). This bulge suggests a prolonged demographic dividend, larger labor force and consumption—yet heightens pressure on jobs, skilling, and urban infrastructure.

Growing Global Disposable Income:

Exhibit 6: Worldwide & India annual disposable income (per capita), CY2020-2030 (In '000s USD)



** Forecasted*
Source: Statista Market Insights, World Bank, OECD, Eurostat, World Bank PovcalNet, WID - World Inequality Database

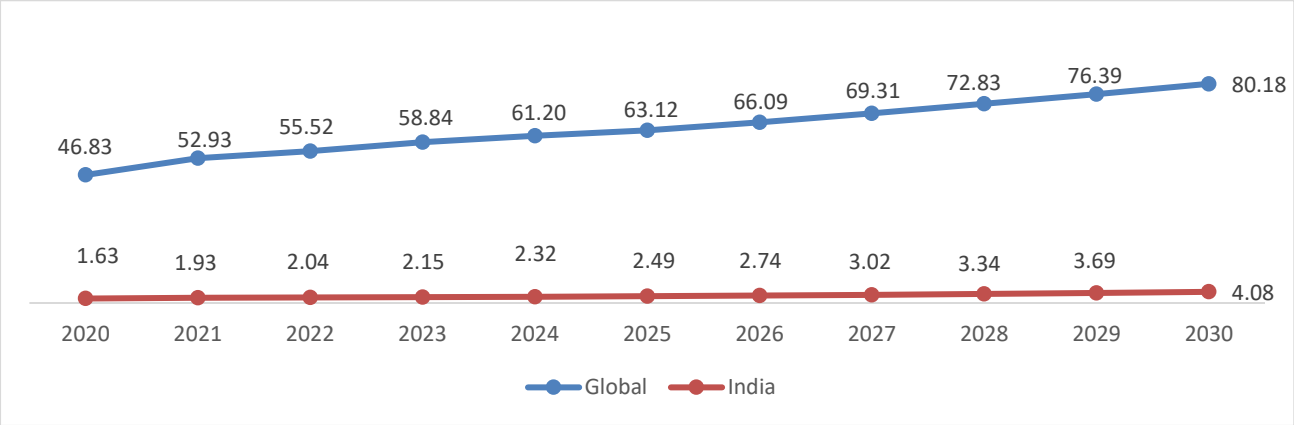
The information illustrates a steady rise in global annual disposable income between 2020 and 2030, climbing from USD 7.93 thousand to 11.41 thousand. Disposable income significantly influences the extent to which individuals and households allocate funds for different buckets of expenses. Increase in global per capita income growth has significantly increased consumer demand, especially in emerging economies.

India's per-capita disposable income more than doubles from US$ 1.9k in 2020 to US$ 4.4k by 2030—implying 8–9% CAGR in USD terms. The gap with the global average remains wide (global US$ 11.4k by 2030), but India's growth slope is steeper, signaling strong consumption tailwinds and a rapidly expanding middle class if inflation stays contained and job creation holds up.

Growing Global Consumer Spend

Worldwide Consumer Spending has witnessed an increasing trend from USD 58.84 trillion in 2023 to reach USD 80.18 trillion in 2030. India's share of global spend climbs from **3.5%** to **5.1%** by 2030 and contributes **7%** of the world's incremental consumption over the decade. India offers outsize growth versus global averages, reflecting deepening middle-class demand and a widening addressable market.

Exhibit 7: Global & India Consumer Spending across select economies, CY 2020-30, USD Trillion



Source: Statista Market Insights, World Bank, IMF, UN, Eurostat

Consumer spending is a significant driver of economic growth. As consumer confidence rises and household incomes increase, individuals are more likely to spend on goods and services, stimulating demand and driving economic activity across various sectors.

Recent U.S. Trade Tariff

In 2025, the U.S. government instituted sweeping trade tariff hikes affecting a wide spectrum of trading partners—most notably Canada, China, Mexico, India, Brazil, and Switzerland.

- Tariff levels surged—from a baseline of approximately 2.5% in early 2025 to nearly 20% on average across all imports.
- Specific tariffs reached up to 50%, targeting goods such as cars, clothing, coffee, and toys.
- Additional hikes included tariffs of 35% on Canadian goods, 39% on imports from Switzerland, and a staged rise to 50% on Indian goods by late August.
- A special 25% tariff was imposed in March as part of Executive Order 14245, targeting goods from any country importing Venezuelan oil.
- The "Liberation Day" tariff rollout in early April prompted immediate market turbulence, signaling real economic and investor anxiety.

These measures mark the highest average U.S. tariff rates in decades and reflect an aggressive trade policy shift. Key impacts of these Tariff Hikes

- **Inflation and Consumer Prices:** Despite the high tariff rates (averaging ~18.6%), overall inflation has remained moderate, with headline inflation around 2.7%, though core inflation—excluding volatile food and energy—has climbed to 3.1%, the highest in several years. Tariff hikes are already causing noticeable price increases in consumer essentials—leather goods (+39%), clothing (+37%), and new car prices rising by up to 12%.
  The average American household is estimated to face an annual financial burden of roughly $2,400 due to these tariffs.
- **Market Reactions and Retail Behavior:** The April tariff announcements triggered a sharp global stock market crash—one of the largest since the pandemic era—though markets rebounded after temporary suspensions. Businesses responded by front-loading imports ahead of tariff

implementation—spiking cargo volumes in early 2025, though projections now indicate declines later in the year.

- **Strategic Adjustments and Legal Challenges:** Certain tariffs were paused or scaled back amidst high-level negotiations, including an agreement keeping U.S.–China tariffs at around 30%, averting even higher increases set to exceed 100%. Legal challenges are mounting: a federal court ruled that some tariffs ("Liberation Day" measures) exceed presidential authority, issuing a permanent injunction against their enforcement.

Recent U.S. trade policy has undergone a dramatic shift, with tariff rates increasing sharply across industries and trade partners. While headline inflation remains contained, consumer prices for many goods are rising. Financial markets reacted with volatility, and legal and diplomatic responses are already in motion.

Impact of US Trade Tariffs on India's BFSI Sector

Overall Impact on the BFSI Sector

The United States has recently imposed steep trade tariffs on Indian exports, raising the effective tariff rate to 50%. This escalation has stoked concerns, but India's economy is largely domestic-driven, which buffers the broader BFSI (banking, financial services, insurance) sector from severe direct shocks. Even if high tariffs persist, analysts estimate the drag on India's GDP growth would be modest (around 0.4–0.8 percentage points over a year). Nevertheless, prolonged tariffs could dampen business sentiment and credit growth somewhat, warranting vigilance in the financial sector.

Impact on the Banking Sector

- **Limited Direct Exposure:** Indian banks have minimal direct exposure to U.S. tariffs, as their business is predominantly domestic and major export sectors (like IT services and pharmaceuticals) are largely exempt from the new duties. Accordingly, it's expected that there will only be a limited impact on banks given India's domestic demand-driven economy.

- **Indirect Risks:** The bigger concern is indirect. Steep tariffs can hurt export-focused industries (e.g. textiles and gems & jewellery), potentially softening credit demand and straining loan repayments in those sectors. Lenders are closely monitoring these vulnerable portfolios in sectors with high U.S. exposure to detect early stress.

- **Mitigation Measures:** To mitigate stress on exporters, banks have offered relief like temporary interest rate cuts, fee waivers, and extra working capital to ease cash flows. They are also guiding clients to diversify into alternative markets and hedge currency volatility to reduce reliance on U.S. trade.

- **Potential Upside:** The trade rift may even carry a silver lining for banks. As global manufacturers relocate production to India to bypass U.S. tariffs, banks anticipate new **financing opportunities** to support these investments and supply-chain shifts.

Impact on the Insurance Sector

- **Higher Premiums & Claims:** Marine cargo and trade credit insurers face higher exposure, as a 50% tariff inflates shipment values and raises the insured value per policy. This translates to costlier coverage (higher premiums) and potentially larger claims if goods are damaged or buyers default.
- **Profitability Pressures:** Property and auto insurers may also feel strain if export-reliant firms incur losses, which could force premium hikes or stricter coverage terms. Meanwhile, market volatility from the trade dispute could erode insurers' investment income, creating a dual impact on profitability – higher claims exposure alongside lower returns.

Impact on NBFCs

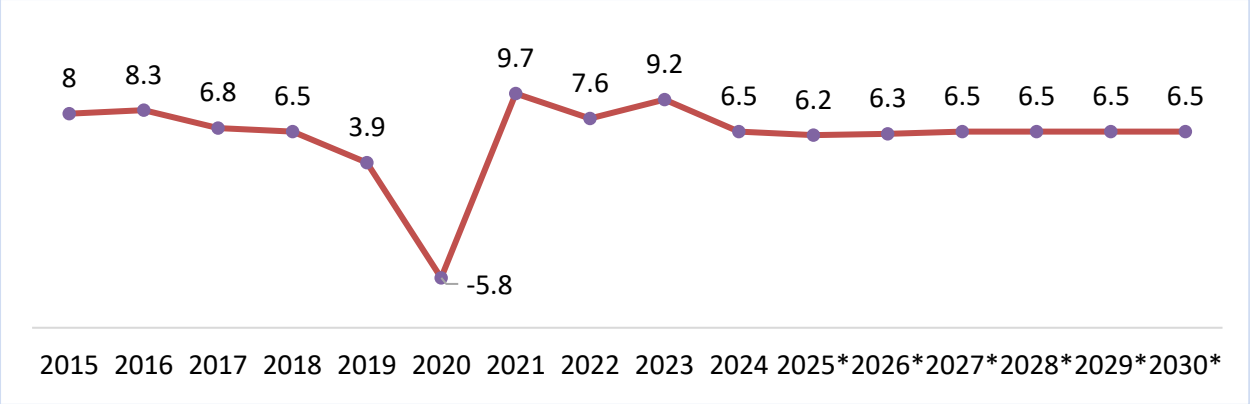
- **Domestic-Focused NBFCs:** Non-bank financial companies serving the domestic market are expected to be largely insulated from U.S. tariffs, as India's robust internal demand continues to drive growth. NBFCs focused on retail loans or purely local industries should see little direct effect from the trade measures.
- **Export-Focused NBFCs:** However, NBFCs that finance export-oriented small/mid-sized firms could face headwinds. With tariff-hit sectors seeing reduced orders and thinner margins, these lenders may experience slower loan growth and rising default risks in their portfolios. Analysts caution that trade-exposed NBFCs might see deteriorating asset quality until U.S.-India trade tensions ease.

1.3 India's Economic Snapshot: A Comprehensive Analysis

India is on track to become the world's third-largest economy by 2027, overtaking Japan and Germany. This goal requires maintaining a growth rate of about 6.3% until then. The country's longer-term vision is to achieve developed economy status by 2047, which would necessitate even higher growth rates of around 10%.

The engine driving India's economic expansion is robust domestic demand, fuelled by a growing consumer base, rising incomes, and a large, ambitious youth population. The MSME sector is expected to play a vital role in this growth, contributing to income generation, innovation, and job creation, particularly in rural areas, thus ensuring widespread economic benefits.

Exhibit 8: Indian Real GDP Growth (%) (2015 – 2030F)



** Forecasted*
Source: IMF, July 2025

1.3.1 India's Demographic Shift: Evolving Income Levels and Age Structure:

Demographic trends in India - Rising Middle Class Income Levels

Over the next ten years, India is set to experience significant growth in its middle-class population, which will drive up consumer demand and expenditure. Projections for the year 2030 indicate that the upper middle class will represent 43.5% of the population, while the lower middle class will account for 34.2%. This demographic shift is expected to have a substantial impact on India's economic landscape, reshaping consumption patterns and market dynamics.

Exhibit 9: Share of Households by income Group, India, CY 2005, CY 2018, and CY 2030P

	2005	2018	2030
Annual Income and Income Grouping	219 million households	293 million households	386 million households
Above $40,000 (Rs. 3.3 million) High income	High 0.5%	High 2.7%	High 7.5%
$8,500-$40,000 (Rs. 705.5 thousand - Rs. 3.3 million) Upper middle income	Upper Mid 7.5%	Upper Mid 20.8%	Upper Mid 43.5%
$4,000-$8,500 (Rs. 332 - Rs. 595.5 thousand) Lower middle income	Lower Mid 23.3%	Lower Mid 33.1%	Lower Mid 34.2%
Below $4,000 (Rs. 332 thousand) Low income	Low 68.9%	Low 43.3%	Low 14.8%

Note: The exchange rate is 1 US Dollar = 83 INR Rupees; CY2030 is Projected
Source: Frost & Sullivan, Secondary Sources

1.3.2 Increase in Working-Age Population:

Unlike China's declining trend, India's working-age population is expected to grow from 2018 to 2030. The country is experiencing a demographic transition, with a large proportion of young people. India adds about 12 million individuals to its workforce each year, leading to projections that the working-age population will increase from 66.8% in 2018 to 67.8% in 2022, and further to 68.4% by 2030.

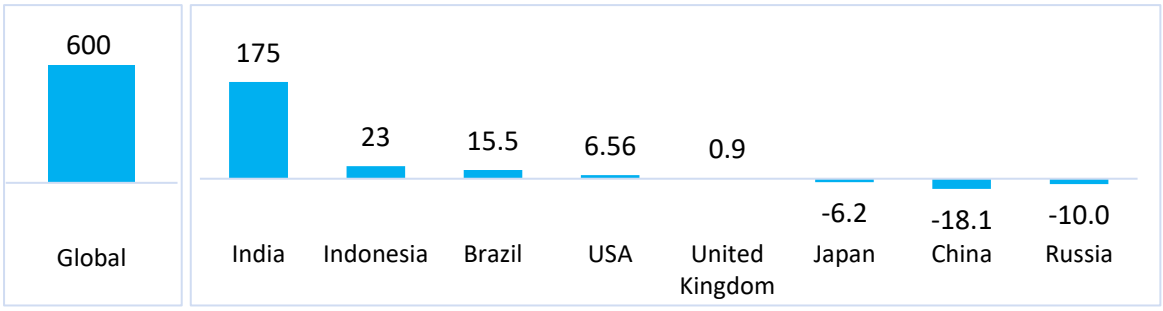
Exhibit 10: Population age structure analysis, India, CY 2005-2030P (%)

	2005	2018	2022	2030
0-14 Years of Age (Children)	32.73%	27.05%	25.31%	23.01%
15-64 Years of Age (Working Age)	62.53%	66.77%	67.79%	68.40%
65 and Above (Elderly)	4.74%	6.18%	6.90%	8.59%
Country Population	1.15 Billion	1.37 Billion	1.42 Billion	1.51 Billion

Source: Frost & Sullivan, Secondary Sources; CY2030 is Projected

India's working-age population is projected to expand both in share and size from 2015 to 2030, contrasting with China's shrinking trend. Within this 15-64 age bracket, the 35-64 subgroup in India will see an increase in its proportion, while other age groups will decrease. This growing working-age population suggests a potential rise in savings and tax revenue, which could fund nationwide investments.

Exhibit 11: Expected Addition to working age population (25 years – 64 years) in millions, Global and across select economies, 2015 – 2030



Source: IMF, World Bank

India has the highest addition in the working age population segment with an estimated 175 million people to be added between 2015 and 2030. India is currently in a stage of demographic

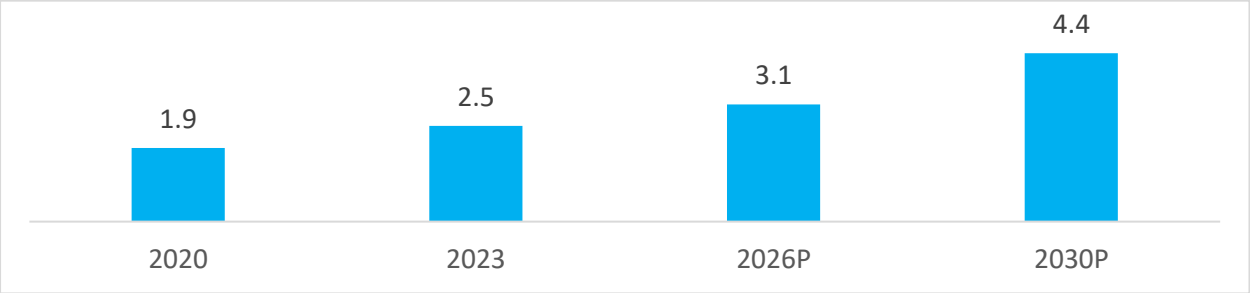
Transition. The proportion of the working-age population is expected to increase by about 600 million globally. India is adding an average of 12 million people to the working population each year

1.3.3 Increasing annual disposable Income:

As income levels rise in India, people's purchasing power and disposable income also rise, which has a direct effect on consumer spending habits. The relationship between rising income levels and consumer spending highlights how crucial income growth is to India's consumer-driven economy by boosting demand and stimulating economic activity.

India is expected to more than double its annual disposable income per capita from USD 1.9 thousand in 2020 to USD 4.4 in 2030.

Exhibit 12: India annual disposable income - per capita. (In USD thousands), FY2019-2030P



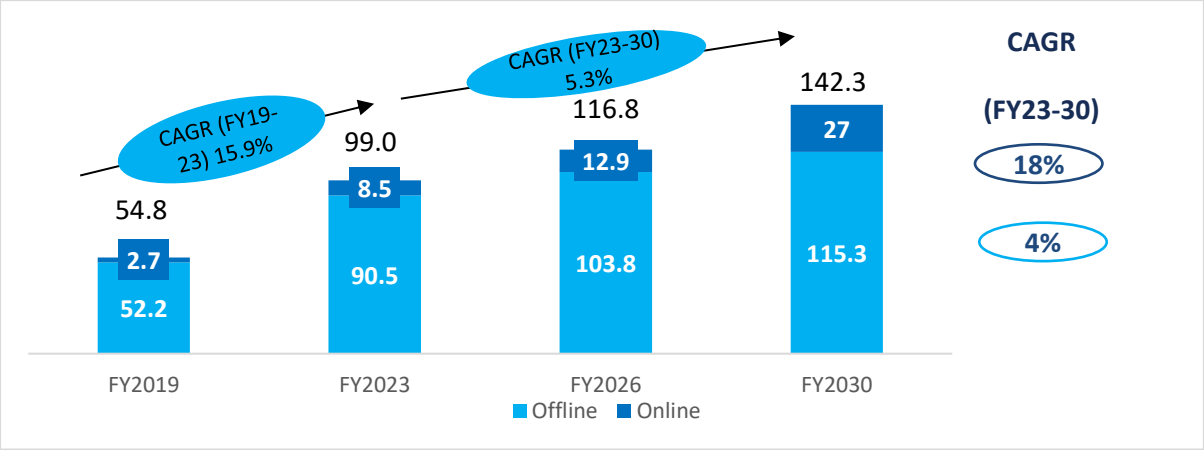
Source: Statista Market Insights, World Bank, OECD, Eurostat, World Bank PovcalNet, WID - World Inequality Database; Trading economics
Note: FY2026 & FY2030 is Projected

Rising middle-class incomes, an increasing working-age population, and higher disposable income significantly enhance the uptake of financial services and tools. As more individuals enter the middle class, they typically seek better financial products, including savings accounts, credit cards, and investment options, to manage and grow their wealth. A growing working-age population translates into more earners with greater purchasing power, leading to increased demand for credit and consumer loans for major purchases. Additionally, higher disposable incomes enable consumers to explore a wider range of financial services, including insurance, retirement planning, and digital payment solutions, driving financial institutions to innovate and expand their offerings to meet these evolving needs.

1.4 Retail Expansion in India: Chain Store Growth

The Indian retail market is the fourth largest retail market globally and one of the fastest growing. India's retail industry on track to be worth a staggering INR 142.3 trillion by the year 2030, growing at a CAGR of 5.3% in the FY23-FY30 period.

Exhibit 13: Retail Market in India (INR Trn), FY2019-FY2030, Split by Offline / Online



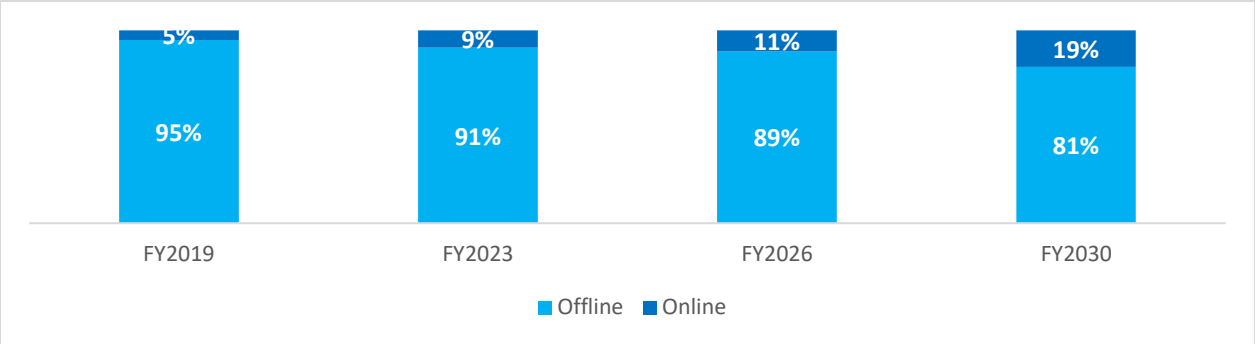
Source: Frost & Sullivan Analysis
Note: FY2026-2030 is Forecasted

A growing middle class, rising disposable incomes, and an expanding urban population are fueling demand for consumer goods and lifestyle products. Rapid digitization and increased internet penetration have also boosted e-commerce growth, while organized retail is expanding with the entry of global players and the rise of large domestic retail chains. Additionally, the youth population and their preference for convenience, coupled with innovations like quick commerce and digital payments, are transforming the shopping experience and driving retail expansion across the country.

1.4.1 Increasing Share of Online in Indian Retail Market:

The share of online retail in the Indian retail market has been rapidly increasing, driven by factors such as rising internet penetration, the growth of digital payments, and changing consumer preferences toward convenience and speed. With more than 850 million internet users, India's e-commerce sector has seen exponential growth, with online retail projected to account for nearly 19% of total Indian retail sales by 2030, up from 5% in 2019.

Exhibit 14: Increasing Share of Online in Indian Retail Market (%), FY2019-FY2030



Source: Frost & Sullivan
Note: FY2026-2030 is Projected

The online retail market is projected to grow from INR 8.5 trillion in FY2023 to INR 27 trillion by FY2030, growing at a CAGR of 18% in the FY2023-2030 period.

Major e-commerce platforms like Amazon, Flipkart, and Reliance JioMart are playing a key role in expanding online retail, offering consumers access to a wide range of products at competitive prices. The COVID-19 pandemic accelerated this shift, with more consumers opting for online shopping for essentials, fashion, electronics, and groceries.

The rise of quick commerce in India represents a significant shift in the retail landscape, driven by the increasing demand for fast delivery of groceries and everyday essentials. Quick commerce, which focuses on delivering goods to consumers within a very short time frame—often within 30 minutes—has gained traction due to the rapid growth of digital penetration and changing consumer behavior. Prominent players in this space include **Blinkit**, Zepto and Swiggy Instamart. This surge in quick commerce not only reflects the changing preferences for immediate gratification but also signifies the potential for significant growth in the Indian retail market, as businesses adapt to meet the evolving needs of consumers

1.5 India as a new power center in Manufacturing

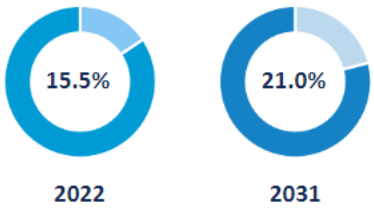
India is quickly emerging as a new power center in the manufacturing world. Owing to its demographic advantage, rapid urbanization, digital transformation, growing middle class, strong economic reforms, strategic geopolitical position, and green energy revolution, it is expected to become a leading global economy during this decade. According to the International Monetary Fund (IMF), India grew 6.5% in 2024 and continue to be one of the fastest-growing economies. Having been a service economy (for the most part) for decades, the country's manufacturing landscape is indicating an upheaval. Aided by a stable political climate and a proactive industrial policy, India is showing all the signs of becoming a major manufacturing alternative to China during the next decade. Global supply chain fragility and an unstable geopolitical situation in the West give India a competitive advantage, which will advance manufacturing development in the country.

Transforming Mega Trend

Dynamic shifts in global geopolitics, such as China's growing influence, the conflict in Ukraine, the fragile nature of global supply chains evidenced by the semiconductor and electronics industry, and economic volatilities, including the ongoing banking crisis in the United States, profoundly impact the stability and resilience of the world's manufacturing landscape.

India, an emerging global economic power, has been enjoying great political stability and high economic growth over the past 2 decades. Unaffected by global geopolitical changes and complemented by a progressive industrial policy, the country is well positioned to leverage global Mega Trends to achieve its manufacturing ambitions. The advancement of digital adoption in India, coupled with the country's massive talent pool with a digital skill set, will provide manufacturing with a workforce that can utilize and innovate in terms of the disruptive technologies about to transform manufacturing.

India – A bright spot in uncertain times

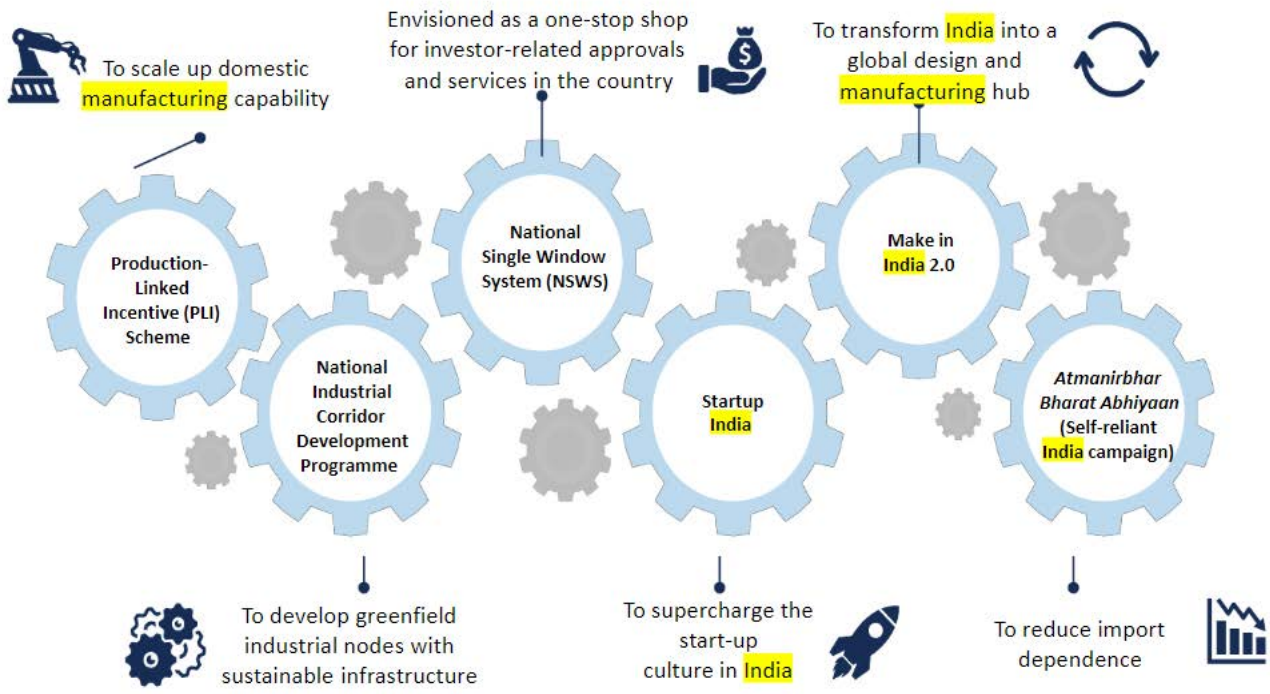


- Manufacturing's share in India's GDP is poised to increase from 15.5% in 2022 to 21.0% in 2031, doubling the country's market share.
- In the 2022–23 fiscal budget, the Indian Government allocated $315 million for the enhancement and development of electronics and IT hardware production.
- $104.3 million was invested in Faster Adoption and Manufacturing of Hybrid and Electric Vehicles in India (FAME - India)*.
- India boasts a large skilled labor force, progressive government initiatives, such as Make in India, and a huge domestic market.
- The Indian Government offers several incentives, including free land to set up base and 24*7 power supply.
- In 2030, India's upper middle class is projected to contribute 47% ($2.8 trillion) to domestic consumption compared to 30% in 2018.
- Global competitiveness: India's manufacturing sector is shifting to Industry 4.0.

Source: Frost & Sullivan

*Note: This indicates the amount of demand incentive disbursed under Phase II of the FAME India scheme until February 2022 to support EV adoption across various product segments. The incentive supported 2,31,257 EVs across various segments

Exhibit 15: Recent Government Initiatives for the Growth of the Indian Industrial Sector



Source: Frost & Sullivan, Ministry of Commerce & Industry – Government of India

Production Linked Incentive (PLI) Scheme:

India's **PLI Scheme** is a government initiative aimed at boosting domestic manufacturing by offering financial incentives to companies that increase their production in specific sectors. Launched in 2020, the scheme covers key industries such as electronics, pharmaceuticals, automobiles, textiles, and more, with the goal of enhancing India's manufacturing capabilities and reducing reliance on imports. Under the PLI scheme, eligible companies receive incentives based on incremental sales and production targets. For example, in the electronics sector, particularly mobile manufacturing, the PLI scheme has attracted global giants like **Apple** and **Samsung**, helping India become a significant exporter of smartphones. The government has allocated **₹1.97 lakh crore (approximately $26 billion)** for the scheme across 14 sectors over five years.

The initiative is expected to create **60 lakh (6 million)** new jobs and increase India's manufacturing GDP contribution. In the **pharmaceutical sector**, the PLI scheme has already led to the investment of **₹15,000 crore ($2 billion)** in bulk drug manufacturing, while the **automobile and components sector** has seen a commitment of **₹26,000 crore ($3.5 billion)** in investments.

Overall, the PLI scheme is set to make India a global manufacturing hub by attracting foreign investments, enhancing local production, and supporting the country's broader goal of **"Atmanirbhar Bharat"** (self-reliant India).

National Industrial Corridor Development Programme:

The **National Industrial Corridor Development Programme** in India is a flagship initiative aimed at developing world-class industrial infrastructure and boosting manufacturing across key regions. The program focuses on creating integrated industrial corridors that connect major cities, ports, and markets, enhancing logistical efficiency and attracting investments in manufacturing. It aims to make India a global manufacturing hub by fostering high-tech industries, improving export competitiveness, and generating employment.

The program covers the development of **11 industrial corridors** across India, including the **Delhi-Mumbai Industrial Corridor (DMIC)**, **Chennai-Bengaluru Industrial Corridor (CBIC)**, and **Amritsar-**

Kolkata Industrial Corridor (AKIC). These corridors are designed to integrate industrial development with smart cities, advanced logistics, and seamless connectivity. The programme is progressing rapidly: over 80% land acquisition is complete, environmental approvals are in hand as of January 2025.

The initiative is now expected to attract approximately $18 billion in investment and generate up to 1 million direct jobs. Its integration with expressways, freight corridors, and city development positioning makes the programme pivotal to India's long-term industrial and economic transformation. The initiative is being implemented in phases and is expected to play a pivotal role in strengthening India's position as a global manufacturing hub over the next decade. While its ambitious targets for job creation and GDP contribution will take longer to materialize, the program is already driving industrial growth and improving India's manufacturing competitiveness.

National Single Window System (NSWS):

The NSWS is aimed at simplifying the business approval process by providing a one-stop digital platform for investors and businesses to access clearances, approvals, and licenses across various sectors and levels of government. Launched in 2021, the NSWS seeks to simplify investment-related approvals across **32 central ministries**, streamlining regulatory processes to make it easier for businesses, especially in the manufacturing sector, to establish and expand their operations in the country.

By offering over 1,400 services from both central and state governments through a single interface, the system significantly reduces the time and complexity involved in obtaining permits. This makes it more attractive for both domestic and foreign investors to set up manufacturing units in India. The platform also enhances transparency, allowing businesses to track the progress of their applications in real-time, thus reducing bureaucratic delays and enhancing ease of doing business.

As of October 2024, it had facilitated over **710,000 applications**, granting around **480,000** approvals through unified workflows and real-time status tracking.By cutting down procedural inefficiencies, the NSWS is expected to encourage manufacturing by providing faster approvals, reducing the compliance burden, and boosting investor confidence, all of which are critical for expanding industrial capacity and driving economic growth.

Startup India:

Startup India launched in 2016 to promote innovation, entrepreneurship, and job creation across India. The program aims to create a supportive ecosystem for startups by offering incentives such as tax benefits, easier access to funding, simplified regulatory requirements, and fostering partnerships between businesses and investors. While its focus spans across sectors, it is also expected to encourage manufacturing by fostering innovation-driven production and creating new-age manufacturing businesses.

One key component of the initiative is the Fund of Funds for Startups (FFS), with a corpus of ₹10,000 crore (approximately $1.3 billion), which aims to provide capital to startups through venture capital firms. This is now backed by 1,173 SEBI-registered AIFs, which in turn have invested around ₹21,276 crore (~USD 2.5 bn) in startups across sectors (as of December 2024). As of December 2024, approximately 157,000 startups have been recognized by DPIIT, contributing to about 1.66 million direct jobs across sectors—with IT services, healthcare & life sciences, and professional services leading in employment share.

Additionally, Startup India promotes innovation in manufacturing by providing financial support to startups working in high-tech and manufacturing sectors, such as electronics, automotive, and clean energy. Programs like the Startup India Seed Fund Scheme and incubation support help manufacturing startups access capital, prototyping facilities, and mentorship, boosting their growth potential.

By creating a robust support system, Startup India encourages the rise of new manufacturing ventures that leverage technology and innovation, contributing to India's broader manufacturing and economic goals.

Make in India 2.0:

Make in India 2.0 is an upgraded version of the original Make in India initiative, launched to further strengthen India's position as a global manufacturing hub. Building on the success of the first phase, Make in India 2.0 focuses on driving investments, promoting innovation, and enhancing skills in key sectors. This phase places a special emphasis on 24 priority sectors, including electronics, textiles, automobiles, pharmaceuticals, and defense manufacturing, to achieve higher production capacities and technological advancements.

The initiative aims to increase the contribution of manufacturing to 25% of India's GDP by 2025, compared to the current level of around 17%. Make in India 2.0 also emphasizes sustainable manufacturing practices, the adoption of advanced technologies like artificial intelligence and robotics, and integrating India into global value chains.

Through policies like the Production Linked Incentive (PLI) Scheme and the National Industrial Corridor Development Programme, Make in India 2.0 is expected to attract large-scale foreign direct investments (FDI) and create 100 million jobs in the manufacturing sector. The initiative has already seen success, with India attracting a record $83.57 billion in FDI in the fiscal year 2021-2022, a testament to its growing appeal as a manufacturing destination.

The Government of India is pushing for greater self-sufficiency in critical technologies like semiconductors and RFID as part of the 'Make in India' and the Atmanirbhar Bharat initiaves which promote domestic manufacturing, including in the technology and electronics sectors.

Overall, Make in India 2.0 aims to enhance industrial capacity, foster innovation, and create a competitive manufacturing ecosystem that can compete on a global scale.

Atmanirbhar Bharat Abhiyaan:

Launched in 2020 with the aim of making India self-sufficient and resilient in key sectors, particularly manufacturing. The initiative promotes domestic production, reduces dependence on imports, and enhances India's competitiveness in global markets. It focuses on creating a robust manufacturing ecosystem by fostering innovation, increasing investment, and building world-class infrastructure.

The government has announced a comprehensive stimulus package of ₹20 lakh crore (around $265 billion) under Atmanirbhar Bharat, which includes measures like the Production Linked Incentive (PLI) Scheme to boost local manufacturing in sectors such as electronics, pharmaceuticals, textiles, and defense. The PLI scheme alone is expected to attract significant investments and generate 60 lakh (6 million) jobs.

Atmanirbhar Bharat also encourages startups and MSMEs (Micro, Small, and Medium Enterprises) to scale up their operations, supported by policies aimed at improving access to capital, simplifying regulations, and fostering innovation. By enhancing domestic production capacities and integrating advanced technologies, Atmanirbhar Bharat aims to position India as a global manufacturing leader while boosting exports and creating a stronger, self-reliant economy

Geopolitical Landscape and India's Manufacturing Ambitions

India's manufacturing ambitions are significantly shaped by the evolving geopolitical landscape, which presents both challenges and opportunities for the country. As global supply chains become

increasingly scrutinized due to geopolitical tensions—such as the trade disputes between the United States and China—India is positioning itself as a viable alternative for manufacturing and sourcing.

The Make in India initiative, launched in 2014, aims to transform India into a global manufacturing hub by promoting local production and attracting foreign investment. This strategy has gained traction as companies look to diversify their supply chains and reduce dependence on single markets. For instance, many multinational corporations are exploring India as a potential manufacturing base to mitigate risks associated with geopolitical uncertainties, particularly in sectors like electronics, automotive, and pharmaceuticals.

Moreover, India's strategic partnerships with countries like Japan and the United States are fostering technology transfer and enhancing manufacturing capabilities. As India strengthens its position in global trade agreements and regional collaborations, it aims to create a robust manufacturing ecosystem that not only supports domestic demand but also positions the country as a key player in the global market.

India's manufacturing ambitions are closely tied to the shifting geopolitical dynamics, with the potential to capitalize on changing global supply chains. By leveraging its strengths and fostering international partnerships, India aims to establish itself as a manufacturing powerhouse on the world stage.

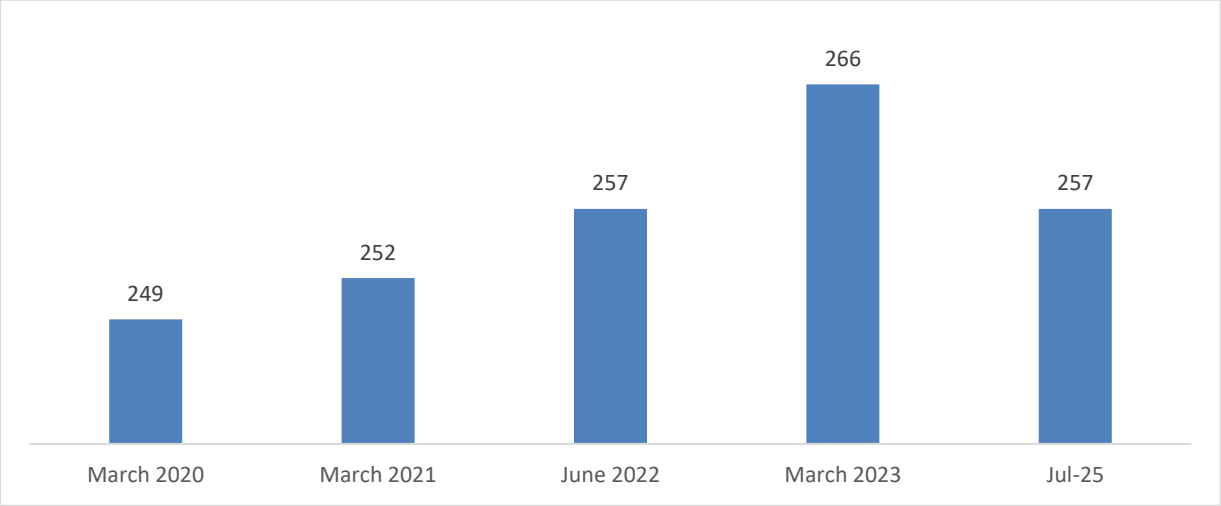
2. FINANCIAL SERVICES ECOSYSTEM: INDIA'S EVOLVING LANDSCAPE

2.1. Financial Product and Service Penetration in India

ATM Penetration in India

Since 2016, India's ATM market has been stagnant, following a period of significant yearly growth of 20 percent between 2011 and 2016. Since FY2016 until FY2021, the growth slowed down to a 3% CAGR (reaching 252,000 ATMs). Since the November 2016 demonetization of high-value currencies, many million people have entered the banking system by opening new accounts. The government's decision to direct welfare payments to people's accounts has boosted the number of new bank accounts. India remains one of the countries with the lowest ATM penetration. There is one ATM for every ten villages in India, even though the country has 650,000 villages.

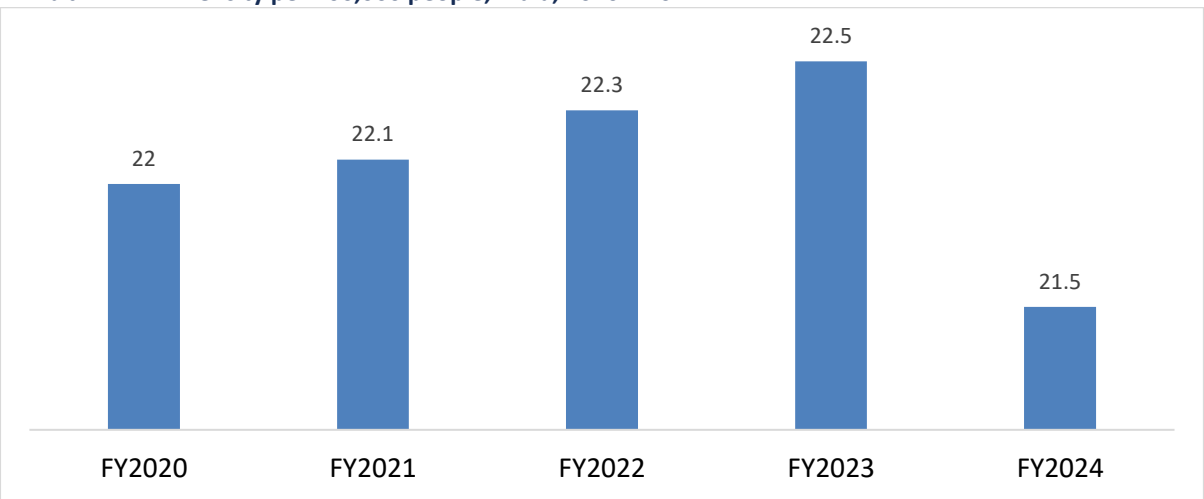
Exhibit 16: Number of ATMs under the National Financial Switch (NFS) network across India 2020-2025 (in 000s)



Source: NPCI, Secondary Sources; Includes Cash Deposit Machines / recyclers

The ATM penetration rate in India as of FY2024, stands at approximately 21.5 per 100,000 individuals. This is significantly lower compared to Brazil's 92.7 and China's 81.4 per 100,000 individuals as of FY2024. Given India's growing population, this low ATM penetration presents a substantial growth opportunity for the financial services sector in the country.

Exhibit 17: ATM Density per 100,000 people, India, 2020 – 2024

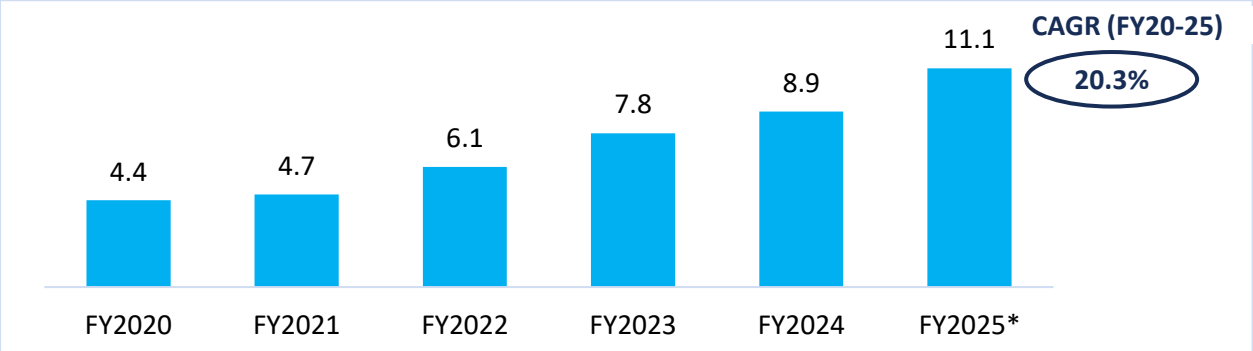


Source: Frost & Sullivan, Secondary Sources

POS Penetration in India

The number of POS terminals in India has grown from 4.4 million in FY20 to 11.1 million in FY2025, representing a CAGR of 20.3%. This increase in Point of Sale (POS) terminals marks a crucial development in India's digital payment ecosystem. The proliferation of POS terminals, which enable card-based transactions, has allowed merchants in both urban and rural areas to accept digital payments, thereby reducing cash dependency. Advancements in financial technology have made POS systems more accessible and affordable for small and medium-sized businesses, further accelerating their adoption.

Exhibit 18: Number of POS Terminals in India (Mn), FY2020– 2025

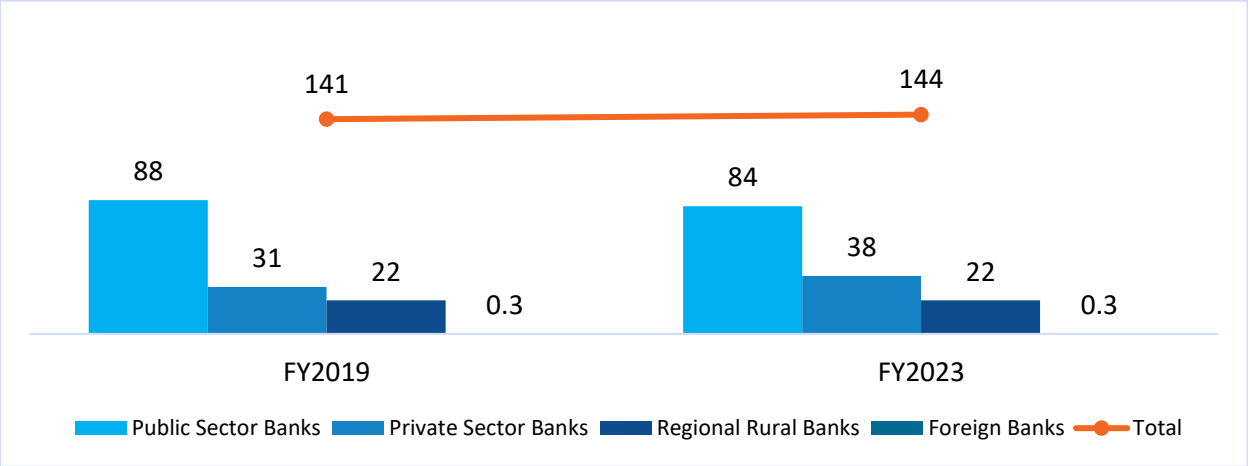


Source: Frost & Sullivan, Secondary Sources; FY2025 data for deployments until March 26th, 2025

2.2. Robust Growth in Banking Infrastructure

2.2.1 Bank Branch Growth: Enhancing Access to Banking Services

Exhibit 19: Rising number of Bank Branches in India (in 1000's), FY2019-FY2023



Source: RBI, Secondary sources

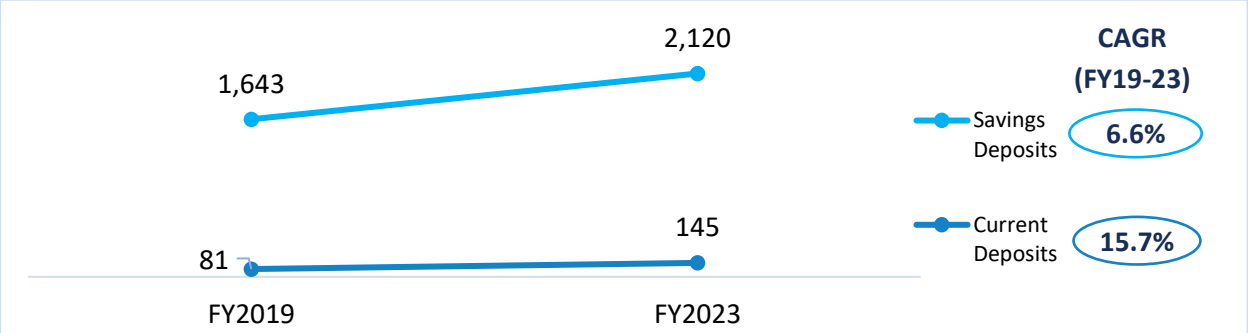
From FY2005 to FY2023, public sector banks saw an increase of about 80% in the number of branches, while private sector banks experienced a much larger growth of 533% in the same period. Both public and private sector banks have substantially expanded their branch networks and digital capabilities to meet the varying needs of customers in both urban and rural regions. Additionally, the introduction of new banking models, such as payments banks and small finance banks, has further diversified the banking sector, boosting competition and fostering innovation.

2.2.2 Account Expansion: Trends in Current and Savings Accounts

There was also a significant rise in the number of savings and current accounts (CASA), which grew from 1,724 million in FY2019 to 2,265 million by FY2023. Although current accounts grew at a higher compound annual growth rate (CAGR) of 15.7%, they started from a lower base compared to savings accounts, which grew at a CAGR of 6.6% during the same period, making up 94% of all CASA accounts.

The increase in the number of savings and current accounts is expected to lead to a corresponding rise in the issuance of debit cards by banks.

Exhibit 20: Number of Current Accounts Savings Accounts (CASA) in India, FY2005 to FY2023 (Mn)



Source: RBI; Secondary Sources
Note: Data pertains to scheduled commercial banks and excludes interbank deposits.

This growth is largely attributed to several key factors:

1. **Financial Inclusion Initiatives**: Government schemes like the **Pradhan Mantri Jan Dhan Yojana (PMJDY)** have played a crucial role in promoting financial inclusion, encouraging millions of previously unbanked individuals to open savings accounts.

2. **Increased Awareness and Digital Banking**: The growing awareness of the benefits of banking, combined with the rise of digital banking platforms, has made it easier for individuals and businesses to access banking services. Mobile banking and online account opening processes have streamlined the experience, attracting younger customers and tech-savvy users.

3. **Economic Growth and Rising Income Levels**: As the Indian economy continues to expand and disposable incomes rise, more people are seeking to manage their finances through formal banking channels. This trend is reflected in the increased demand for current accounts, especially among small and medium-sized enterprises (SMEs) looking for better financial management options.

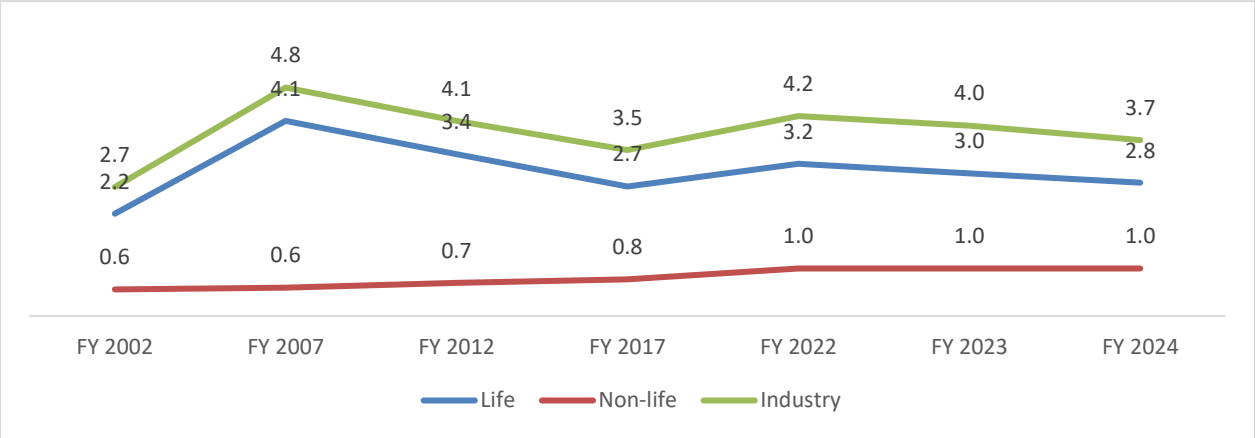
4. **Competitive Banking Environment**: The competitive landscape among banks has led to more attractive offerings for current and savings accounts, including higher interest rates, minimal fees, and value-added services. This competition incentivizes consumers to open accounts and engage with the banking system.

The increasing number of current and savings accounts in India highlights a positive trend towards greater financial inclusion and awareness. With ongoing government initiatives, advancements in digital banking, and rising income levels, the trajectory for account growth is expected to remain strong in the coming years.

2.3. Growing Insurance Industry in India

The insurance industry in India has seen a notable increase in penetration over the past few years, driven by various factors such as economic growth, rising awareness about financial security, and regulatory support. As of March 2024, the insurance penetration in India reached approximately 3.7% of the GDP.

Exhibit 21: Penetration of life and non-life insurance in India, FY2002-2024



Source: Frost & Sullivan Analysis, IRDA (India); Various sources (Swiss Re, Sigma, Various Issues)

This expansion can be attributed to several key drivers:

1. **Increasing Awareness and Financial Literacy:** Public awareness regarding the importance of insurance products has grown, especially in the wake of economic uncertainties and health crises like the COVID-19 pandemic. Various initiatives aimed at improving financial literacy have empowered consumers to make informed decisions about their insurance needs

2. **Government Initiatives:** The Indian government has introduced various schemes to promote insurance penetration, including the Pradhan Mantri Jeevan Jyoti Bima Yojana and the Pradhan Mantri Suraksha Bima Yojana. These initiatives aim to provide affordable life and accident insurance to low-income individuals, contributing to increased coverage and accessibility.

3. **Technological Advancements:** The rise of digital platforms has transformed the way insurance products are marketed and sold. Online policy comparisons, mobile apps for policy management, and digital claims processing have made insurance more accessible and user-friendly, appealing to a tech-savvy population.

4. **Diverse Product Offerings:** Insurers are increasingly offering a wide range of products tailored to different customer needs, including health insurance, life insurance, and specialized products such as term plans and ULIPs (Unit Linked Insurance Plans). This diversification has attracted a broader customer base.

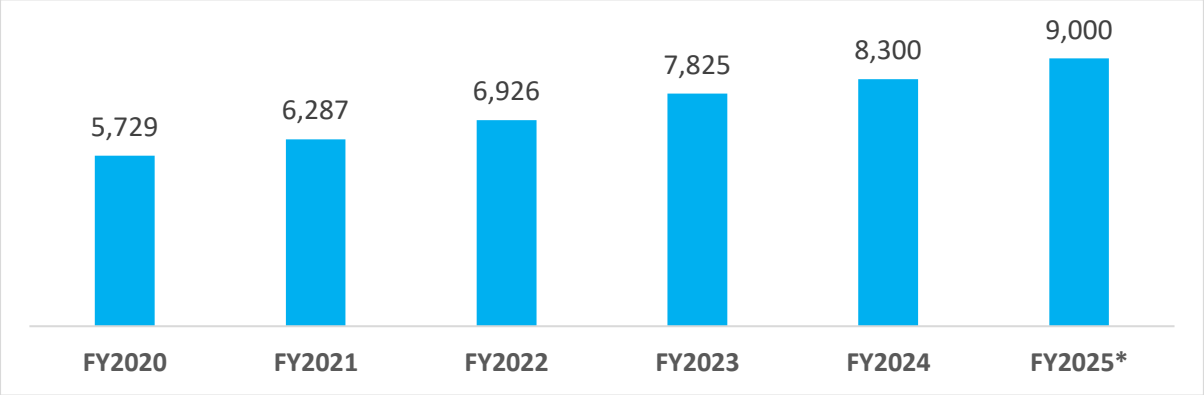
5. **Economic Growth and Rising Income Levels:** The growth of the Indian economy and rising disposable incomes have led to an increase in demand for insurance products. As more individuals and families aspire to improve their living standards, there is a greater need for financial protection against unforeseen events.

The growing penetration of the insurance industry in India signifies a shift towards greater financial security and risk management among consumers. With continued government support, increased awareness, and technological innovations, the insurance sector is well-positioned for further growth in the coming years.

2.3.1 Strong growth in Life insurance market

The aggregate gross premiums collected by life insurance firms in India increased from INR 5,729billion in FY2020 to INR 8,300 billion in the FY2024 fiscal. The aggregate gross premium is projected to grow to INR 9,000 billion in FY2025.

Exhibit 22: Life Insurance Premium (INR Bn), India, FY2020-2025

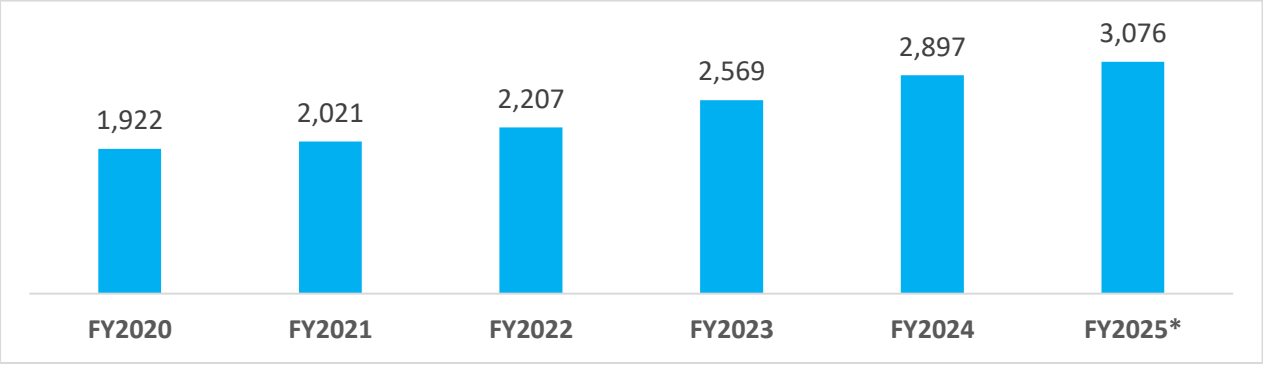


Source: IRDA; Frost & Sullivan analysis
**Estimates*

2.3.2 Strong growth in non-life insurance market

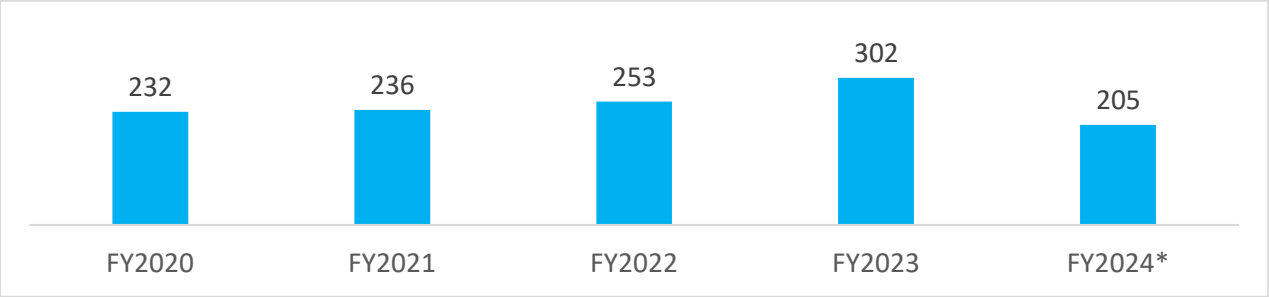
The non-life insurance market in India has experienced robust growth in recent years, driven by increased awareness, evolving consumer needs, and supportive regulatory frameworks. As of March 2024, the non-life insurance segment reported a significant increase in premiums, reaching approximately INR 2,897.3 billion. The same is projected to reach INR 3,076 billion by FY2025. Factors contributing to this surge include rising healthcare costs, the growing demand for motor and property insurance, and the heightened focus on risk management amid economic uncertainties. Additionally, government initiatives promoting health and accident insurance, alongside innovations in digital distribution channels, have expanded access to insurance products for a broader demographic. As a result, the non-life insurance sector is expected to continue its upward trajectory, addressing the diverse needs of Indian consumers and enhancing overall financial security.

Exhibit 23: Gross Premium written of Non-Life Insurers (INR Bn), India, FY2020-2025



Source: Frost & Sullivan Analysis, IRDA (India)
**Estimates*

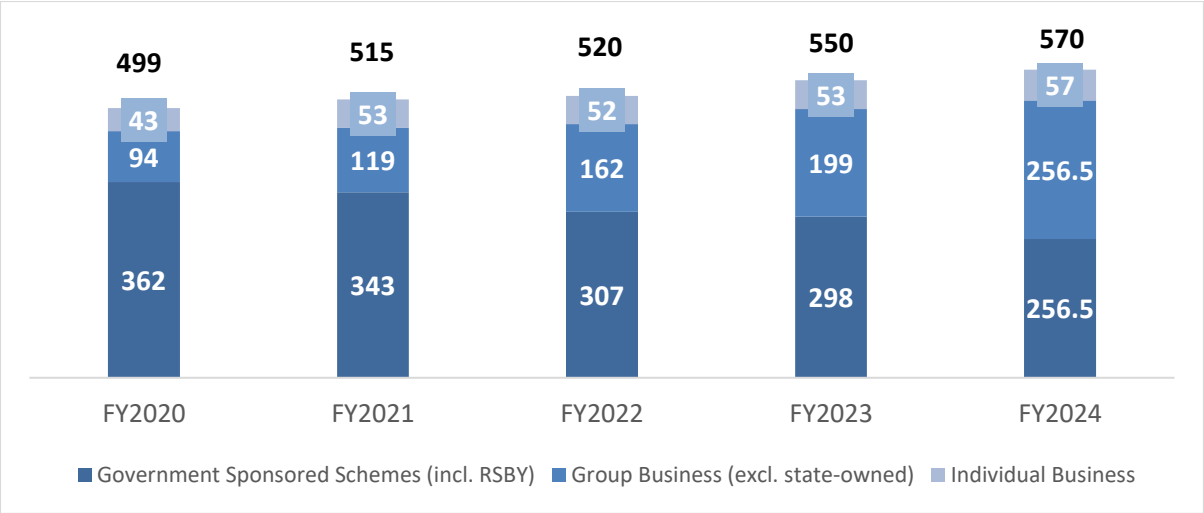
Exhibit 24: Number of Non-Life Insurance Policies (Mn), India, FY2020-2024



Source: LIC, IRDAI, IBEF; FY24 data is provisional while FY25 data is not yet available
**Provisional*

2.3.3 Continuous increase in number of lives being covered under Health insurance

Exhibit 25: Number of lives covered under health insurance in India, FY 2020-2024 (Mn)

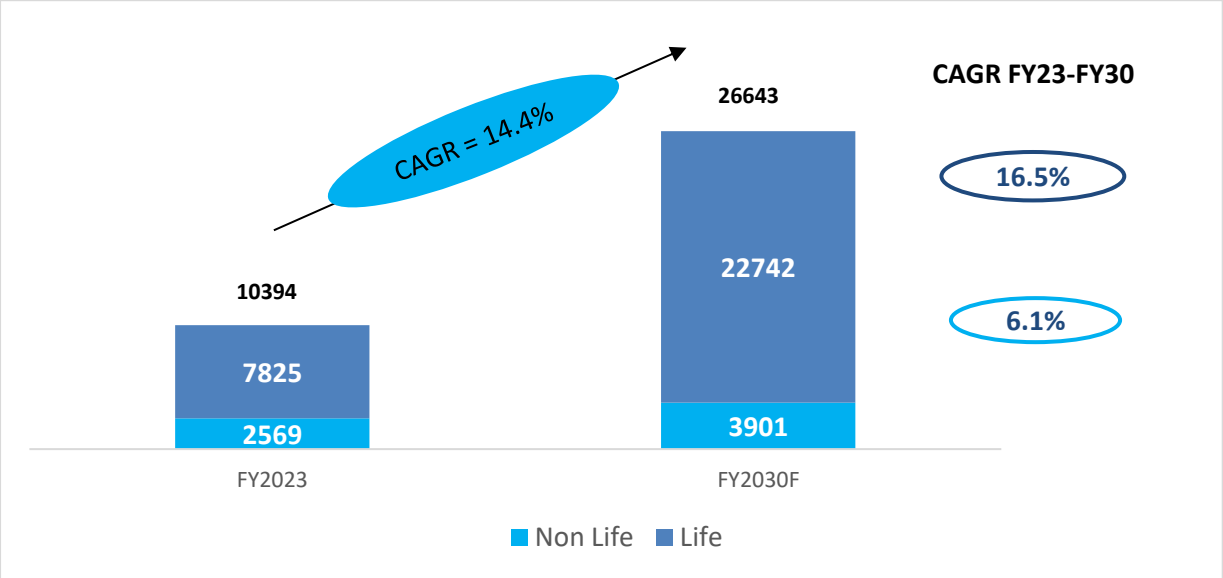


Source: IRDA, Frost & Sullivan Analysis

In the fiscal year of 2024, over 570 million people across India were covered under health insurance schemes. Of these, the highest number of people were insured under government-sponsored health insurance schemes in FY23, while in FY24, almost the same number of people were insured under government-sponsored health insurance schemes and group policies, while individual insurance plans had the lowest number of people.

2.3.4 Robust Growth expected in Indian Insurance industry as reflected by Insurance Premiums

Exhibit 26: Non-Life & Life Insurance Premium (INR Bn) Forecast, FY2023 – FY2030



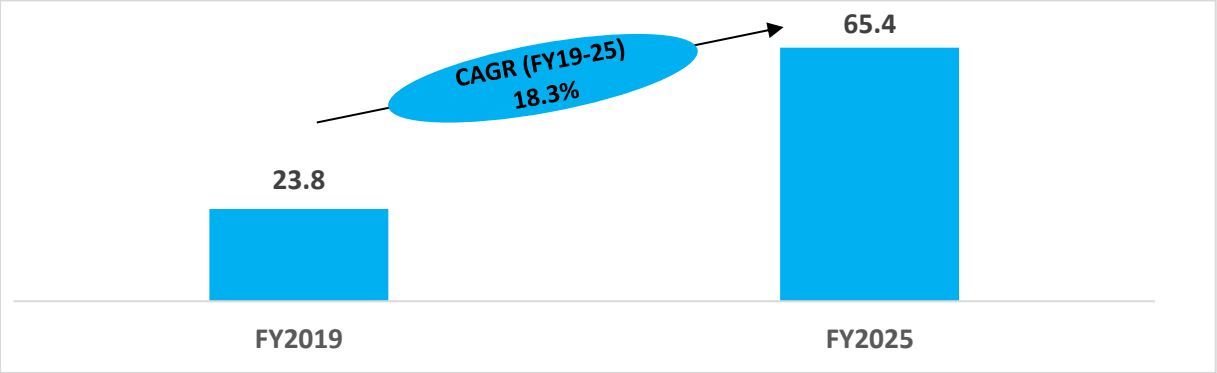
Source: IRDA, Swissre, Secondary Sources, Frost & Sullivan Analysis
Note: FY2030 is Forecasted

The insurance sector in the country is poised for a stupendous growth with total premium (life and non-life) expected to grow from INR 10,394 Bn in FY2023 to INR 26,643 Bn by FY2030, growing at a CAGR of 14.4% during the period. While the non-life insurance premium is expected to grow to INR 3,901 Bn in FY2030 growing at a CAGR of 6.1%, life insurance premium is expected to witness a steeper growth to INR 22,742 Bn in FY2030 growing at a CAGR of 16.5%.

2.4. Growing Mutual Funds Assets Under Management (AUM) in India

The Indian Financial Services Market has seen impressive expansion, driven by a range of factors. This sector, which includes areas such as mutual funds, wealth management, stock markets, insurance, and banking, has flourished due to growing wealth, technological advancements, and favourable government regulations. As an example, the mutual funds industry has experienced substantial growth, with its assets under management (AUM) increasing from INR 23.79 trillion in FY2019 to INR 65.4 trillion in FY2025, witnessing a CAGR of 18.3% in the 2019-2025 period.

Exhibit 27: Mutual Funds Assets under Management (AUM) (INR Trillion), India, FY2019-2025

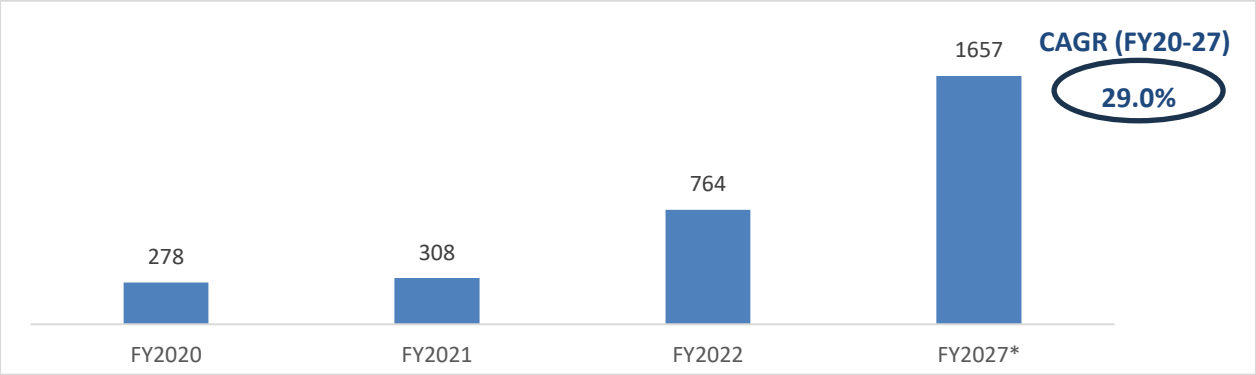


Source: Association of Mutual Funds – AMFI

The Assets Under Management (AUM) of domestic mutual funds (MFs) grew by 35% in FY2023-24, reaching a record ₹53.40 lakh crore as of March 2024, up from ₹39.42 lakh crore in March 2023. This marks an increase of nearly ₹14 lakh crore in AUM during the fiscal year. The assets under management (AUM) further reached a record ₹65.74 lakh crore in March 2025, compared with ₹53.40 lakh crore a year earlier (FY2024), recording an annual growth of 23.11%. This expansion was largely fueled by strong net inflows throughout the year, underscoring sustained investor confidence and participation in the market.

India's wealth management market is undergoing significant growth, fuelled by increasing affluence, wealth creation, and changing investor preferences. The population of high-net-worth individuals (HNWIs) in India reached 308,000 by the end of 2021, and 763,674 by the end of FY 2022, with projections suggesting this number will rise to 1.657 million by 2027. HNWIs are defined as individuals possessing investable assets of US$ 1 million or more, excluding their primary residence, collectibles, consumables, and consumer durables. Among the wealth management services, HNWIs particularly value advisory asset management and tax planning.

Exhibit 28: Rising number of High-Net-Worth Individuals (HNWI) (in '000s), India, FY2020-2027



Source: World Wealth Report by Capgemini, Asia Pacific Wealth Report 2021 by Capgemini, Secondary sources
FY2027 is Forecasted

2.4.1 Growth in Folio as the preferred barometer for Mutual Funds Industry in India

At a macro level, the total number of mutual fund folios as of June 2025 stood at 240 million; compared to 191 million in June 2024, 186 million in May 2024, 181.5 million in April 2024, 178 million folios in March 2024, and 174.2 million folios in February 2024. Each month, the folios have steadily built steam. On a YoY basis, compared to June 2024, total folios are up at a robust 25.7% in June 2025.

This growth can be attributed to several key factors:

1. **Increased Financial Literacy**: Growing awareness about the importance of investing and financial planning has led more individuals to explore mutual funds as a viable investment option. Financial literacy initiatives by various organizations have played a critical role in educating the public about the benefits and workings of mutual funds

2. **Digital Transformation**: The rise of digital platforms and mobile applications has made it easier for investors to access mutual fund services. Online investment platforms allow for seamless transactions, easy portfolio tracking, and greater transparency, attracting a younger demographic that prefers digital solutions

3. **Regulatory Support**: The Securities and Exchange Board of India (SEBI) has implemented various regulatory measures to protect investors and enhance the mutual fund ecosystem.

Initiatives like the introduction of the Direct Plan for mutual funds have made investing more cost-effective by eliminating commission fees.

4. **Diverse Product Offerings**: Mutual funds now offer a wide range of products tailored to meet varying risk appetites and investment goals, including equity funds, debt funds, hybrid funds, and sector-specific funds. This diversity allows investors to choose products that align with their financial objectives.

5. **Rising Income Levels**: Increased disposable incomes and economic growth have resulted in a higher propensity to invest among the Indian middle class. As more individuals enter the workforce and experience salary growth, there is a notable shift towards investment in financial instruments like mutual funds.

Overall, the growth of mutual fund AUM in India highlights the changing investment landscape, characterized by a move towards more structured and regulated investment avenues. The continued focus on financial education, technological advancements, and regulatory support is expected to further boost the mutual fund industry in the coming years.

3. PAYMENT CARD INDUSTRY IN INDIA: EVOLVING LANDSCAPE

3.1. Payment Card Technology: Past, Present, and Future in India

The evolution of **payment card technology** in India reflects the country's journey toward a digital and cashless economy. In the past, traditional magnetic stripe cards dominated the payment landscape, offering convenience but limited security. The introduction of EMV (Europay, Mastercard, Visa) chip cards in the 2010s marked a significant shift, enhancing security through encryption and reducing fraud. Today, India has embraced contactless payments via NFC-enabled cards, enabling faster and more convenient transactions, especially in urban areas. Innovations like tokenization and mobile wallet integration have further expanded the ecosystem. Looking ahead, the future of payment card technology in India is poised to include biometric authentication, dynamic CVV, and integration with blockchain for secure and transparent transactions. These advancements, coupled with initiatives like RuPay and UPI-linked debit cards, will continue to drive financial inclusion and make India a leader in digital payments.

3.2. Personalization and Certification : Insights

Personalization

Personalization bureaus play a significant role in the **credit and debit card manufacturing process**, offering services that allow card issuers (such as banks and financial institutions) to customize cards with personalized elements. These bureaus handle the customization, printing, and embedding of user-specific data onto cards, helping issuers provide tailored products that enhance customer engagement, loyalty, and brand identity.

1. Data Embedding and Security

- **Personalization bureaus** are responsible for securely embedding **sensitive cardholder information**, such as the cardholder’s name, account number, and expiration date, onto the credit or debit card. This process also includes encoding the magnetic stripe, EMV chip, and contactless technologies with encrypted data for secure transactions.

- These bureaus follow stringent **security protocols** and comply with **Payment Card Industry Data Security Standards (PCI DSS)** to protect sensitive customer data during production. This level of personalization ensures that each card is unique to the individual cardholder, safeguarding against fraud.

2. Custom Design and Branding

- Personalization bureaus offer the flexibility to design cards that align with a bank's or retailer's **brand identity**. This may include custom graphics, unique card colors, embossed logos, or even textured finishes. By offering visually appealing and exclusive designs, issuers can differentiate themselves in the competitive market.
- Bureaus also allow issuers to develop **co-branded or affinity cards**, often in partnership with retail brands, airlines, or service providers, providing customers with exclusive benefits tied to the co-branded entity.

3. Personalized Services for Niche Markets

- Some card issuers target specific customer segments, such as **millennials**, **high-net-worth individuals (HNWIs)**, or **corporate clients**, and personalization bureaus enable them to create cards with features and designs specific to these groups.

4. Efficiency in Mass Customization

- While producing unique cards for each user, **personalization bureaus** must also handle large-scale, high-volume production efficiently. **Automated printing systems** and **data encoding machines** allow these bureaus to produce personalized cards quickly without compromising on security or quality.
- These facilities often work closely with card manufacturers, banks, and payment networks (like **Visa**, **Mastercard**, **American Express** and **RuPay**) to ensure seamless integration of new technologies such as **contactless payments** and **biometric authentication**.

5. Eco-Friendly Initiatives

- With growing demand for sustainability, personalization bureaus are increasingly offering **eco-friendly materials** such as cards made from recycled plastic or biodegradable materials. This trend is being embraced by consumers who value environmentally responsible products, and banks are leveraging this as a selling point for their card offerings.
- For instance, several issuers now offer **eco-cards** with personalizations that promote environmental sustainability, helping banks align with their corporate social responsibility (CSR) goals while meeting customer demand for green products.
- Mastercard has mandated a transition to eco-friendly cards, encouraging issuers worldwide to adopt sustainable alternatives by 2028. This initiative aligns with Mastercard's commitment to reducing environmental impact and combating plastic waste. Under this program, all newly produced cards will utilize recyclable, biodegradable, or ocean-salvaged materials instead of traditional PVC plastics. Mastercard is partnering with global issuers to ensure compliance while promoting sustainable innovation within the payments ecosystem. This move reflects the company's broader efforts toward environmental responsibility and supports global sustainability goals.

6. End-to-End Card Issuance Solutions

- Many personalization bureaus offer **end-to-end services**, including not just card production but also **packaging, distribution, and activation** services. This helps banks streamline the card issuance process, from manufacturing to delivery. Additionally, they may offer solutions for **card reissuing**, **renewals**, and **replacement**, ensuring that the personalization of cards remains consistent over time.

Certification

Credit and debit card manufacturers must comply with a range of certifications that address security, functionality, and quality in the production of physical and smart cards. These certifications ensure that cards meet the highest standards of **data security**, **durability**, and **interoperability**, while also adhering to the brand requirements of payment networks like Visa, Mastercard, RuPay and others. As the market evolves with new technologies such as **contactless payments** and **eSIMs**, these certifications will continue to expand, driving innovation and ensuring trust in global payment systems.

3.3 Factors Fueling Credit and Debit Card Adoption in India

3.3.1 Card Expiry and Renewal: Untapped Potential in India

In the world of finance, debit and credit cards have become indispensable. As these cards come with an expiration date, their renewal cycles create significant opportunities for manufacturers.

Card expiration and renewal processes not only guarantee a steady demand for the production of new cards but also allow for the integration of evolving technologies, opportunities for branding, and meeting regulatory requirements. Each cycle provides financial institutions the chance to offer upgraded products to enhance customer experience, which in turn stimulates growth in the credit and debit card manufacturing market. Additionally, the industry's shift toward sustainability and personalization further strengthens the market as card manufacturers innovate to meet evolving consumer and regulatory expectations.

Lifespan of Cards: Credit and debit cards typically have an expiration date ranging from three to seven years. This programmed obsolescence guarantees that banks and financial institutions regularly issue new cards to maintain functionality and customer service. The expiry ensures that card manufacturers consistently have a steady stream of orders to meet this cyclical replacement need.

Regulatory Compliance and Security: Many financial institutions are also bound by regulatory standards to update card features to the latest security protocols. This includes adherence to updates on PCI DSS (Payment Card Industry Data Security Standard) or other regional regulatory guidelines, which often require replacing older cards with more secure, updated versions.

3.3.2 Technological Upgrades:

Emerging Security Features: Card renewal cycles allow financial institutions to introduce newer technologies like EMV chips, contactless payment systems, and biometric authentication methods. As fraud prevention becomes more sophisticated, card manufacturers must incorporate these technologies into each new batch of cards issued. For instance, the adoption of EMV (Europay, Mastercard, and Visa) chips saw a mass card replacement process globally.

Technological Trends and Consumer Preferences: With each renewal, banks and card issuers aim to provide customers with advanced features. For instance, contactless payments became more popular during the COVID-19 pandemic due to hygiene concerns, spurring the issuance of millions of NFC-enabled contactless cards. This shift also encouraged card manufacturers to upgrade their equipment and technology to meet this rising demand.

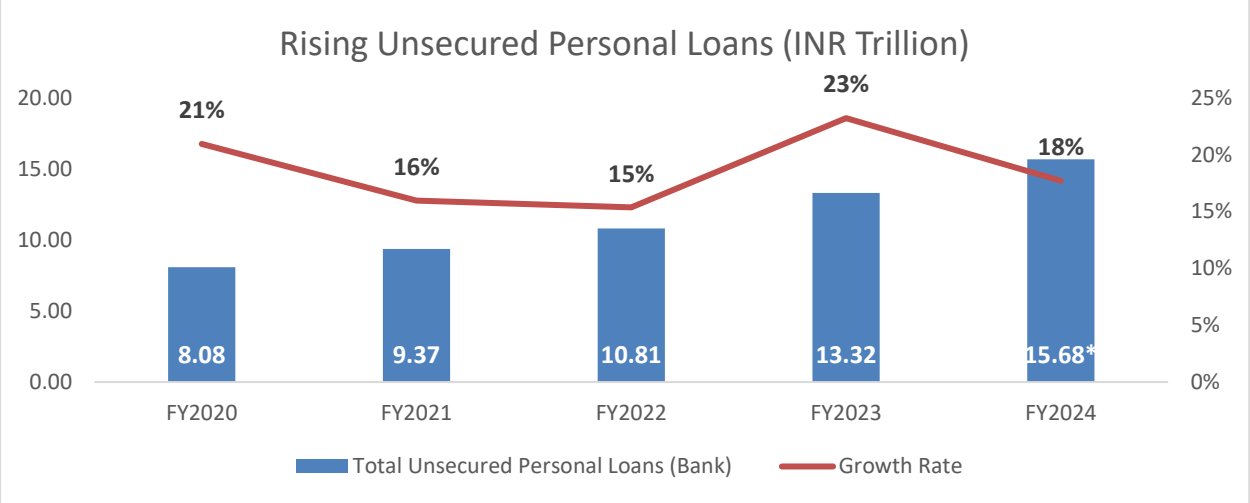
3.3.3 Customization and Branding

Brand Refresh Opportunities: Expiry and renewal cycles also serve as an opportunity for financial institutions to rebrand or refresh the card design, offering new features like personalized cards, co-branded partnerships, or custom card aesthetics. This is a significant selling point for card issuers, especially in competitive markets where banks use premium card designs and features to attract and retain customers.

3.3.4 Unsecured Retail Loans: The Role of Credit Cards in India

The expansion of unsecured personal loans, encompassing credit card receivables, consumer durable loans, and other personal loans, in banks between March 2017 and March 2024, recorded a Compound Annual Growth Rate (CAGR) of 20.5% growing from INR 4.26 trillion in March 2017 to INR 15.68 trillion by March 2024. This surpassed the growth rate of personal loans, which demonstrated a CAGR of 16.2% over the same period (growing from INR 18.6 trillion in FY 2017 to INR 53.31 trillion by FY 2024). Unsecured personal loans now constitute nearly one-third of the total personal loan portfolio of banks.

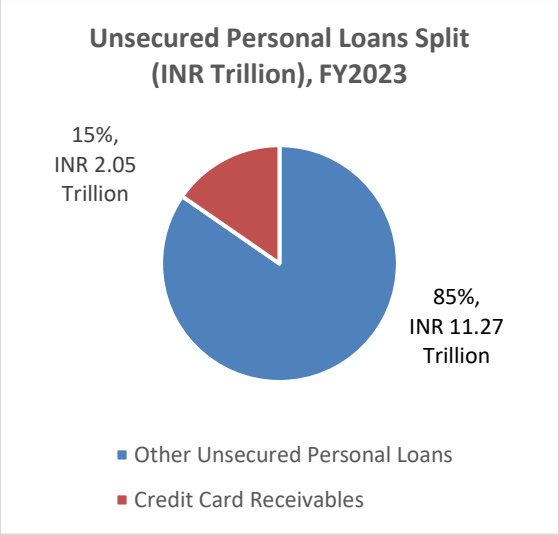
Exhibit 29: Rising Unsecured Personal Loans (INR Trillion), India, FY2020-FY2024



Source: RBI
**Frost & Sullivan Estimate*

Several factors have driven this substantial increase in unsecured personal loans. These include shifts in demographics, economic formalization, enhanced purchasing power, the rise of FinTech firms, widespread Internet and feature phone access, the adoption of digital payment systems, among other contributors.

Exhibit 30: Unsecured Personal Loans Split, India, FY2023-FY2024



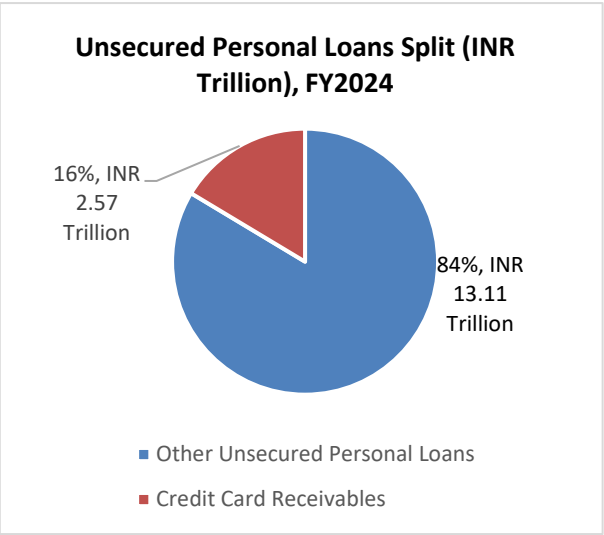
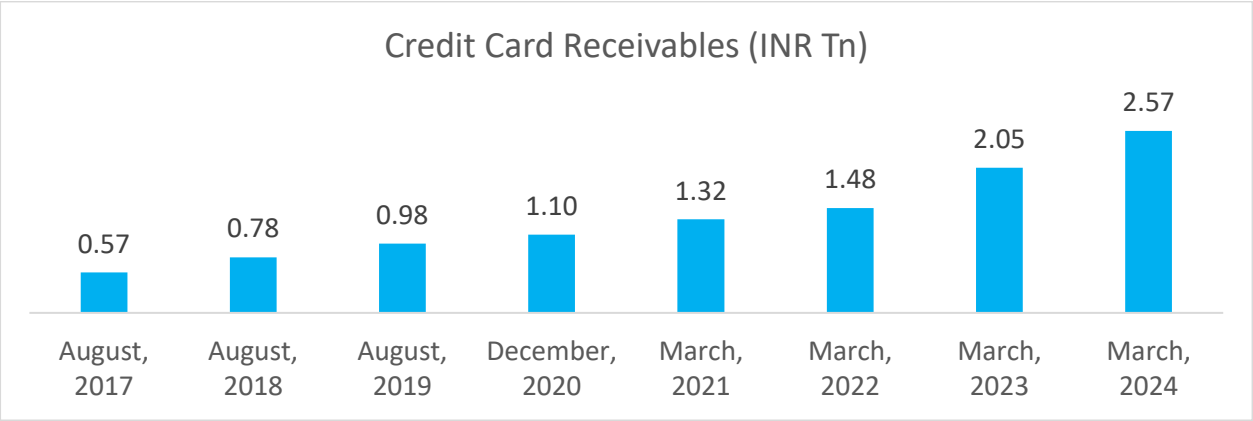


Exhibit 31: Rising Credit Card Receivables (INR Trillion), India, 2017 - 2024



Source: RBI

The utilization of credit cards has seen a marked increase, accompanied by a parallel rise in outstanding receivables. Credit card receivables have been trending upward, escalating from INR 0.57 trillion in August 2017 to INR 2.57 trillion in March 2024. This upswing in credit card outstanding receivables in India is indicative of shifting consumer preferences and enhanced credit accessibility.

In a subdued environment for corporate lending, banks' increasing focus on retail loans has led to accelerated growth in credit card and other unsecured retail lending.

The swift expansion of credit cards within India's unsecured loans market can be attributed to several pivotal factors. Recent data indicates a significant uptick in credit card spending in India, substantially contributing to the growth of the unsecured credit sector.

This surge in credit card usage can be traced to multiple drivers. A critical factor is the proliferation of digital and information-driven lending, which has propelled the expansion of retail credit, particularly in unsecured consumption-oriented products. TransUnion CIBIL reported a compound annual growth rate (CAGR) of 47% in this segment from March 2021 to March 2023[1]. Notably, the heightened credit card spending also elevates the risk of defaults, a factor that banks are vigilantly monitoring.

[1] [1] TransUnion CIBIL

3.3.5 Co-Branded Cards: Expanding Reach and Rewards in India

Co-branded cards are driving growth in India's credit and debit card market by offering unique value propositions, enhancing consumer loyalty, increasing transaction volumes, and expanding the customer base into new segments. These cards not only foster strong customer-brand relationships but also align with the broader shift towards digital and cashless transactions in India. This makes them an important tool for both banks and brands to capture a larger share of the payments market.

The co-branding credit card partnership industry is experiencing rapid growth, characterized by strategic alliances between various companies and financial institutions. In India, this trend has become increasingly prevalent, with companies such as Amazon, Airtel, Flipkart, Myntra, and Swiggy partnering with major banks to launch co-branded credit cards, reshaping customer payment habits.

HDFC Bank has been actively expanding its co-branded credit card offerings through various partnerships with Swiggy (launched July 2023), Flipkart-Axis card, IRCTC-SBI card, Marriott Bonvoy (hotel travel card), Tata Neu, Flipkart Wholesale, and Retailio, More recently (June 2025), HDFC & SBI have launched a new co-branded RuPay card with PhonePe tailored for UPI-enabled digital transactions while ICICI Bank has collaborated with companies like HPCL, Amazon and MakeMyTrip to provide exclusive co-branded cards.

1. Enhanced Consumer Benefits

- **Loyalty rewards and incentives**: Co-branded cards offer rewards that are directly linked to a specific brand or sector, such as airlines, retail chains, or e-commerce platforms.
- **Customization for specific user groups**: This targeted value proposition increases the likelihood of usage and customer acquisition.

2. Increased Consumer Spend

- **Higher transaction frequency**: The perks associated with co-branded cards encourage users to make frequent transactions, leading to higher spend volume per customer.
- **Brand loyalty**: Co-branded cards foster brand loyalty by linking usage to exclusive rewards or privileges.
- **Promotions and discounts**: Retailers and service providers often offer **limited-time offers** or **seasonal discounts** on co-branded cards.

3. Expansion of the User Base

- **Partnership with trusted brands**: Co-branded cards give banks access to the brand's customer base, enabling them to attract new customers who might not have otherwise considered using a credit or debit card. This cross-promotional strategy helps expand the cardholder base.
- **E-commerce and digital payments**: With the rapid growth of e-commerce in India, co-branded cards with leading e-commerce platforms like **Amazon** drive increased digital

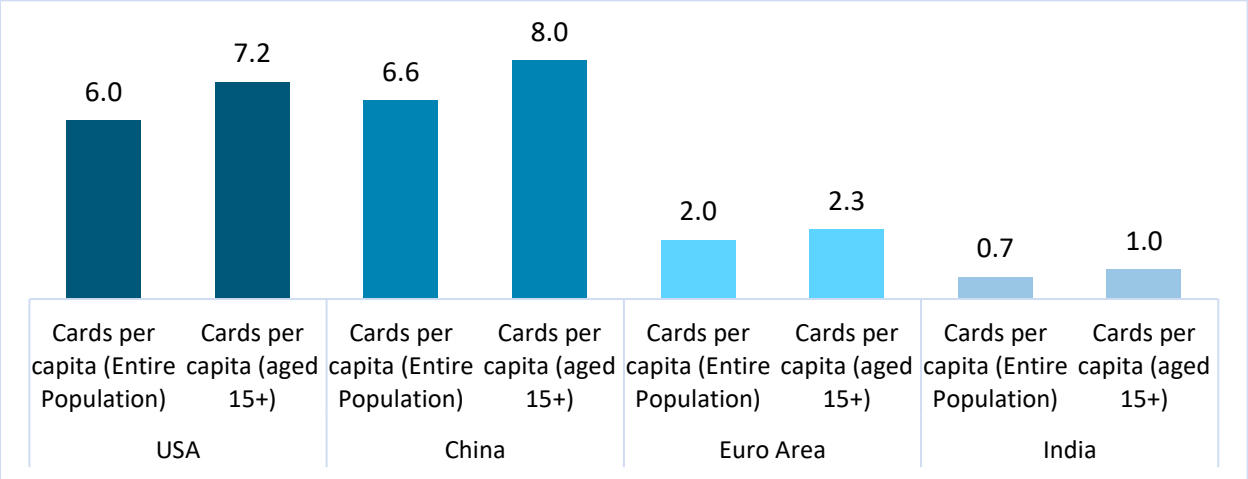
transactions. These platforms provide exclusive benefits, further driving adoption and usage in the online shopping space.

3.3.6 Fintech Players: Shaping India's Payment Card Ecosystem

India's fintech revolution, especially in the payment cards market, showcases the country's rapid digital transformation, driven by changes in consumer behavior, regulation, and the financial ecosystem. Strong investment in the sector has fueled innovation, enabling fintechs to diversify and scale. The surge in digital payments is due to widespread adoption of fintech solutions like real-time payments and comprehensive merchant services. Fintechs are expanding into areas such as lending, insurtech, and banking-as-a-service. India's fintechs, supported by robust funding, focus on customer-centric growth, evolving from payment providers into full-service financial ecosystems.

3.3.7 Cards Per Capita Remains Low in India

Exhibit 32: Cards Per Capita, CY2023



Source: Secondary Sources; Frost & Sullivan analysis

The adoption of payment cards varies considerably across the USA, Europe, China, and India, influenced by differences in economic progress, financial systems, and consumer habits. In the United States, card usage is extensive, with a high penetration rate of 7.2 for the population aged 15 and above. This widespread adoption is fuelled by well-established financial structures and a society accustomed to credit utilization.

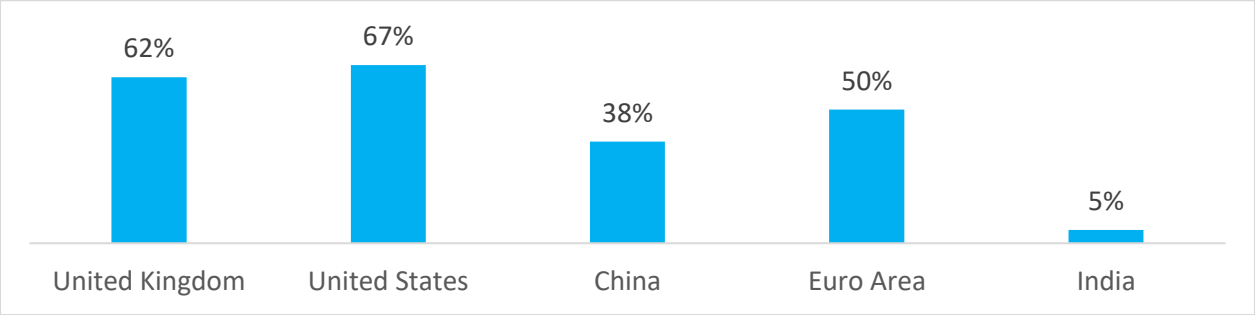
The Euro area also demonstrates significant card penetration, with a rate of 2.3 for the population aged 15 and above. However, there's a marked inclination towards debit cards over credit cards, especially in nations like Germany and the Netherlands where aversion to debt is more pronounced.

China exhibits a remarkably high card penetration rate of 8 for the population aged 15 and above, primarily driven by the widespread use of debit cards. This reflects the country's rapid financial modernization and changing consumer payment preferences.

In India, both credit and debit card penetration is on an upward trajectory. This growth is propelled by government-led initiatives and efforts to increase financial inclusion across the country. The rising adoption of cards in India signifies the nation's evolving financial landscape and increasing integration into the global digital economy.

3.3.8 Credit Card Penetration: Opportunities in an Untapped Indian Market

Exhibit 33: Credit Cards Penetration, CY2023



Source: Secondary Sources; Frost & Sullivan analysis

The adoption of payment cards varies considerably across the USA, UK, Euro area, China, and India, influenced by differences in economic progress, financial systems, and consumer habits. In the United States, credit cards usage is extensive, with a high penetration rate of 67% for the population aged 15 and above. This widespread adoption is fueled by well-established financial structures and a society accustomed to credit utilization.

The Euro area also demonstrates significant credit card penetration, with a rate of 50% for the population aged 15 and above.

China exhibits a remarkably high credit card penetration rate of 38% for the population aged 15 and above. This reflects the country's rapid financial modernization and changing consumer payment preferences.

In India, credit cards are on an upward trajectory. The rising adoption of cards in India signifies the nation's evolving financial landscape and increasing integration into the global digital economy.

3.3.9 Multiple Card Ownership: Trends and Implications in India

The increasing trend of individuals holding multiple credit and debit cards in India is a significant driver of market growth. This trend is driven by several factors:

1. **Diversified Benefits and Rewards**: Consumers often hold multiple cards to take advantage of different rewards and cashback offers.
2. **Tailored Financial Products**: Financial institutions are launching cards tailored to specific needs, such as travel, dining, fuel, or entertainment.
3. **Credit Building and Management**: Holding multiple cards helps individuals build and manage credit scores more effectively.
4. **Co-branded and Premium Cards**: Banks and retailers are offering more co-branded and premium cards, often with exclusive perks.

This trend not only boosts card issuance but also leads to increased transaction volumes and fee income for banks and financial institutions in India.

3.3.10 Automated Permanent Academic Account Registry (APAAR) ID in India

The Automated Permanent Academic Account Registry (APAAR) ID is a pioneering initiative introduced by the Government of India aimed at streamlining and enhancing the management of academic records for students across the country. The APAAR ID is designed to provide a unique, secure, and

digital identity for each student, serving as a permanent academic account that tracks and stores their educational milestones throughout their academic journey.

The APAAR ID system is being gradually rolled out across educational institutions in India, with plans for integration into the broader National Digital Education Architecture (NDEA). Over time, the initiative is expected to enhance educational transparency, make student data management more efficient, and provide a robust platform for lifelong learning and career development.

The APAAR ID is a vital step in India's vision to create a more accessible, transparent, and future-ready educational ecosystem. By digitizing and centralizing academic records, it not only simplifies administrative processes but also empowers students, institutions, and policymakers with the tools to drive educational reform and innovation.

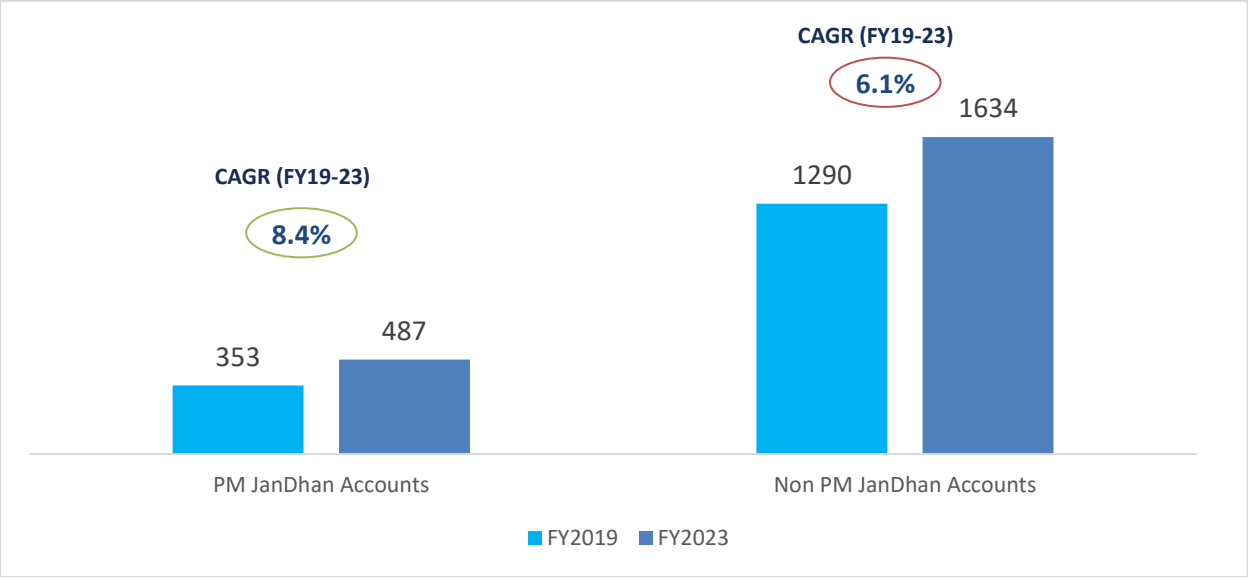
3.3.11 JanDhan Accounts and Demographic Dividend: Catalysts for Payment Card Adoption

Demographic dividend

The demographic dividend, marked by an expanding working-age population, is set to be a key driver in the growth of debit and credit card issuance. As younger individuals join the workforce, their newfound financial independence and increased spending capacity lead to a greater need for banking services, including debit and credit cards. This expansion is propelled by increased consumer expenditure, urban development, digital technology adoption, efforts towards financial inclusion, improved credit access, and innovations in financial services. These factors collectively contribute to a thriving market for card-based financial transactions.

Jan Dhan Accounts

Exhibit 34: Savings Accounts in India: Split by JanDhan and Non-JanDhan (in Mn), FY2019-23



Source: RBI; Secondary research

The proportion of JanDhan accounts within the overall savings account landscape has shown steady growth, rising from 13% in the 2015 fiscal year to 21% in fiscal year 2019, and further to 23% in fiscal year 2023. A considerable number of JanDhan account holders have yet to be issued debit cards, presenting a significant opportunity for both banking institutions and card manufacturing companies.

As the utilization of JanDhan accounts increases, there will be a corresponding rise in demand for debit cards linked to these accounts. According to the most recent data, a total of 552.2 million Jan-Dhan accounts have been opened till March 2025, while only 380.7 million (69%) possess Rupay debit cards.This gap indicates substantial potential for growth in card issuance within this segment of the banking population.

3.4 Credit Card Regulations: Impacts and Implications

1) **New Guidelines on Credit Card Issuance:** In April 2022, the Reserve Bank of India (RBI) issued new directives related to the issuance of credit and debit cards. These guidelines covered several areas, including the closure of credit cards, billing practices, and the requirement to obtain customer consent. Lenders were required to obtain customer consent on various aspects, provide key fact statements during the application process, and strengthen their grievance redressal mechanisms. Moreover, the guidelines aimed to enhance transparency by requiring lenders to disclose the reasons for rejecting credit card applications and mandated compensation for unsolicited credit card issuances. These regulations brought more accountability and consumer protection to India's credit card market. While they increased compliance costs for issuers, they also encouraged more responsible credit use and improved the overall customer experience. In the long term, these changes could contribute to a healthier credit market with stronger consumer confidence. These remain in force with further amendments introduced in March 2024. The 2024 amendments further enhanced the protections by introducing penalties for delayed card closure, requiring clearer warnings about the risks of paying only the minimum amount due, tightening oversight on business credit card usage, expanding rules on co-branded cards and data privacy, and allowing new card form factors with customer control. Together, these measures have improved accountability, transparency, and consumer protection in India's credit card market. While compliance requirements for issuers have increased, the reforms have encouraged more responsible credit usage and enhanced customer trust, contributing to a healthier and more robust credit ecosystem.
2) **Enhancing Risk Weights and Strengthening Credit Standards:** Expanding on these initiatives, additional regulatory measures were enacted in November 2023, specifically targeting consumer credit and bank lending to non-banking financial companies (NBFCs). These actions encompassed an increase in risk weights for consumer credit exposure by commercial banks and NBFCs, as well as for credit card receivables. Financial institutions were prompted to reassess their sector-specific exposure limits for consumer credit and establish Board-approved thresholds for various sub-segments. The primary objective of these measures was to bolster prudent risk management practices across the financial sector. These measures had a significant impact on the credit card market by tightening consumer credit, limiting bank lending to NBFCs, and improving risk management practices. These regulations led to more conservative lending, slower growth in credit card issuance, and a focus on prime borrowers. While the measures strengthened the financial system by reducing systemic risks, they also posed challenges for NBFCs, especially those that were aggressively expanding in the consumer credit market. By mid-2025, these measures continue to influence the credit landscape significantly. They tightened consumer credit conditions, moderated credit card issuance growth, and shifted focus toward prime borrowers with stronger repayment profiles. For NBFCs, especially those with aggressive consumer credit expansion plans, these regulations created funding constraints and operational challenges, prompting greater caution in risk-taking. While these steps have strengthened the

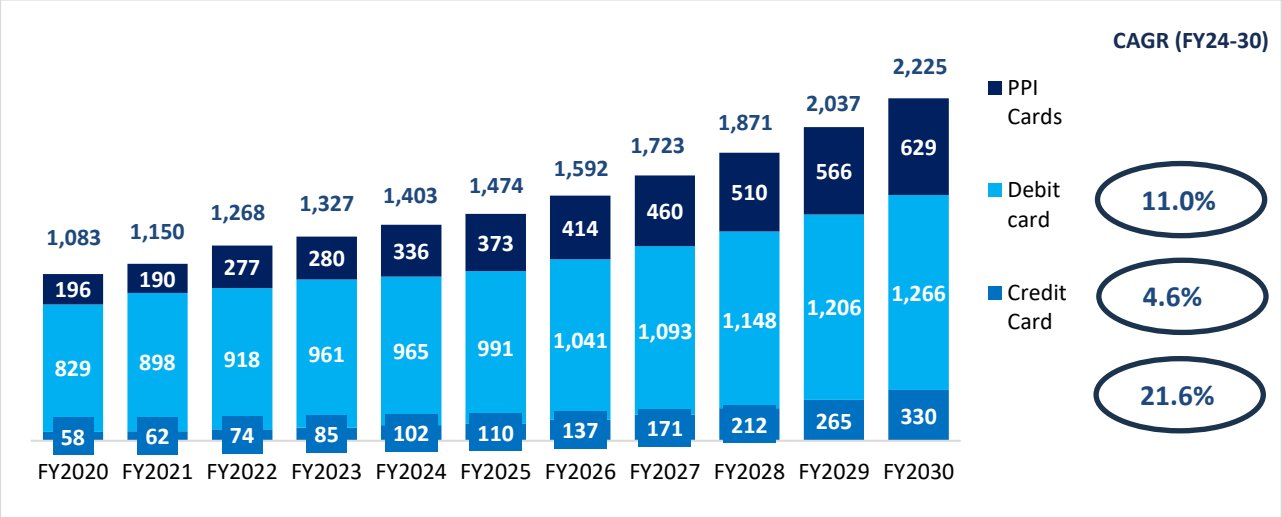
resilience of the financial system and improved risk management practices, they have also slowed unsecured lending growth and led to a more conservative credit environment overall.

3) **Recent RBI regulations impacting fintech companies issuing credit cards:** The regulations underscore RBI's commitment to ensuring consumer protection, data privacy, and fair practices in the fintech and banking sectors. By restricting the issuance of credit cards to regulated entities and enhancing transparency, the RBI aims to foster a more secure and customer-friendly financial environment

- ***Issuance of Credit Cards:*** Only banks / NBFCs are authorized to issue credit cards. Fintech companies must collaborate with these entities to offer credit cards. This move ensures that only regulated financial institutions with adequate risk management frameworks are involved in issuing credit cards.
- ***Data privacy and sharing:*** The RBI has prohibited co-branding partners from accessing customer data post-issuance of credit cards. This regulation ensures that customer data remains secure and is not misused by third parties.

3.5 Payment Card in Circulation & Issuance in India: Trends and Growth Patterns

Exhibit 35: Total Payments Card in Circulation (Million), India, 2020 – 2030F

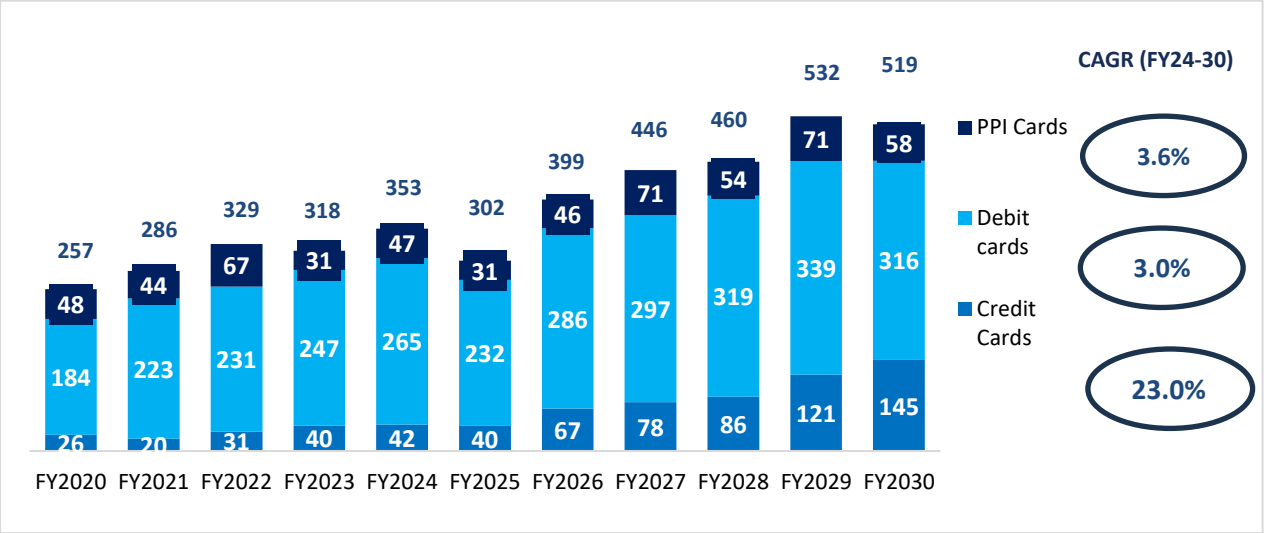


Source: Frost & Sullivan
Note: FY2025-2030 is Forecasted

The total number of payment cards in circulation in India, encompassing credit cards, debit cards, and PPIs, stood at 1,083 million units in 2020. By 2024, this figure had increased to 1,403 million units and is anticipated to grow to 2,225 million units by 2030, with an expected CAGR of 8.0% from 2024 to 2030.

Among the various segments, credit cards are expected to experience the highest growth, with a projected CAGR of 21.6% in the FY24-30 period. Prepaid payment instruments (PPI) are expected to follow, with a CAGR of 11% in the same period of FY24-30.

Exhibit 36: Total Payments Cards Issued (Million), India, 2020 – 2030F

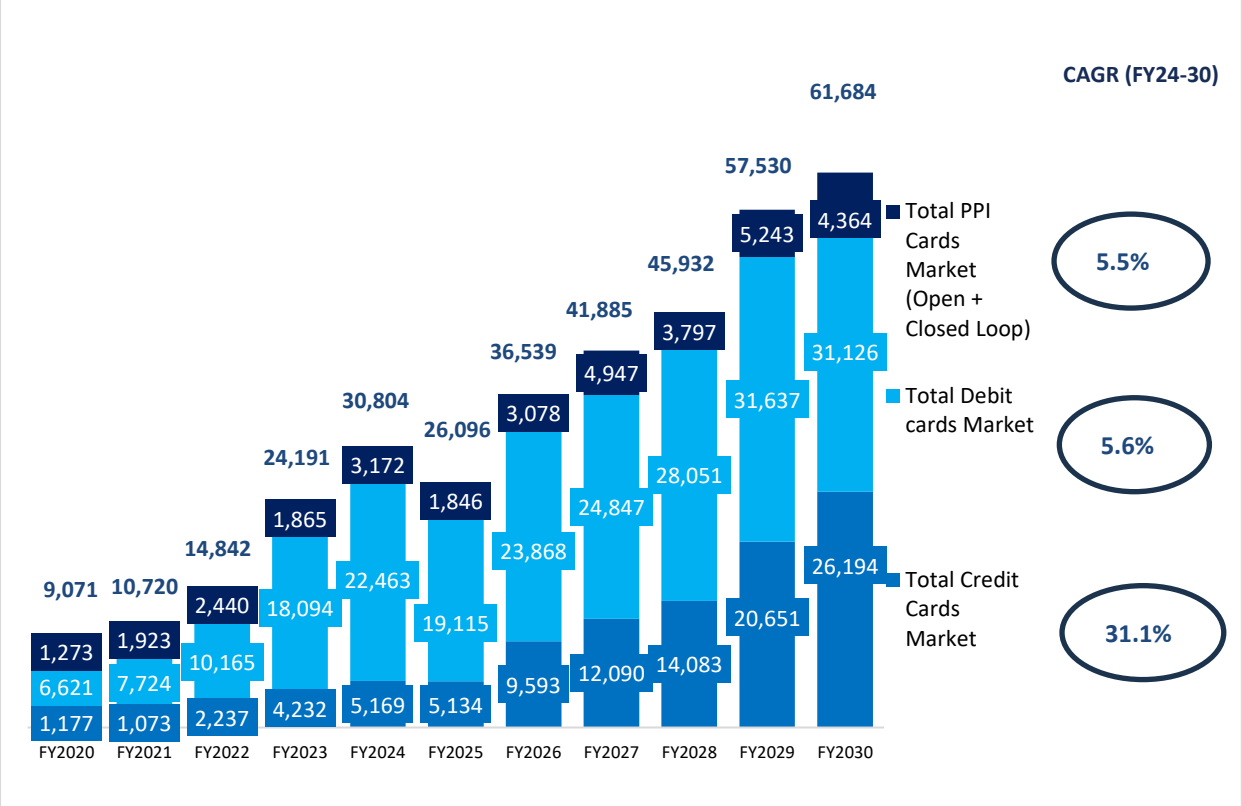


Source: Frost & Sullivan
Note: FY2025-2030 is Forecasted

The total number of payment cards issued in India, including credit cards, debit cards, and prepaid payment instruments (PPI), was 257 million units in 2020. This number grew to 353 million units in 2024 and is projected to reach 519 million units by 2030, with an expected compound annual growth rate (CAGR) of 6.6% from FY2024 to FY2030.

3.6 India's Payment Card Market: Size, Trends, and Projections

Exhibit 37: India: Total Available Market (TAM) for Payment Cards (INR Million), FY2020-2030F



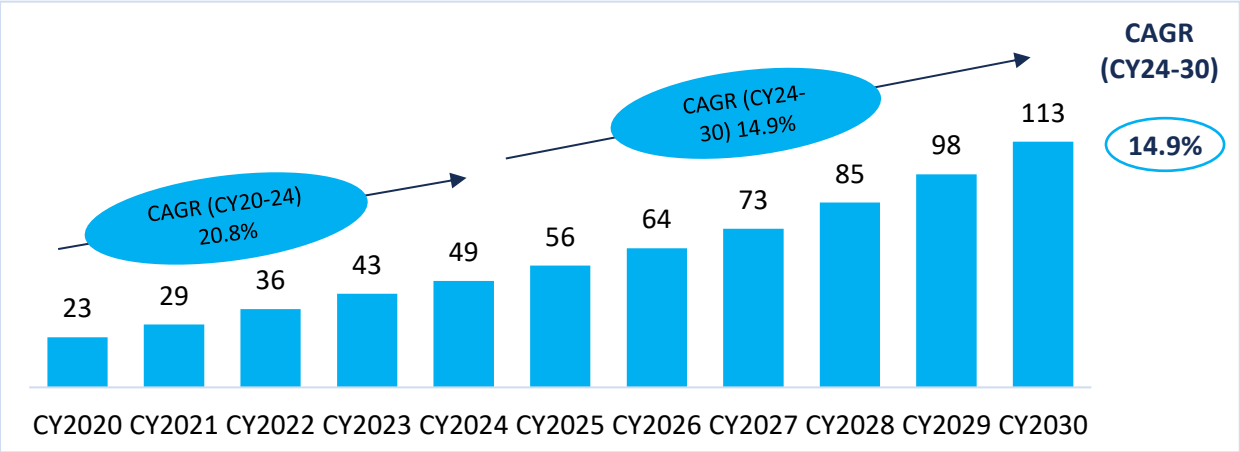
Source: Frost & Sullivan
Note: FY2025-2030 is Forecasted

In 2020, the total market for payment cards in India, which includes credit cards, debit cards, and prepaid payment instruments (PPI), was valued at INR 9,071 million. By 2024, this market had expanded to INR 30,804 million , and it is projected to reach INR 61,684 million by 2030, growing at a compound annual growth rate (CAGR) of 12.3% during the FY2024-30 period. This market size highlights the potential for card manufacturers in India.

3.7 Metal Cards Market: Analyzing Global and Indian Trends

3.7.1 Global Metal Cards Market Size and Growth Outlook:

Exhibit 38: Global Metal Cards Market Size by Number of Cards Issued, in Millions, 2020-2030F



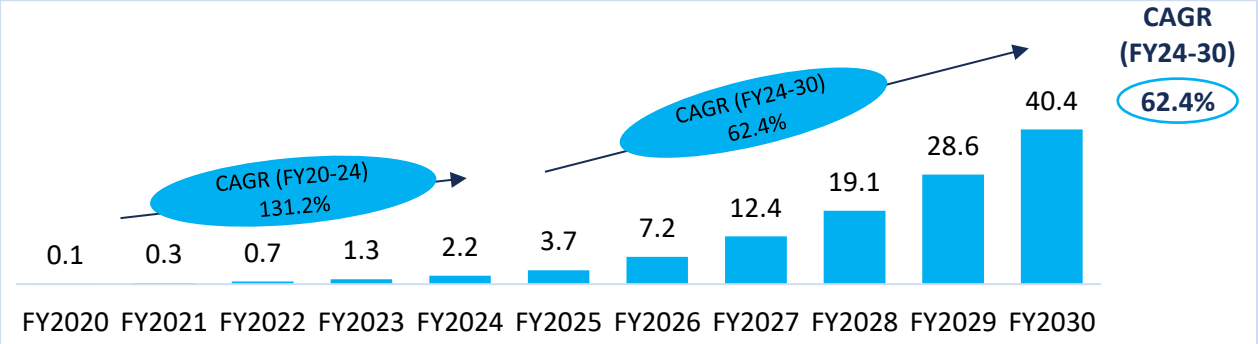
Source: Frost& Sullivan, Secondary Sources
Note: CY2025-2030 is Forecasted

The global metal cards market is projected to grow from 23 million units in 2020 to 49 million units by 2024. It will further grow to 113 million units by 2030 growing at a compound annual growth rate (CAGR) of 14.9% from 2024 to 2030.

This robust growth is anticipated to be driven by multiple factors. As the demand for premium payment cards rises, financial institutions are increasingly adopting metal cards to distinguish their products and cater to consumer preferences for durable, high-end offerings. Metal cards are more durable than plastic cards, which appeals to customers looking for long-lasting, high-quality payment instruments. This makes them ideal for long-term loyalty programs and credit card products with extended lifespans. The market is also expected to benefit from the growing appeal of metal cards among a diverse range of consumers, particularly tech-savvy millennials and Gen Z, who are drawn to the combination of functionality and luxury these cards offer. Furthermore, technological advancements that enhance the security and convenience of metal cards, such as contactless payment options and biometric authentication, are expected to contribute to market growth.

3.7.2 India Metal Cards Market Size and Growth Outlook

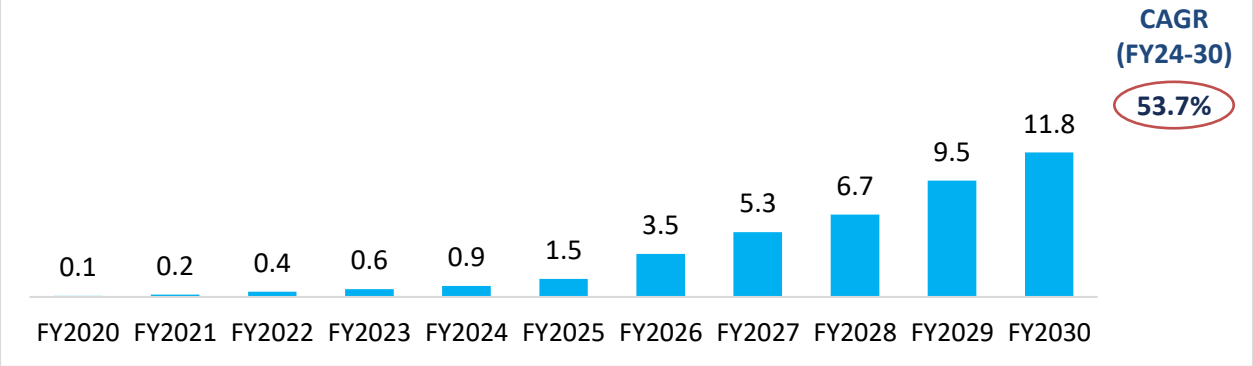
Exhibit 39: Total India Metal Cards, Size by number of cards in Force, (Million), 2020 – 2030F



Source: Frost & Sullivan
Note: FY2025-2030 is Forecasted

The total metal cards in circulation in India is expected to grow from 2.2 million units in 2024 to 40.4 million units in 2030 growing at a CAGR of 62.4% between FY2024 - 2030.

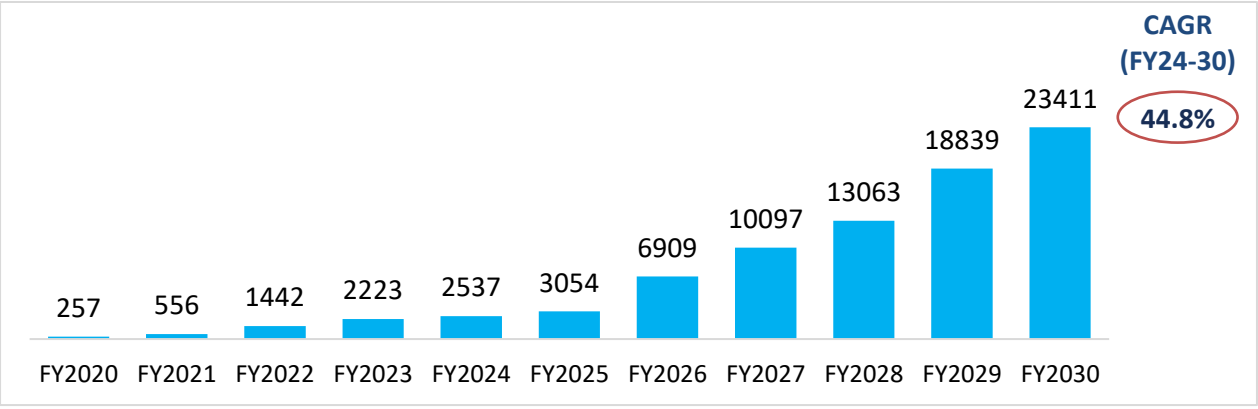
Exhibit 40: Total India Metal Cards, Size by number of cards Issued (Million), India, 2020 – 2030F



Source: Frost & Sullivan
Note: FY2025-2030 is Forecasted

The distribution of metal cards in India is projected to expand significantly, rising from 0.1 million units in 2020 to 11.8 million units by 2030, with an impressive compound annual growth rate (CAGR) of 53.7% between fiscal years 2024 and 2030.

Exhibit 41: Total India Metal Cards Issuance Market Size (INR Million), 2020 – 2030F



Source: Frost & Sullivan
Note: FY2025-2030 is Forecasted

The Indian metal cards market grew from INR 257 million in FY2020 to INR 2537 million in FY2024 and is expected to grow to INR 23,411 million in FY2030 growing at a CAGR of 44.8% between FY2024 - 2030.

The demand for metal cards is growing in Indian and global markets, driven by consumer preference for enhanced security, durability and prestige. These high end payment solutions offer opportunities for businesses to tap into both consumer and enterprise markets by addressing the evolving needs of financial institutions, fintech and affluent customers.

3.8 Threats and Challenges: India's Payment Card Industry

In the payment card industry, encompassing credit and debit cards, manufacturing vendors encounter numerous threats and challenges, such as:

Regulatory Changes:

Increased Regulation: More stringent regulatory requirements can lead to higher compliance costs and greater operational complexities.

Data Protection Laws: Complying with data protection regulations can be both difficult and costly.

Cybersecurity Threats:

Data Breaches: The ongoing threat of hacking and data breaches can cause significant financial losses and harm to reputation.

Fraud and Identity Theft: The rising incidents of fraud and identity theft require continuous investment in security technologies.

Consumer Behavior Changes:

Shift to Digital Payments: The move towards non-card-based digital and contactless payments may decrease the demand for physical cards.

Economic Factors:

Economic Downturns: Economic instability can result in reduced consumer spending and higher default rates on credit cards.

Inflation: Inflation results in higher interest costs on credit, and thus negatively impacts consumer spending.

Operational Challenges:

Technological Upgrades: Constant technological upgrades are necessary to remain competitive, which can be resource-intensive and costly.

Partnership and Integration Risks:

Reliance on Third Parties: Dependence on third-party providers for technology and services can pose risks if these partners encounter problems.

Global Market Dynamics:

Geopolitical Risks: Political instability and changes in trade policies can impact global operations, the economy, and consumer spending.

Environmental Concerns:

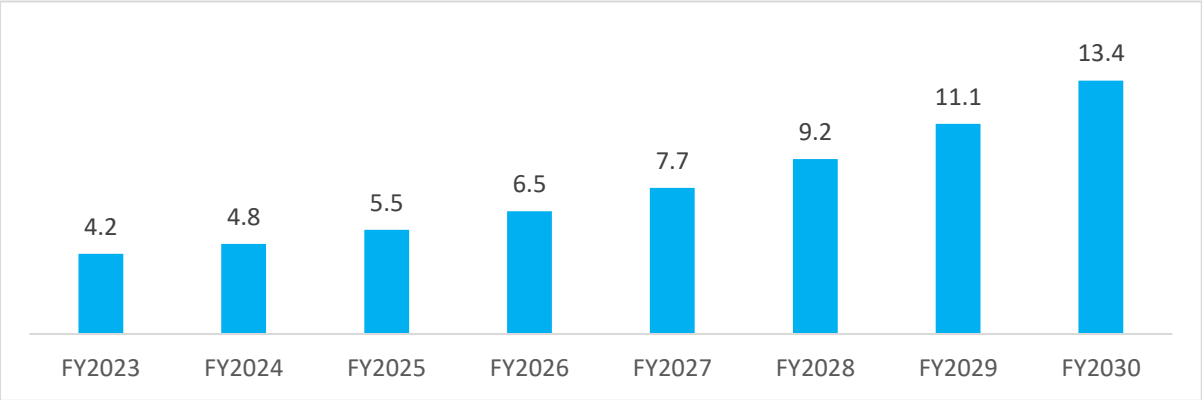
Sustainability Pressures: Growing awareness and regulatory pressures around environmental sustainability will require the development of eco-friendly cards, increasing production costs.

3.9 Wearable Technology : A Growing Payment Opportunity

In an age characterized by technological innovation, people's everyday life is increasingly intertwined with digital solutions. One such pioneering advancement is wearable technology, which has now become a significant avenue for enhancing convenience and efficiency. Beyond its notable role in promoting health and fitness, wearables are forging a promising path in the realm of digital payments, offering new possibilities to both consumers and enterprises. Wearable technology is increasingly emerging as an

expanding frontier for digital payments, presenting users with the advantages of seamless and secure transactions, unparalleled convenience, and integration into burgeoning technological ecosystems.

Exhibit 42: Global Wearables Payment Device Market, FY2023 – 2030F (INR Trillion)



Source: Frost & Sullivan Analysis
Note: FY2024-2030 is Forecasted

The global market for wearables payment devices is estimated to be INR 4.2 trillion in FY2023, with an anticipated surge to INR 13.4 trillion by FY2030. This signifies a substantial CAGR of 17.8% during the period from 2023 to 2030.

3.9.1 Global Payment Wearable Keyfobs Market: Trends and Growth Drivers:

The **payment wearable keyfobs market** is an innovative segment of the contactless payments industry, combining convenience, security, and versatility. These keyfobs, embedded with NFC (Near-Field Communication) or RFID (Radio Frequency Identification) technology, allow users to make secure payments by simply tapping the device on a point-of-sale terminal. Designed for portability, payment keyfobs are emerging as a popular alternative to smartphones and traditional payment cards in both developed and emerging markets.

Key Trends

1. **Rising Demand for Contactless Payment Solutions**: The pandemic-driven shift toward hygiene-focused, contactless transactions has bolstered the adoption of payment keyfobs. These wearables are particularly appealing in environments like gyms, festivals, and public transportation, where users seek quick, hassle-free payments.
2. **Integration with Wearable Ecosystems**: Keyfobs are increasingly becoming part of a larger wearable ecosystem, complementing other payment-enabled devices like smartwatches and rings. Their lightweight and standalone functionality make them ideal for active users or those looking for minimalistic solutions.
3. **Customization and Branding Opportunities**: Businesses and event organizers are leveraging customizable payment keyfobs as promotional tools, enhancing brand visibility while providing consumers with a practical payment solution.

Growth Drivers

1. **Technological Advancements**: Innovations in NFC and RFID technologies have improved the reliability, security, and efficiency of payment keyfobs. Features like encryption and tokenization further enhance transaction security.

2. **Adoption in Emerging Markets**: Payment keyfobs are gaining popularity in regions like Asia-Pacific and Latin America, where there is increasing financial inclusion and smartphone penetration is moderate. These wearables offer a cost-effective alternative to high-end devices while enabling users to access contactless payment ecosystems.
3. **Collaborations Between Fintech and Banks**: Partnerships between financial institutions, payment networks, and wearable device manufacturers have accelerated the availability of keyfobs. Companies like Visa, Mastercard, and various banks are driving adoption by promoting keyfobs as secure and convenient payment methods.
4. **Growing Popularity in Specific Use Cases**: Payment keyfobs are widely used in closed-loop payment systems, such as theme parks, concerts, and corporate campuses, where they enable seamless transactions and access control.

The global payment wearable keyfobs market is poised for sustained growth as consumer demand for portable, secure, and contactless payment options continues to rise. Expanding use cases, technological enhancements, and collaborations across industries will further drive adoption. As the financial technology landscape evolves, keyfobs are expected to play a significant role in transforming the way consumers interact with digital payment systems worldwide.

3.9.2 Growth Drivers Global Payment Wearable Wristbands Market: Trends and Growth Drivers:

The **payment wearable wristbands market** is witnessing significant growth, driven by the rising global preference for contactless payment solutions. Embedded with **NFC (Near-Field Communication)** or **RFID (Radio Frequency Identification)** technology, these wristbands provide a secure, convenient, and stylish way to conduct transactions, making them a preferred choice in diverse applications such as retail, events, healthcare, and transportation.

Key Trends

1. **Integration with IoT and Smart Ecosystems**: Payment wristbands are increasingly integrated into smart wearable ecosystems, allowing users to access a range of services, including payments, health tracking, and access control. Their multi-functionality makes them highly appealing for both individual users and businesses.
2. **Popularity in Events and Hospitality**: Wristbands are widely used in closed-loop payment systems at events such as music festivals, amusement parks, and corporate gatherings. They enable seamless transactions while doubling as entry passes, improving the overall user experience.
3. **Rising Adoption in Fitness and Healthcare**: Fitness enthusiasts and healthcare providers are leveraging payment wristbands with additional health-monitoring features. These dual-purpose devices are becoming popular in gyms, sports facilities, and wellness centers.
4. **Enhanced Security Features**: With growing concerns around cybersecurity, payment wristbands now incorporate encryption, tokenization, and two-factor authentication to ensure secure transactions, building trust among users.

Growth Drivers

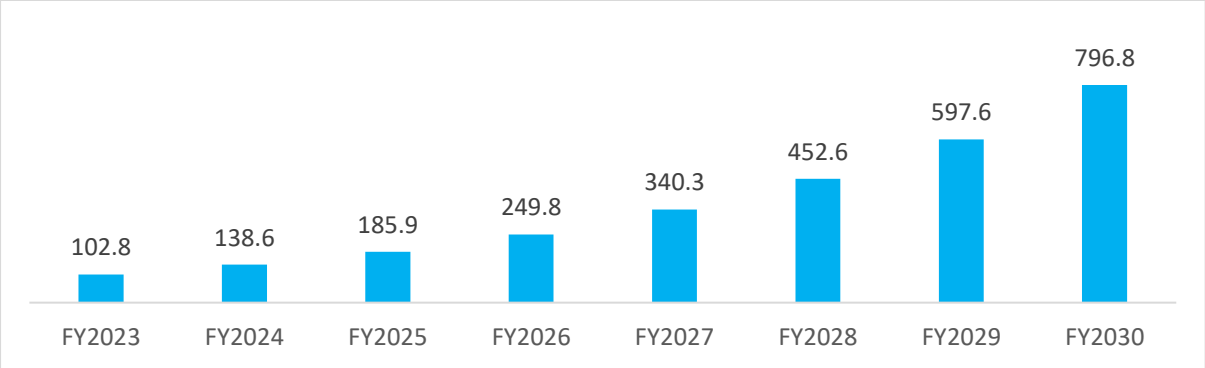
1. **Increasing Contactless Payment Adoption**: The post-pandemic shift towards hygiene-focused, contactless payment options is a major growth driver. Wristbands offer a simple, hygienic, and portable payment method that aligns with global consumer trends.
2. **Expanding Wearable Technology Market**: The overall growth in the wearable technology market, particularly in smart devices, is positively influencing the adoption of payment wristbands. They are a natural extension for users already accustomed to wearables like smartwatches and fitness trackers.
3. **Supportive Government and Corporate Initiatives**: Governments and financial institutions worldwide are promoting cashless economies. Many banks and fintech companies are collaborating with wearable manufacturers to introduce branded payment wristbands, especially in regions with growing digital infrastructure.
4. **Customization and Branding**: Payment wristbands are being adopted by businesses for their branding potential. Customizable wristbands serve as both promotional tools and practical payment solutions in retail, hospitality, and transportation sectors.

The **global payment wearable wristbands market** is set to grow significantly, driven by advancements in technology, increasing consumer awareness, and expanding use cases across industries. As the integration of IoT and AI in wearable devices accelerates, payment wristbands are expected to evolve with enhanced functionality and personalization. Key markets such as **North America**, **Europe**, and **Asia-Pacific** will continue to dominate, while emerging markets in **Latin America** and **Africa** offer new growth opportunities due to rising smartphone penetration and financial inclusion initiatives. Generation Z or new age customers prefer payment instruments across multiple formats and not just the card form factor. Since this population is growing and the needs of this segment require to be addressed, the payment on the go form factor variants will appeal in design and form to the Generation Z segment.

3.9.3 India’s Payments Wearable Market

In India, the rapid expansion of the digital payments ecosystem, especially after demonetization in 2016 and the increasing demand for smartwatches, smart bands and fitness trackers have prompted consumer electronics brands to introduce products with advanced payment features. Consumer electronics companies are partnering with banks and financial institutions to offer integrated payment services. For example, in August 2024, Airtel Payments Bank teamed up with Noise and the National Payments Corporation of India (NPCI) to launch a smartwatch enabled with the National Common Mobility Card (NCMC) and integrated with the RuPay chip. Similar innovations in other regions are expected to contribute to substantial growth in the regional market.

Exhibit 43: Indian Wearables Payment Device Market, FY2023 – 2030F (INR Billion)



Source: Frost & Sullivan
Note: FY2025-2030 is Forecasted

The Indian market for wearables payment devices is estimated to be INR 138.6 billion in FY2024, with an anticipated surge to INR 796.8 billion by FY2030. This signifies a substantial CAGR of 33.8% during the period from 2024 to 2030.

3.9.4 Payments Wearable Market in India- Growth drivers & trends

Smartwatches, rings, wristbands, and fitness bands are just a few examples of wearable technologies enabling secure transactions. In addition, several companies have introduced innovative wearable devices that link directly to users' bank accounts. A major factor driving the growth of the global wearable payments market is the growing shift toward wearable payment solutions across industries, aiming to enhance customer convenience. By adopting wearable payment technologies, businesses can streamline the customer experience, eliminating the need to carry cash and reducing concerns over pickpocketing. Furthermore, many retail and transportation companies are integrating wearable technology to offer customers a more seamless and practical experience, further fuelling the market's expansion.

The growth of the payment wearable device market in India is being driven by several key factors:

1. **Expansion of Digital Payments Ecosystem**: India's rapidly growing digital payments landscape, fueled by initiatives such as the *Digital India* campaign and the adoption of UPI (Unified Payments Interface), is creating a strong foundation for wearable payment devices. The increasing adoption of cashless transactions and the push for financial inclusion are driving consumer interest in contactless, convenient payment methods through wearable devices.

2. **Rising Smartphone and Internet Penetration**: As smartphone usage and internet penetration continue to rise, more consumers have access to digital payment platforms, making wearable payment devices a logical extension. The growing use of mobile wallets, UPI apps, and digital banking is contributing to the adoption of wearables that integrate seamlessly with these platforms.

3. **Increased Demand for Smartwatches and Fitness Trackers**: The growing popularity of smartwatches, fitness trackers, and other wearable devices, particularly among the tech-savvy and health-conscious populations, has paved the way for the integration of payment functionality into these devices. Fitness tracking and health monitoring capabilities paired with payment options have made wearables more attractive to consumers.

4. **Collaborations Between Consumer Electronics Brands and Financial Institutions**: Partnerships between technology companies, banks, and financial institutions are driving innovation in the wearable payment space. For example, companies like Noise, Fitbit, and Samsung are collaborating with banks like ICICI and Axis Bank, as well as payment networks like RuPay and Visa, to offer integrated payment solutions on wearables. These collaborations are enhancing the availability and reliability of wearable payment solutions.

5. **Convenience & Security**: Wearable devices offer consumers the convenience of making payments on the go without the need for cash or physical cards. The added layer of security provided by biometric authentication (e.g., heart rate sensors, fingerprints) and tokenization technology makes wearable payments more appealing in terms of safety and ease of use.

6. **Government Initiatives & Support for Cashless Transactions**: The Indian government's continued efforts to promote a cashless economy, including the promotion of digital payments through platforms like *BHIM* and *UPI*, has accelerated the adoption of wearable payments. The government's support for digital payments through subsidies, financial literacy programs, and regulatory frameworks is also encouraging the growth of the sector.

7. **Consumer Preference for Contactless Payments**: Following the COVID-19 pandemic, there has been an increased demand for contactless payment methods to reduce physical contact. Wearable devices, with their ease of use and hygiene benefits (no need to touch a card or cash), align perfectly with this shift in consumer behavior.

Together, these factors are fueling the growth of the wearable payment device market in India, positioning the country as one of the key markets for wearables in the global digital payment ecosystem.

The payment wearable device market in India is poised for significant growth in the coming years, driven by evolving consumer needs, technological advancements, and the expanding digital ecosystem. Some key future trends in the Indian market include:

1. Integration with Advanced Payment Systems (NFC, UPI, RuPay) for Contactless Payments: As more Indian consumers embrace contactless payment methods, wearables will increasingly integrate Near Field Communication (NFC) technology. This will enable secure, tap-and-go transactions at retail outlets, transportation systems, and more. With the rise of UPI as a dominant payment method in India, wearable devices will increasingly support UPI for instant, seamless transactions. This will allow consumers to make payments directly from their wearables by linking them with their UPI IDs. Wearables integrated with India's domestic payment network, RuPay, are likely to become more common. With government support and growing acceptance of RuPay in India, wearables that support RuPay for payments will gain traction.

2. Increased Adoption of Biometric Authentication, AI & Machine Learning: The future of wearable payment devices in India will likely see greater use of biometric authentication technologies such as fingerprint scanning, facial recognition, and even heart rate sensors to validate transactions. This will improve security and user experience by reducing the need for PINs or passwords, making transactions more seamless and secure. Integration of artificial intelligence (AI) and machine learning (ML) for personalized payment experiences and fraud detection will enhance the security and functionality of wearable payment devices.

3. Expansion into Public Services & Transportation: Payment wearables will be increasingly integrated into smart city infrastructure, enabling easy payments for public transport, tolls, parking, and other civic services. For example, wearables could be used for contactless ticketing on buses, metro trains, and taxis, providing a seamless experience for commuters. Growth of wearables in the transportation sector is also expected, with devices enabling payments across different modes of transport (e.g., trains, buses, ride-sharing services) with a single device linked to multiple accounts.

4. Health & Wellness Features Integration: Payment wearables in India will evolve beyond basic transaction functions to include advanced health and fitness tracking features. Devices will not only facilitate payments but also monitor vital signs, track physical activity, and provide health data analytics, creating a holistic experience for health-conscious users. As wearables gather more health data, insurance companies may offer wearable-linked health policies, and wearable devices may enable payments for medical services directly, streamlining healthcare transactions.

5. Virtual Wallet Integration: Future wearables will likely integrate with digital wallets and mobile payment platforms (e.g., Google Pay, Paytm) to provide a unified payment experience. This will make it even easier for consumers to manage multiple payment options on a single device.

6. Affordability & Increased Consumer Access : As the market matures, the cost of wearable payment devices will decrease, making them more affordable and accessible to a larger demographic, including middle-income consumers. This will drive the mass adoption of wearables, particularly in tier 2 and tier 3 cities across India. In addition to smartwatches, expect an increase in the variety of wearable devices capable of making payments, such as fitness bands, rings, and even smart jewelry. This variety will cater to a broader audience and diverse consumer preferences.

7. Collaborations Between Tech and Financial Sectors: Indian banks and fintech companies will continue to partner with consumer electronics and wearable brands to launch co-branded wearable payment devices. The collaboration between tech companies like Apple, Samsung, and Indian financial institutions will drive innovation and product availability. Payment wearable devices will also work across different platforms, supporting multiple payment methods, currencies, and transaction types, enabling consumers to use the same device in both domestic and international markets.

The future of the wearable payment device market in India looks promising, with rapid advancements in technology, changing consumer behavior, and increased digital payments adoption. As wearables become more integrated into daily life, offering convenience, security, and personalization, the market is set to expand rapidly, transforming how consumers in India make payments and interact with the digital economy.

3.9.5 Threats and Challenges to the Growth of the Payment Wearables Market:

The global payment wearables market faces several threats and challenges that could hinder its expansion:

High Initial Costs and Limited Affordability: Payment wearables, especially premium devices like smartwatches and luxury bands, often come with high price points. This limits their accessibility to budget-conscious consumers, particularly in emerging markets where disposable incomes are lower.

Data Security and Privacy Concerns: As payment wearables rely on wireless communication technologies like NFC and Bluetooth, they are vulnerable to cyberattacks, data breaches, and

skimming. Consumer apprehension regarding the security and privacy of their financial information remains a significant barrier to adoption.

Fragmented Ecosystem and Lack of Interoperability: The payment wearables market is characterized by a lack of standardization and interoperability across devices, platforms, and financial systems. This fragmentation can lead to compatibility issues, limiting user convenience and adoption rates.

Dependence on Smartphone Pairing: Many payment wearables rely on pairing with smartphones for functionality, which can deter users who prefer standalone devices or who lack access to compatible smartphones.

Market Saturation in Developed Economies: In regions like North America and Europe, where wearables adoption is already high, market growth may slow due to saturation and limited room for new customers.

Limited Awareness and Adoption in Emerging Markets: While emerging markets represent significant growth potential, limited awareness, lack of infrastructure, and slower adoption of digital payment technologies pose challenges to market expansion in these regions.

Technological and Battery Limitations: Wearable devices face challenges related to battery life, performance, and durability. Frequent charging and maintenance requirements can impact user experience and acceptance.

Regulatory and Compliance Issues: Payment wearables operate in a highly regulated environment. Navigating complex financial regulations, compliance standards, and regional laws can be a significant hurdle for manufacturers and service providers.

Addressing these challenges will require ongoing innovation, strategic collaborations, and targeted efforts to build consumer trust, enhance device affordability, and expand infrastructure to support the adoption of payment wearables globally.

4. CREDIT AND DEBIT CARD MARKETS: INTERNATIONAL BENCHMARKING

4.1. Global Payment Card Landscape: Total Number of Cards

Exhibit 44: Total Payment Cards in Circulation, Global, in Billion, CY2023-29F
Source: Frost & Sullivan, Secondary Sources
Note: FY2024-2029 is Forecasted

The total payment cards in circulation reached 18.6 billion in 2023 and is projected to grow to 21.6 billion by 2029, with a Compound Annual Growth Rate (CAGR) of approximately 2.5% during the 2024-2029 period.

This segment's expansion is propelled by a global transition towards digital transactions, including card-based payments, a trend that gained momentum due to the COVID-19 pandemic. Key factors driving this growth include the convenience of contactless payments, robust security measures, and increasing consumer confidence in digital transaction methods (encompassing card-based payments). Enhanced security measures powered by AI-driven fraud detection and biometric authentication (such as fingerprint-enabled cards) have also bolstered consumer trust. Additionally, the rise of embedded finance and super-app wallets has integrated payment cards into broader ecosystems that merge loyalty, BNPL, and identity features. Global initiatives, such as Europe's pan-EU wallet "Wero" and the integration of stablecoins into major networks like Visa and Mastercard, are reshaping the infrastructure and interoperability of payments.

Debit cards in circulation totalled 15.2 billion units in 2023 and are expected to reach 17.7 billion by 2029, demonstrating a CAGR of 2.6% between 2023 and 2029. The surge in debit card usage can be attributed to various factors, including the ease of acquisition when opening new bank accounts, the rise in online and in-store shopping, and a general shift away from cash transactions. Debit cards also offer enhanced security features and are increasingly integrated with digital wallets and contactless payment technologies.

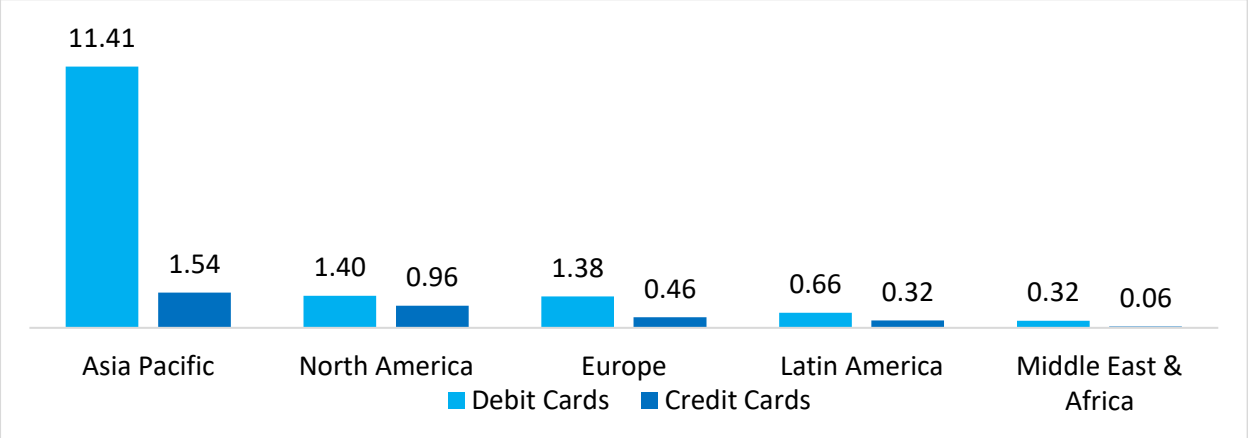
The total credit cards in circulation was 3.3 billion units in 2023 and is projected to expand to 3.7 billion units by 2029, growing at a CAGR of 1.8% from 2023 to 2029. This growth is fuelled by increased consumer spending, the expansion of e-commerce platforms, and the rise in global travel. Credit cards remain popular due to associated benefits such as reward points, cashback offers, and the opportunity to build credit history. Moreover, financial institutions continually innovate credit card features, introducing co-branded cards and enhancing security measures to attract a wider customer base.

The prepaid cards market comprised 0.14 billion units in circulation in 2024 and is anticipated to reach 0.16 billion units by 2029, exhibiting a CAGR of 2.6% from 2024 to 2029. The growth in this sector is primarily driven by the versatility and convenience of prepaid cards, making them a preferred choice for budget management and for consumers without access to traditional banking services. These cards are widely utilized for specific purposes such as gift cards and travel expense cards. Furthermore, the increasing adoption of digital and mobile-first solutions, particularly in emerging economies, is contributing significantly to the market growth of prepaid cards.

4.2. Regional Debit and Credit Card Breakdown

The Asia Pacific region stands out as a powerhouse with an impressive 11.41 billion debit cards, reflecting a strong growth trajectory. This surge is driven by rapid economic development, the expansion of middle-class populations, and the widespread adoption of digital financial services. Governments and financial institutions in the region have been proactive in promoting financial inclusion, significantly increasing the number of individuals with access to debit cards, thereby contributing to the overall growth in the region.

Exhibit 45: Total Credit Cards & Debit Cards by Region, 2024 (Billion)



Source: World Bank, Frost & Sullivan Analysis

In North America and Europe, the total number of debit cards is 1.4 billion and 1.38 billion, respectively. These mature markets show steady growth, bolstered by technological advancements, a focus on financial literacy, and evolving consumer preferences. The ongoing shift towards a cashless society and the convenience of debit cards for both online and offline transactions continue to maintain their prominence.

Latin America, with 663 million debit cards, is witnessing a gradual but steady rise in card usage. Factors like surging internet penetration, a growing middle class, and efforts to formalize the economy have helped in the rise of debit card adoption. Governments in the region are actively working to promote electronic payments and financial inclusion, presenting opportunities for further expansion. In the Middle East & Africa, where the total number of debit cards is 315 million, initiatives focused on enhancing financial infrastructure and expanding banking services are driving the adoption of debit cards, opening up new avenues for growth and development.

For credit cards, the Asia-Pacific (APAC) region leads the market with 1.54 billion credit cards in circulation, followed by North America with 961 million credit cards. North America's well-developed financial infrastructure, combined with a culture of consumer spending, has been a key driver of credit card growth in the region. The convenience and flexibility offered by credit cards, along with attractive rewards and loyalty programs, have contributed to their popularity among North American consumers, fuelling the continuous expansion of the market.

Europe ranks third with 461 million credit cards, indicating a significant presence in the region's financial landscape. Factors such as rising disposable income, increasing consumer confidence, and the convenience of credit card transactions have propelled their adoption. Furthermore, regulatory initiatives like the Payment Services Directive (PSD2) have stimulated competition and innovation in the European payments market, creating opportunities for fintech startups and traditional financial institutions to offer innovative credit card products and services.

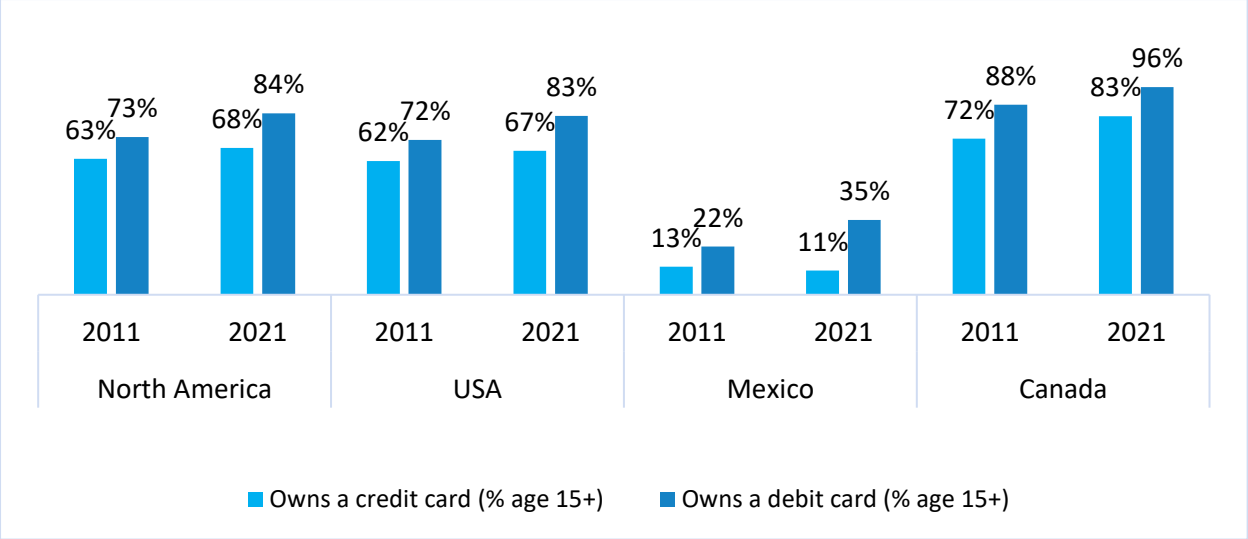
As the global landscape of financial transactions continues to evolve, new developments and opportunities are emerging. The integration of advanced technologies such as blockchain, artificial intelligence, and biometrics is reshaping the payment card ecosystem, enhancing security, and providing innovative functionalities. Cross-industry collaborations, regulatory advancements, and the ongoing digitalization of economies present opportunities for stakeholders to capitalize on the growing demand for secure and convenient payment solutions. These factors ensure the continued growth and relevance of payment cards on a global scale, with debit cards playing a significant role in this transformation.

4.3. International Benchmarking: Debit and Credit Card Issuance

North America

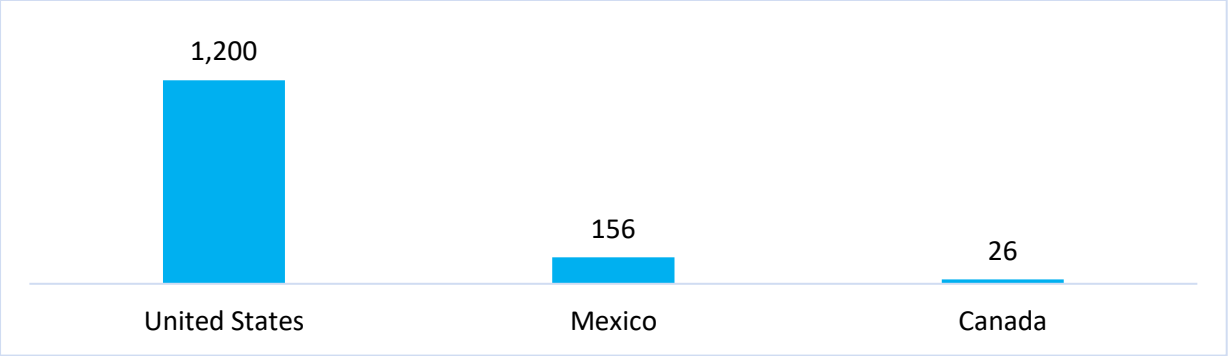
Credit and debit card penetration continues to grow in North America. In the USA, credit card penetration increased from 62% in 2011 to 67% in 2021, while debit card penetration rose from 72% to 83% over the same period. In Mexico, credit card penetration has slightly decreased, dropping from 13% in 2011 to 11% in 2021, but debit card penetration has grown from 22% to 35%. Decline in credit card penetration in Mexico could be linked to higher costs associated with such cards in Mexico, a strong cultural preference for cash in the region and also the rise of digital alternatives. In Canada, penetration levels are notably high; credit card penetration climbed from 72% in 2011 to 83% in 2021, and debit card penetration increased from 88% to 96% during the same timeframe.

Exhibit 46: North America Credit & Debit Card Penetration (%), 2011-2021



Penetration based on proportion of populace aged 15+
Source: World Bank, Frost & Sullivan Analysis

Exhibit 47: North America Debit Cards (Million) By Country, 2023



Source: World Bank, Frost & Sullivan Analysis

In North America, the United States takes the lead with an astonishing 1200 million debit cards and 827 million credit cards. Financial infrastructure, widespread access to banking services, and a culture of consumer spending are factors that contribute to the growth of debit and credit cards usage in the U.S. Similarly, in Canada, the credit and debit cards penetration rate is high owing to availability of advanced banking facilities and a tech-savvy population.

Exhibit 48: North America Credit Cards (Million) By Country, 2023

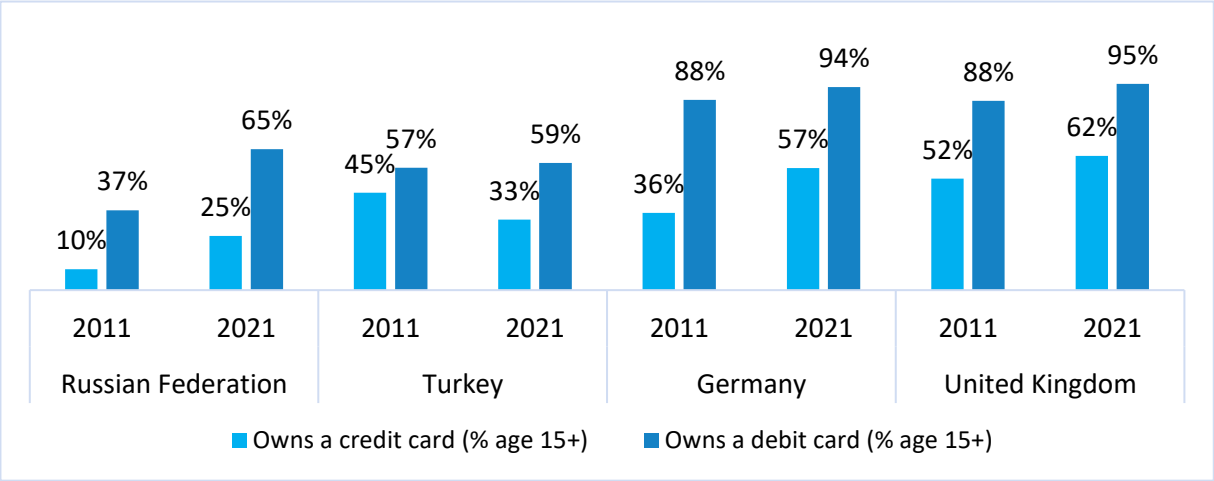
Source: World Bank, Frost & Sullivan Analysis

Europe

Credit and debit card penetration rates are high across most European countries. In the UK, credit card penetration increased from 52% in 2011 to 62% in 2021, while debit card penetration rose from

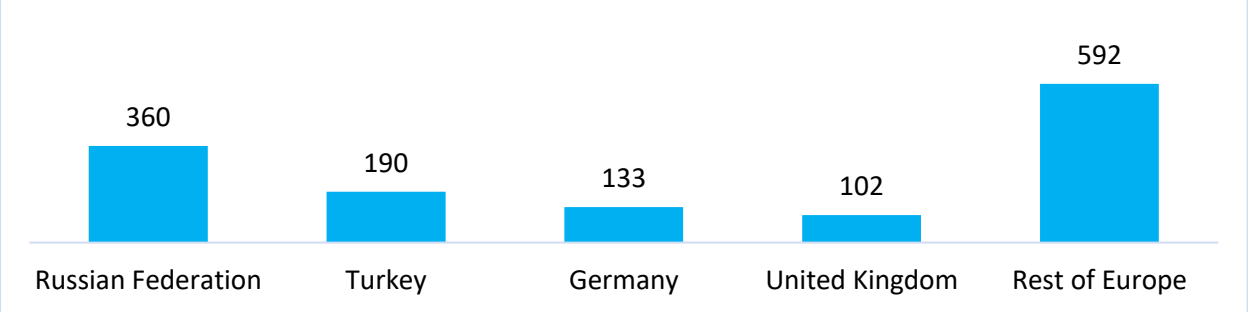
88% to 95% over the same period. In Germany, credit card penetration grew from 36% in 2011 to 57% in 2021, and debit card penetration increased from 88% to 94%.

Exhibit 49: Europe Credit & Debit Card Penetration (%), 2011-2021



Penetration based on proportion of populace aged 15+
Source: World Bank, Frost & Sullivan Analysis

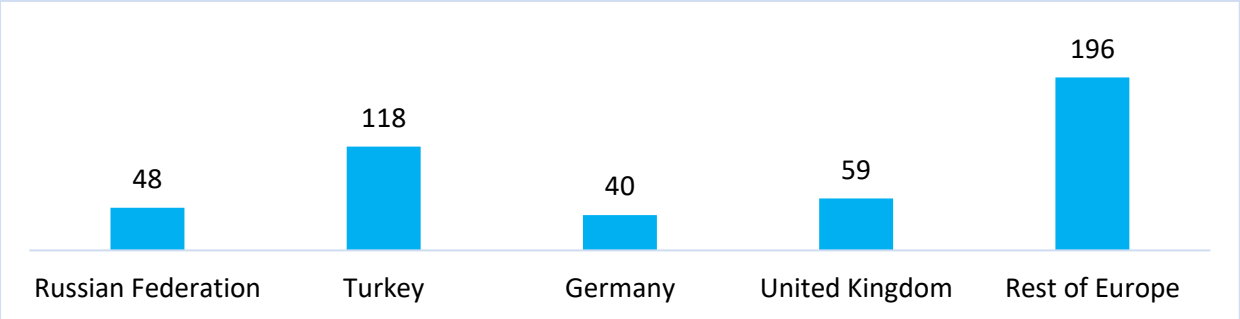
Exhibit 50: Europe Debit Cards (Million) By Country, 2023



Source: World Bank, Frost & Sullivan Analysis

Countries like the United Kingdom, Germany, France, and Italy exhibit strong adoption rates for credit and debit cards, supported by well-established banking systems, strong consumer protection laws, and a preference for cashless transactions. The growth of digital banking platforms and the adoption of contactless payment technology have further boosted debit card usage in these nations. Moreover, initiatives focused on promoting financial literacy and improving digital infrastructure create additional opportunities for expansion in the European market.

Exhibit 51: Europe Credit Cards (Million) By Country, 2023

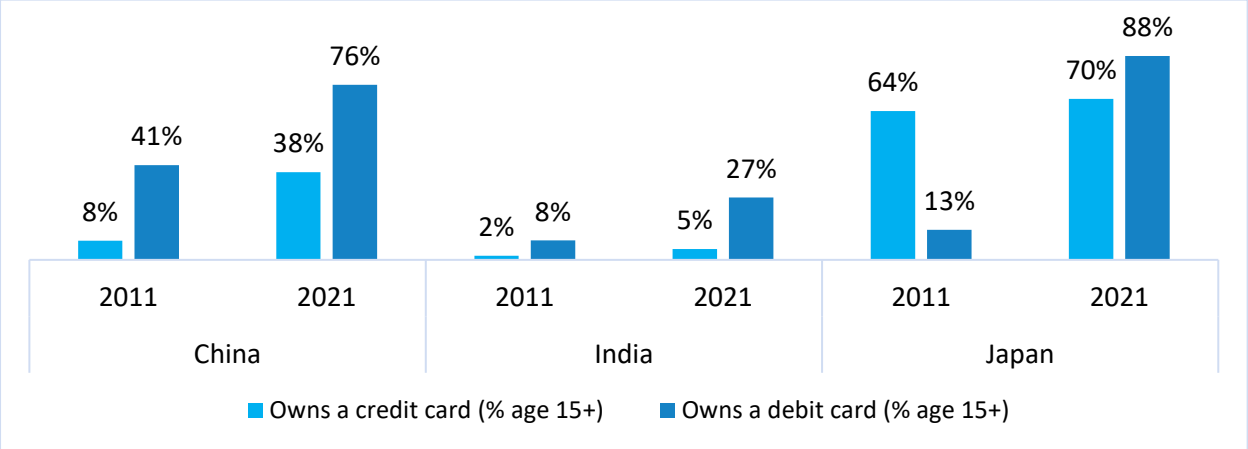


Source: World Bank, Frost & Sullivan Analysis

Asia Pacific

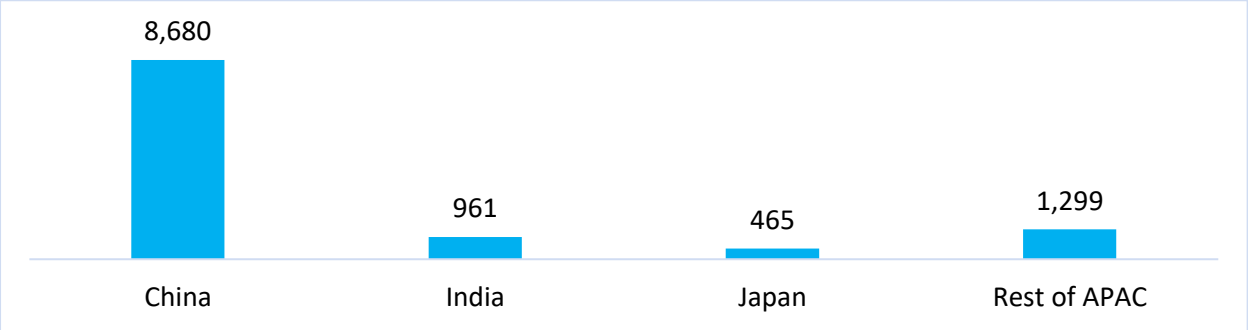
Credit and debit card penetration rates are moderate across most countries in the Asia Pacific region. In Japan, credit card penetration increased from 64% in 2011 to 70% in 2021, while debit card penetration saw a significant rise from 13% to 88% over the same period. In India, credit card penetration grew from 2% in 2011 to 5% in 2021, and debit card penetration increased from 8% to 27%. These low to moderate penetration rates indicate substantial growth potential for credit and debit cards in some of these markets.

Exhibit 52: Asia Pacific Credit & Debit Card Penetration (%), 2011-2021



Penetration based on proportion of populace aged 15+
Source: World Bank, Frost & Sullivan Analysis

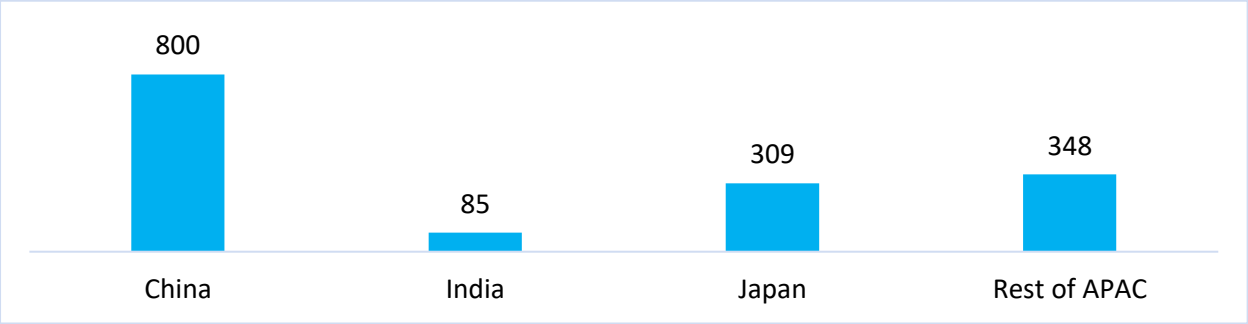
Exhibit 53: Asia Pacific Debit Cards (Million) By Country, 2023



Source: World Bank, Frost & Sullivan Analysis

In the Asia Pacific region, China stands out as a dominant force with 8.68 billion debit cards and 800 million credit cards. The widespread adoption of debit cards is fueled by the country's rapid economic growth, urbanization, and government-led efforts to promote financial inclusion. Similarly, in Japan, a well-developed banking infrastructure and a tech-savvy population drive the high usage of debit cards for both online and offline transactions. There are significant growth opportunities in countries like India and Indonesia, where penetration rates are still relatively low but are steadily rising due to increased access to banking services and growing smartphone usage.

Exhibit 54: Asia Pacific Credit Cards (Million) By Country, 2023

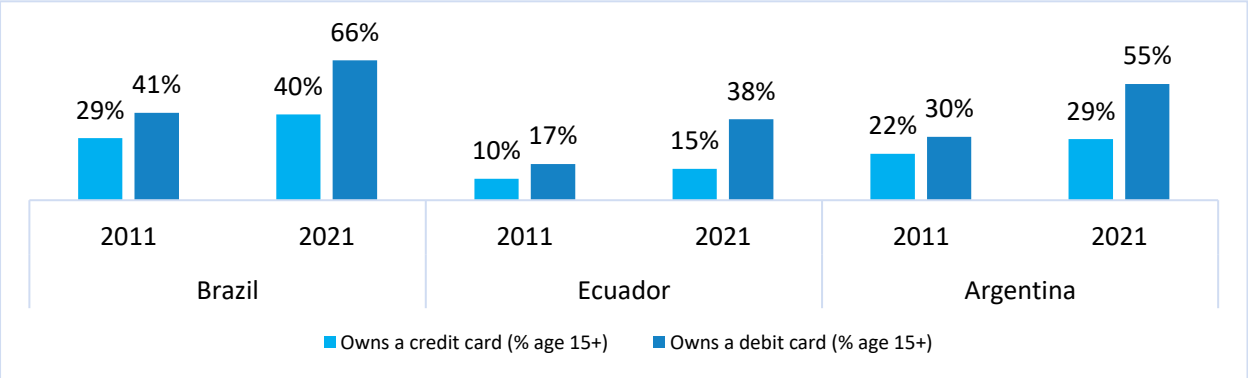


Source: World Bank, Frost & Sullivan Analysis

Latin America

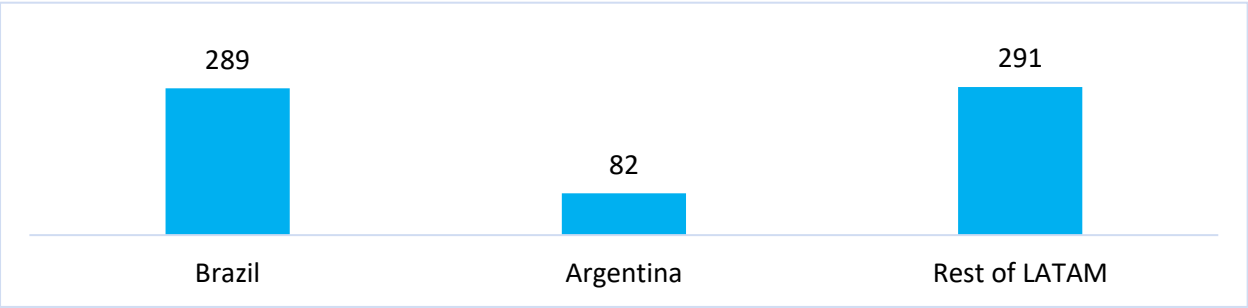
Credit and debit card penetration rates are moderate across most countries in Latin America. In Brazil, credit card penetration increased from 29% in 2011 to 40% in 2021, while debit card penetration grew from 41% to 66% over the same period. In Argentina, credit card penetration rose from 22% in 2011 to 29% in 2021, and debit card penetration increased from 30% to 55%.

Exhibit 55: Latin America Credit & Debit Card Penetration (%), 2011-2021



Penetration based on proportion of populace aged 15+
Source: World Bank, Frost & Sullivan Analysis

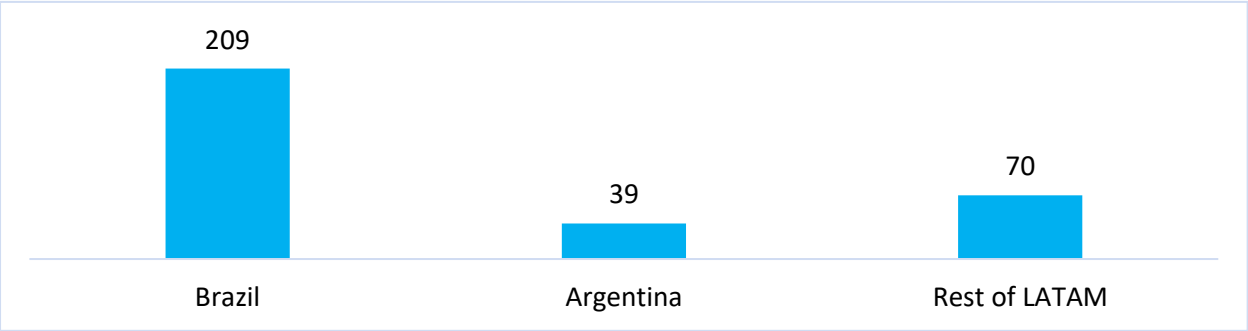
Exhibit 56: Latin America Debit Cards (Million) by Country, 2023



Source: World Bank, Frost & Sullivan Analysis

In Latin America region, Brazil is a major debit and credit cards market with 289 million and 209 million cards respectively in circulation. Factors such as better financial infrastructure, government initiatives to promote digital payments, and a growing middle class contribute to the growth of debit card usage in these regions.

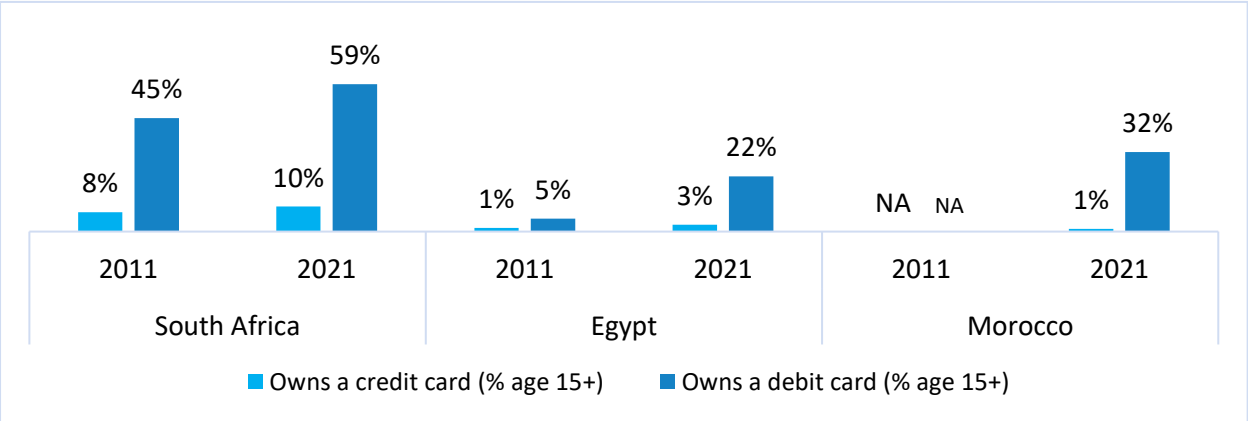
Exhibit 57: Latin America Credit Cards (Million) By Country, 2023



Source: World Bank, Frost & Sullivan Analysis

Middle East & Africa (MEA)

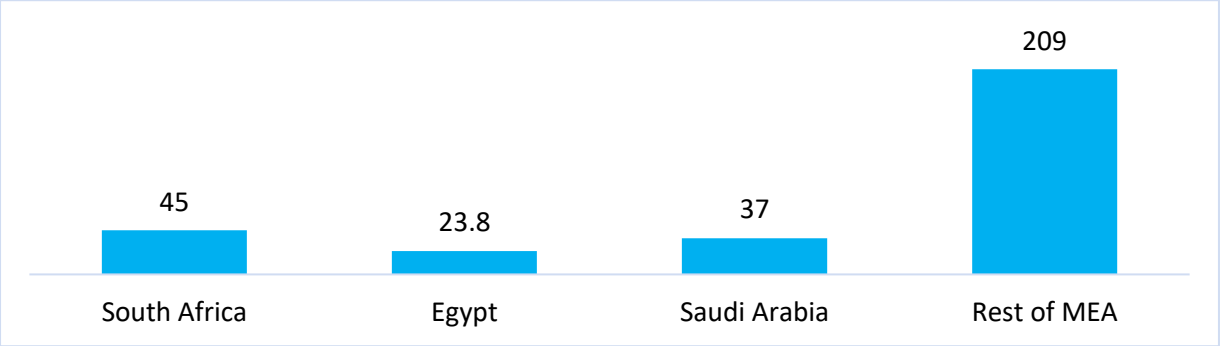
Exhibit 58: Middle East Credit & Debit Card Penetration (%), 2011-2021



Penetration based on proportion of populace aged 15+
Source: World Bank, Frost & Sullivan Analysis

The penetration rates for credit cards and debit cards vary across countries in Middle East & Africa. For South Africa, the penetration of credit cards has risen from 8% in 2011 to 10% in 2021, whereas the same for debit cards has risen from 45% in 2011 to 59% in 2021. For Egypt, the penetration of credit cards has risen from 1% in 2011 to 3% in 2021, whereas the same for debit cards has risen from 5% in 2011 to 22% in 2021. The low penetration rates signify huge upside potential for such cards in some of these regions

Exhibit 59: MEA Debit Cards (Million) By Country, 2023

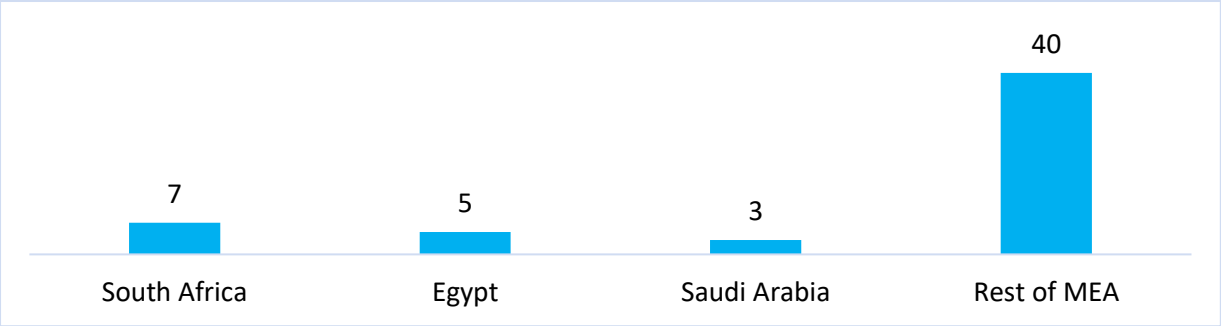


Source: World Bank, Frost & Sullivan Analysis

Within the MEA region, South Africa is one of the most significant markets for payment cards with 45 million debit cards in circulation. Challenges persist, including low levels of financial literacy and restricted access to banking services, hindering widespread adoption in the region. However, initiatives aimed at overcoming these obstacles and leveraging the increasing demand for digital

payments provide stakeholders with opportunities to enhance their foothold in these markets and stimulate additional growth in both debit and credit card utilization.

Exhibit 60: MEA Credit Cards (Million) By Country, 2023



Source: World Bank, Frost & Sullivan Analysis

4.4. Debit and Credit Cards: Drivers, Challenges, Trends, and Opportunities

Growth Drivers, Challenges, Trends and Opportunities for Debit Cards:

Growth Drivers:

The rise of e-commerce and online services has boosted debit card usage for digital transactions, driven by convenience, speed, and security features like two-factor authentication. Financial inclusion initiatives, such as India's Jan Dhan Yojana, have increased debit card issuance in developing countries. Debit cards offer a balance of convenience and security, with features like PINs and chip technology making them safer than cash.

Challenges:

Debit card issuers face challenges including regulatory compliance with evolving AML and KYC norms, competition from alternative payment methods like digital wallets and peer-to-peer apps, and maintaining operational efficiency as transaction volumes grow. Additionally, shifting consumer preferences, such as the rise of contactless and mobile payments, require continuous innovation to stay competitive.

Trends:

The growth of e-commerce has driven increased debit card usage, often incentivized by cashback offers. Contactless payments are becoming the norm in many countries, while mobile wallets and banking apps integrate debit card features for added convenience. Biometric authentication enhances security, and issuers are adopting eco-friendly debit cards to reduce environmental impact.

Opportunities:

Debit card issuers are expanding into emerging markets by tailoring financial products for unbanked populations. They are also using data analytics to offer personalized services and enhance fraud detection. Partnerships with fintechs, such as Niyo's collaboration with banks to offer innovative debit cards with features like zero forex markup, are driving innovation and growth.

Growth Drivers, Challenges, Trends and Opportunities for Credit Cards

Growth Drivers:

The global credit card holder base is growing, driven by high adoption rates in countries like Canada and the U.S., reflecting a trend towards financial inclusion globally. A surge in digital transactions has led to increased credit card use, particularly for online shopping. Despite concerns about debt, many cardholders rely on credit for financial management. The widespread acceptance of credit cards by merchants underscores their importance in modern commerce. With convenience and enhanced security features, credit cards remain essential for consumers. Additionally, the emergence of co-branded cards, which offer tailored benefits through partnerships, is fueling growth in the credit card market.

Challenges:

As credit card usage grows, so do security concerns and the risk of data breaches, prompting companies to invest in advanced security measures to maintain consumer trust. The credit card market also faces challenges in navigating varying regulatory environments related to consumer protection. Additionally, economic changes like inflation and shifts in consumer spending can impact credit card usage patterns and debt management.

Trends:

Credit card issuers are expanding their product ranges, introducing premium tiers and segmented offerings to cater to diverse consumer needs. Further, there's a shift in consumer preference from points-based rewards to cashback incentives, prompting issuers to adjust their marketing strategies. Issuers are closely monitoring delinquency rates for signs of financial distress, while the global trend toward cashless transactions benefits the credit card industry, particularly in regions like Asia Pacific.

Fintech companies are driving innovation through AI-driven underwriting, alternative data usage, and user-friendly credit solutions that broaden access to underserved demographics, particularly in emerging markets like India..

Robust data security measures such as AI-powered fraud detection, biometric authentication, and adherence to evolving standards like PCI DSS 4.0 remain critical to protect against cyber threats, maintain regulatory compliance, and foster consumer trust in the digital payment ecosystem.

Opportunities:

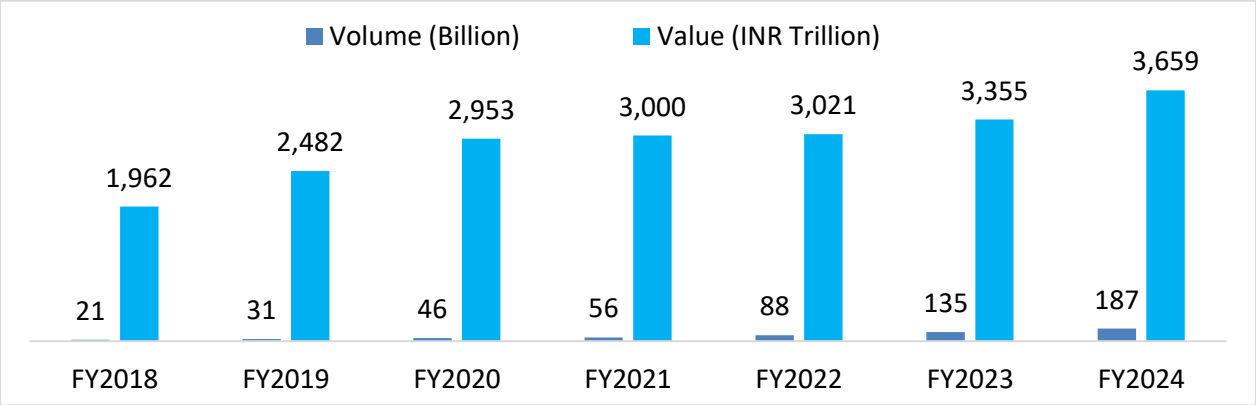
The credit card industry has opportunities to enhance security and user experience through emerging technologies like blockchain and artificial intelligence. The Asia Pacific region presents significant growth potential due to increasing urbanization and a shift toward cashless payments. Further, improving reward programs can help issuers attract and retain customers, while targeting new demographics and market segments offers further avenues for expansion.

5. DIGITAL PAYMENTS IN INDIA: ANALYZING THE LANDSCAPE

5.1. Digital Transactions in India: Volume and Value Breakdown

The rapid expansion of digital transactions has become a hallmark of India's economic evolution in recent times. This remarkable shift has been propelled by a combination of factors. Government-driven programs, like the "Digital India" initiative, have established a comprehensive digital framework, making electronic transactions more widely available. The deployment of Aadhaar, a biometric identification system, has simplified verification procedures, bolstering security and user-friendliness.

Exhibit 61: Total Volume/Value of Digital Transactions in India, 2024

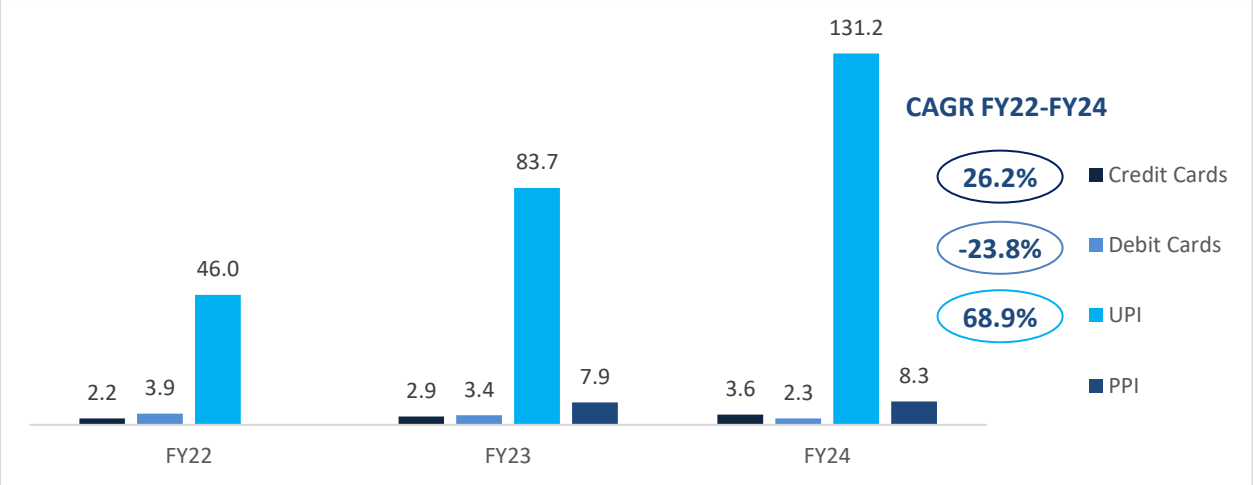


Note: Digital payment tools included Real Time Gross Settlement (RTGS), Unified Payments Interface (UPI), National Electronic Fund Transfer (NEFT), Immediate Payment Service (IMPS), Credit and Debit cards, Prepaid Payment Instruments, National Automated Clearing House (NACH), Aadhaar enabled Payment Service (AePS) (Fund Transfers), BHIM Aadhaar Pay, and National Electronic Toll Collection (NETC) (linked to bank account)
Source: RBI, Frost & Sullivan; pib.gov.in/PressReleasePage.aspx?PRID=2057013

The Indian government is committed to promoting digital transactions throughout the nation's economy, with the aim of fortifying the financial industry and nhancing citizens' living standards. This coordinated endeavor, involving all relevant parties, has resulted in a notable surge in digital payment transactions, escalating from 2,071 crore transactions in FY 2017-18 to an impressive 18,737 crore transactions in FY 2023-24, demonstrating a CAGR of 44.4 percent, while the value of transactions stood at ₹3,659 trillion in FY23-24 up from ₹1,962 lakh crore in FY17-18 growing at CAGR of 11%. The volume of digital transactions reached 8,659 crore by August end in FY25 while the total value of transactions for the same period stood at ₹1,669 trillion. Over the past five years, various user-centric digital payment methods such as Bharat Interface for Money-Unified Payments Interface (BHIM-UPI), Immediate Payment Service (IMPS), and National Electronic Toll Collection (NETC) have experienced substantial growth. These payment modes have transformed the digital payment landscape, enabling both person-to-person (P2P) and person-to-merchant (P2M) transactions. Similarly, the National Electronic Funds Transfer (NEFT) and Real Time Gross Settlement (RTGS) systems have played a crucial role in reshaping the country's digital payment environment. In the past few years (2021-2024), NEFT and RTGS systems have seen remarkable growth, with NEFT experiencing a 135% increase in volume (from 3.1 billion in FY21 to 7.3 billion in FY24) and a 56% rise in value (from INR 251 trillion in FY21 to INR 391 trillion in FY24), while RTGS has witnessed a 70% increase in volume (from 0.16 billion in FY21 to 0.27 billion in FY24) and a 62% increase in value (from INR 1,056 trillion in FY21 to INR 1,709 trillion in FY24). Online card transactions have also been on an upward trajectory. In the second half of CY2023, the overall value of online purchases via card transactions saw a 24% increase to INR 7.34 trillion compared to the same period in 2022. Credit card transactions experienced a significant surge of 40%, amounting to INR 6.12 trillion during this timeframe. This uptick in credit card spending is attributed to increased consumption of high-value goods and services.

5.1.1 Split of Total Transactions Volume in India

Exhibit 62: Split Of Total Digital Transactions Volume in India (in Billions), FY2022-2024



Source: RBI, Frost & Sullivan, Secondary Sources

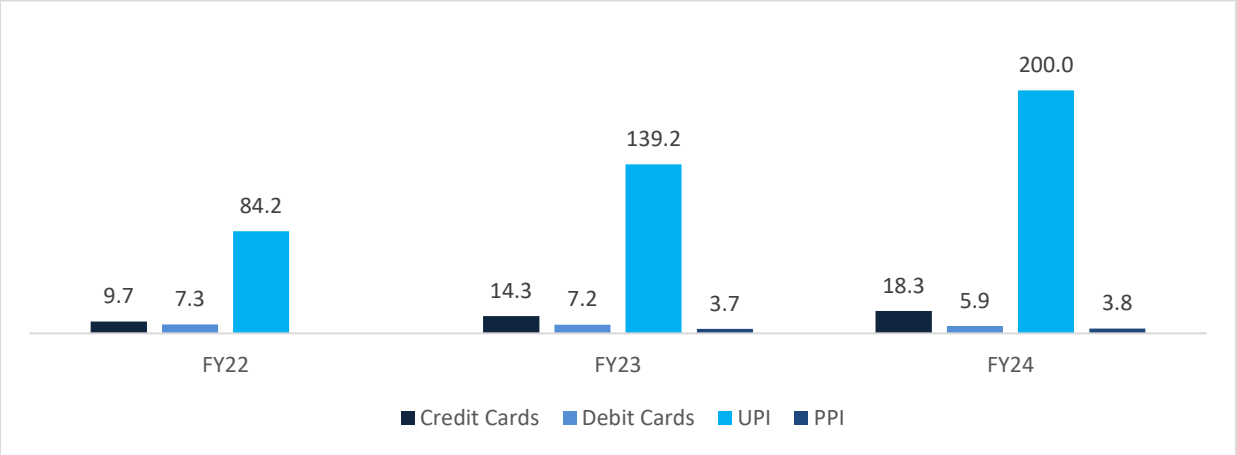
UPI saw a transaction volume of 131.2 billion FY2024 up from 46 billion in FY2022 growing at a CAGR of 68.9%. UPI has witnessed growing merchant acceptance of UPI, with more businesses integrating UPI as a preferred payment method. The total number of transactions for UPI further surged to 185.8 billion transactions, marking an impressive 41% year-on-year growth.

Credit card transactions registered a significant growth, reaching 3.6 billion, a 22.7% increase from FY2023. This growth shows a growing consumer preference for credit cards, particularly for high-value purchases. Credit cards are increasingly being used in diverse sectors like e-commerce, travel, and high-end retail, driven by factors like reward programs, EMI options, and enhanced security features.

Debit card transactions stood at 2.3 billion in FY2024 witnessing a 33% decline from FY2023 when the transactions totalled 3.4 billion, while the average transaction size (ATS) increased by a strong 24% to INR 2,642 in H2,CY23 as compared to H2,CY22 indicating a relevant usage of debit cards for higher value transactions. Despite facing competition from UPI, particularly for lower-value transactions, debit cards continue to be a staple in the digital payment landscape. They are widely used across various consumer segments, especially for direct bank account debits, reflecting their reliability and widespread issuance by banks.

5.1.2 Split of Total Transactions Value

Exhibit 63: Split Of Total Digital Transactions Value in India (INR Trillion), FY2022-2024



Source: RBI, Frost & Sullivan, Secondary Sources

The transaction value for UPI has grown at a CAGR of 54.2% over the FY22-24 period. In FY2024, the total transaction value for UPI reached an impressive INR 200 trillion. This enormous figure

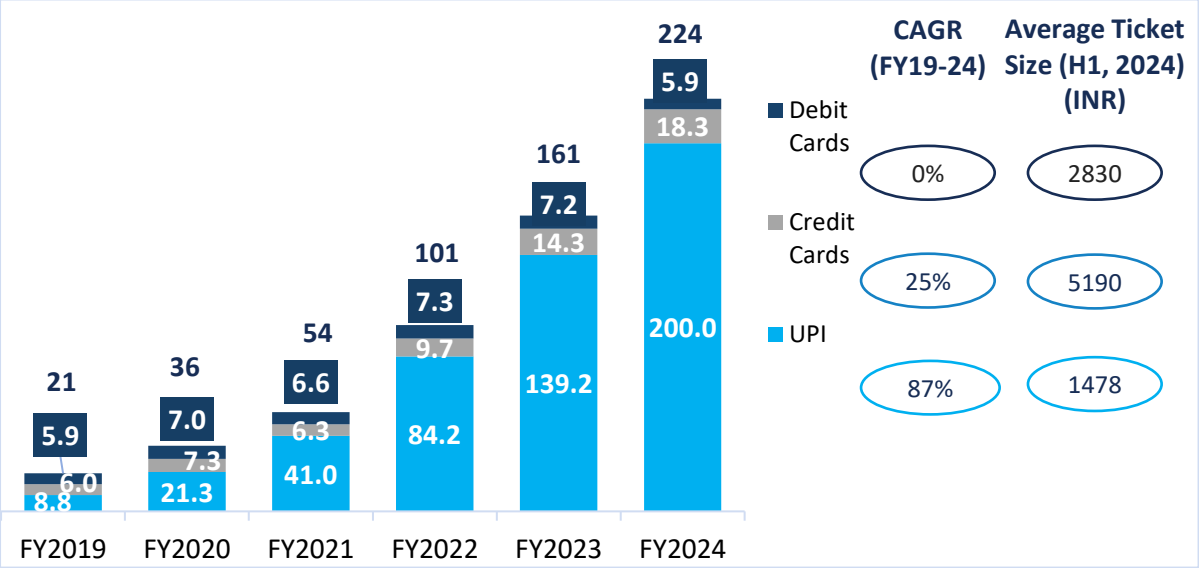
highlights UPI's adaptability and effectiveness in handling a wide range of transactions, from small everyday purchases to substantial business transfers. What's worth taking note of is UPI's increasing role in retail and service-based payments, promoting a cashless and digital economy.

The transaction value for credit cards have grown at a CAGR of 37.4% over the FY22-24 period. Credit card transactions reached a value of INR 18.3 trillion, indicating their predominant use for higher-value transactions in sectors such as travel, luxury retail, and electronics. This substantial transaction value reflects consumer confidence in using credit cards for larger purchases, benefiting from features like credit availability, reward points, and EMI options.

The transaction value for debit cards have declined at a CAGR of 10.1% over the FY22-24 period. Debit cards recorded a transaction value of INR 5.9 trillion in the FY2024. Despite facing competition from UPI, particularly for smaller transactions, debit cards remain a significant player in the digital payments market. They are especially popular for direct bank account debits and among users who prefer immediate withdrawal of funds.

5.1.3 Average Transaction Size: Trends across Payment Instruments in India

Exhibit 64: Average Transaction Ticket Size (ATS) for Payment Instruments in India (INR Trillion), FY2019-24



Source: RBI, NPCI, Worldline India Digital Payments Report, other secondary sources, Frost & Sullivan analysis

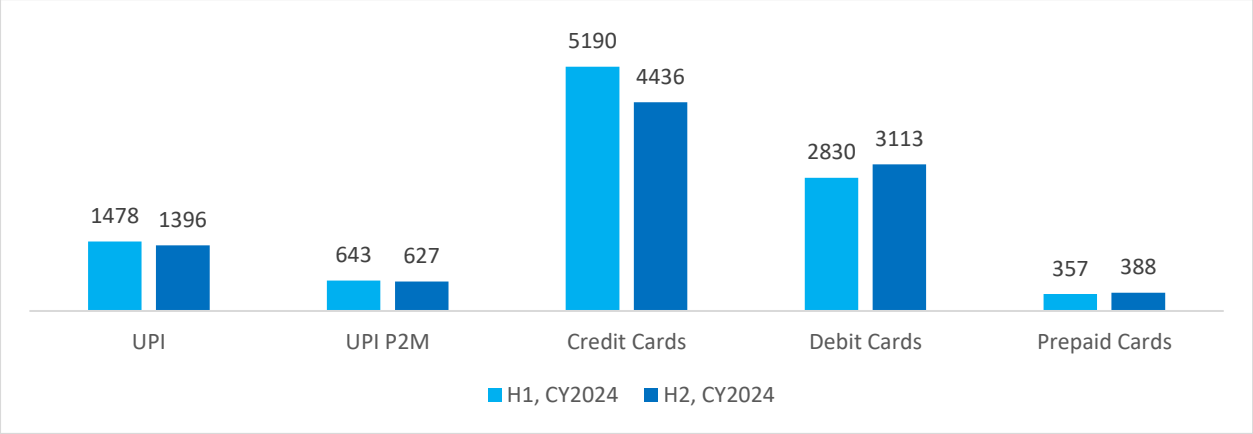
UPI for primarily small ticket transactions: The total transaction value for UPI reached INR 200 trillion in FY24. This staggering figure underscores UPI's versatility and efficiency in managing a vast range of **primarily small ticket transactions** from small everyday purchases to even large-scale business transfers.

The increase in P2M transaction value signifies the expanding role of UPI in retail and service-based transactions, facilitating a cashless and digital economy.

Robust growth for credit cards: Credit card transactions amounted to INR 18.3 trillion in value in FY24, growing at a CAGR of 25% in the FY19-24 period. This substantial figure is indicative of credit cards being used predominantly for higher-value transactions, including in sectors like travel, luxury retail, and electronics. The robust transaction value reflects consumer confidence in using credit cards for significant purchases, benefiting from aspects like credit availability, reward points, and EMI options.

Debit Cards total transaction values have remained stable since FY19: The transaction value of debit cards stood at INR 5.9 trillion in FY24, and have remained stable since FY19. Debit cards remain a major player, with usage more prominent in direct bank account debits and for users who are more comfortable with the direct withdrawal of funds, despite competitive pressure from UPI, particularly for smaller transactions.

Exhibit 65: Average Ticket Size (ATS) for Payment Instruments in India (in INR), H1 CY2024) , H2 (CY2024)



Source: RBI, Frost & Sullivan, Secondary Sources, Worldline India Digital Payments Report

The ATS for UPI decreased from INR 1,478 in H1'24 to INR 1,396 in H2'24, indicating a growing trend towards smaller-value transactions. This relatively low ticket size is indicative of UPI's widespread use for smaller, everyday transactions, demonstrating its deep penetration across various consumer segments. The convenience and ease of use of UPI have made it a popular choice for a wide range of transaction sizes, but its dominance in smaller transactions is particularly noteworthy.

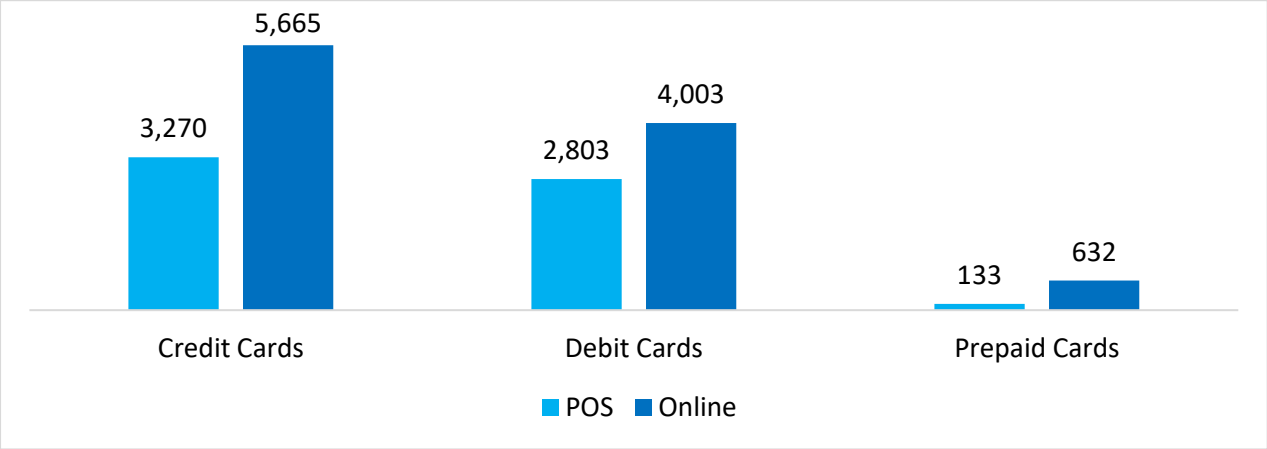
UPI P2M's ATS of INR 627 indicates that its usage for microtransactions is growing. This trend is important for UPI P2M because it demonstrates how consumers and merchants alike are choosing to use UPI, even for low-value transactions, due to its effectiveness and convenience.

Credit card transactions exhibited an decrease in ATS from INR 5,190 in H1'24 to INR 4,436 in H2'24. This drop is attributed to a significant increase in the number of credit card transactions. These trends indicate a shift in consumer behavior, with credit cards being increasingly used for a broader range of purchases, including everyday transactions. The surge in transaction volume, especially in the latter half of the year, suggests greater adoption and reliance on credit cards for diverse spending needs.

The average ticket size for debit card transactions rose from INR 2,830 in H1,CY24 to INR 3,113 in H2, CY24. Despite the rise in ATS, the total number of debit card transactions decreased year-over-year, indicating that while fewer transactions occurred, they were of higher value. The increase in ATS suggests a trend where consumers are using debit cards for higher-value purchases, possibly reserving them for specific types of transactions.

In the Indian financial landscape, UPI and payment cards will continue to coexist in India, each catering to distinct consumer needs and transaction scenarios. While UPI offers a seamless, instant payment solution ideal for peer-to-peer and small merchant transactions, payment cards—both debit and credit—provide critical benefits such as global acceptance, credit access, and rewards programs. Together, they form a complementary ecosystem that supports the diverse and evolving payment preferences of India's burgeoning digital economy.

Exhibit 66: Average Ticket Size (ATS) for POS / Online in India (in INR), H2 of CY2024



Source: RBI, Frost & Sullivan, Worldline India Digital Payments Report

Share of Cards on POS payments and its movement over years, Loyalty & rewards points market driving credit and debit cards

In H2, CY24, total card transactions volume on POS terminals was 2.27 billion, a 4% YoY increase. During the same period, credit card transactions were 1.245 billion, (a 34% rise) while debit card transactions were 607.5 million, (a 27% fall).

Credit and debit cards continue to play a vital role in the payment ecosystem, bolstered by robust loyalty and rewards programs. India's loyalty programs market is projected to grow by 18.3% annually, reaching US$3.58 billion in 2025. Also most banks offer reward points on card transactions, redeemable for various benefits such as shopping vouchers and travel discounts. These programs incentivize consumers to continue using cards, especially for high-value purchases, by offering tangible rewards and cashback options .

While UPI has revolutionized small-ticket transactions and become the preferred mode for everyday payments, credit and debit cards maintain their relevance through attractive loyalty and rewards programs. These incentives not only encourage continued card usage but also cater to specific consumer segments seeking value-added benefits.

5.2 UPI Transactions: Increasing Volume, Decreasing Ticket Size

The average ticket size (ATS) for UPI transactions has been declining, reflecting its increased use for smaller, everyday purchases. For instance, the ATS for UPI P2M (Person-to-Merchant) transactions decreased from INR 839 to INR 659 (H1'23), a 21% reduction. It further reduced to INR 656 & to INR 627 in H2'23 & H2 2024 respectively. In June 2023, a significant 57.46% of all UPI transactions were peer-to-merchant (P2M), and a substantial 83.92% of these transactions were for amounts between INR 0 and INR 500. This reduction suggests a deeper embedding of UPI for smaller or micro-transactions, primarily driven by growth in person-to-merchant (P2M) transactions.

Additionally, the year-on-year growth rate of UPI transactions suggests that the market is reaching saturation. The growth rate was 117.2% in FY 2021-22 but fell to 78.5% in FY 2022-23 and further to 56.5% in FY 2023-24. While UPI's transaction volume continues to rise significantly, there is a clear shift towards smaller ticket transactions, which could be seen as a limitation for its use in larger transactions.

5.3. Credit Cards Average Ticket Size for Transactions At 3-4 Times That of UPI

In 2023, India's digital payment sector saw a notable contrast in transaction patterns between credit cards and UPI. The Reserve Bank of India's bulletin revealed that in May 2023, the average size of credit card transactions was triple that of UPI transactions. This data highlights both the strength of credit cards in managing larger payments and their crucial position in India's financial system.

Credit cards have become associated with greater spending capacity and monetary flexibility. The average transaction amount for credit cards reached Rs. 4,968 in May 2023, considerably surpassing UPI's average of Rs. 1,582. This gap expanded further in the second half of 2023, with credit card transactions averaging Rs. 5,276, compared to UPI's Rs. 1,515. This marked difference suggests that consumers place higher confidence in credit cards for substantial purchases. Credit cards offer a combination of security features, rewards programs, and delayed payment options that make them preferable for more significant and thoughtful expenditures, unlike UPI. The ATS for UPI in H2'CY24 stood at INR 1,396 whereas the same for credit cards stood at INR 4,436.

The calendar year 2023 as well as 2024 witnessed a notable rise in credit card transactions compared to the previous year, indicating growing trust and preference for credit cards among Indian consumers. This trend is further supported by the significant increase in credit card usage at Point of Sale (PoS) terminals, emphasizing the card's role in stimulating consumer spending and economic activity.

While UPI leads in the number of transactions, credit cards excel in average transaction size, reflecting their key role in larger economic exchanges. The inherent advantages of credit cards, such as payment grace periods, instalment plans, and rewards programs, provide financial leverage that UPI can't match. In March 2024 alone, credit card transactions rose by 10.07% YoY to US$ 19.69 billion (Rs. 1.64 trillion), mainly driven by the end of the financial year spending and festival sales. The increasing spend and average ticket size for such spends on credit cards also marks a significant shift in consumer spending habits, underlining the card's superiority in handling high-value transactions

5.4. Drivers of Digital Transactions: India's Perspective

1) Structural enablers for growth in the digital payments:
    - ***Rapid Growth and Transformation:*** India's digital payments have seen notable growth as the total digital payment transactions volume increased from 31.3 billion in FY19 to 187.4 billion in FY24 growing at a CAGR of 43%.
    - ***Government and Big Tech Initiatives:*** NPCI's several programs, government initiatives like the JAM trinity (initiative to link JanDhan accounts, mobile numbers and Aadhaar cards), along with the entry of big tech players (like Google Pay, PhonePe, Amazon Pay, Paytm etc.), have enhanced the services and reach of digital payments.
    - ***Other initiatives by the Government:*** Government efforts have led to a substantial increase in digital transactions. Instant transfer features enhanced financial inclusion, increased government system transparency, and improved speed of transactions are some of the key benefits of these initiatives. Specific programs like NETC for highway toll payments, BBPS for bill payments, and initiatives to enhance credit access and security have further bolstered digital transactions in India.
2) Expansion of payment acceptance infrastructure:

- **Payment Infrastructure Development Fund (PIDF):** Aims to subsidize the deployment of payment infrastructure in Tier-3 to Tier-6 centers. It includes creating 30 lakh new touchpoints annually for digital payments.
- **Subsidy and Support for Payment Devices:** The RBI offers varying subsidies for the deployment of various payment acceptance devices, including physical and digital PoS.

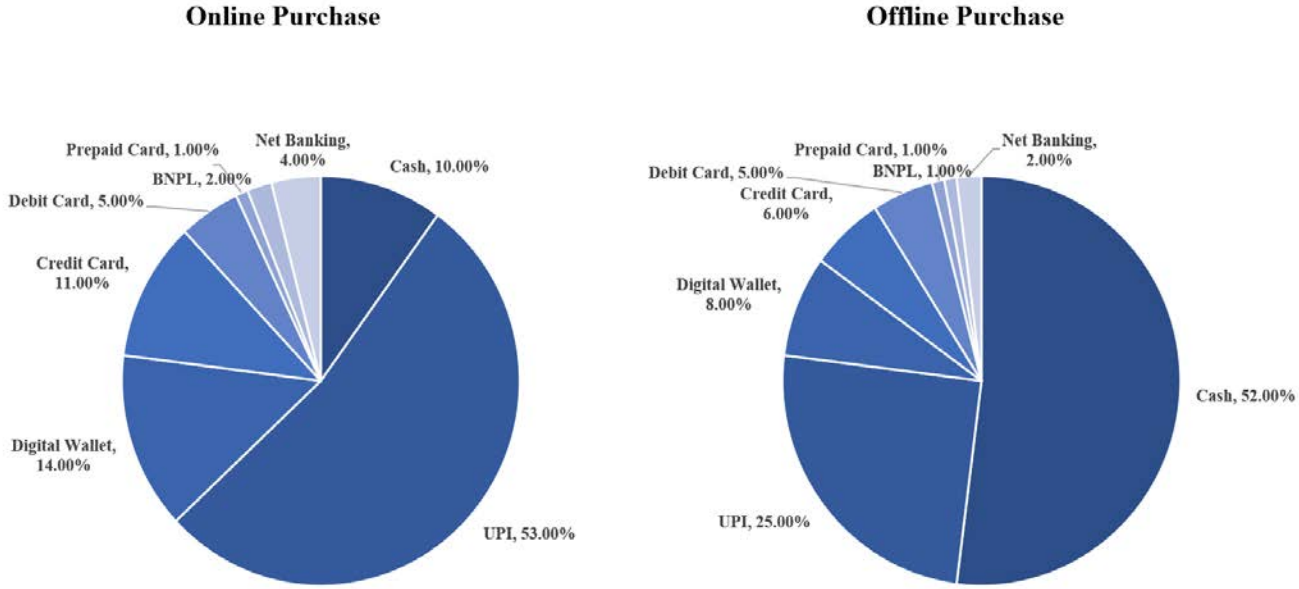
3) Credit cards and other digital payment services fuel the e-commerce:

- **Boost from Smartphone and Internet Penetration**: The increase in smartphone users and internet accessibility, aligned with the Digital India movement, has significantly contributed to the expansion of e-commerce.
- **Diversity of Payment Methods**: The availability of various payment methods like credit cards, UPI, e-wallets, etc., has made online transactions more convenient, thereby boosting e-commerce.
- **Security and Consumer Trust**: Security measures like PCI DSS compliance, encryption, OTPs, etc., ensure safe transactions, encouraging repeat business and higher spending.

5.5. Preferred Payment Methods in India: Analyzing Trends

In India, preferred payment methods reflect a blend of traditional and digital options. Cash remains significant for offline purchases, and especially in rural and semi-urban areas, due to accessibility and trust factors. Cash accounts to 52% of all offline purchases followed by UPI which accounts to 25% of the preferred method of payments in India. Credit cards and debit cards together account for 11% and 16% of all offline and online purchases respectively.

Exhibit 67: Preferred Methods of Payment in India (Online Vs Offline) FY2024



Source: How Urban India Pays; Frost & Sullivan Analysis

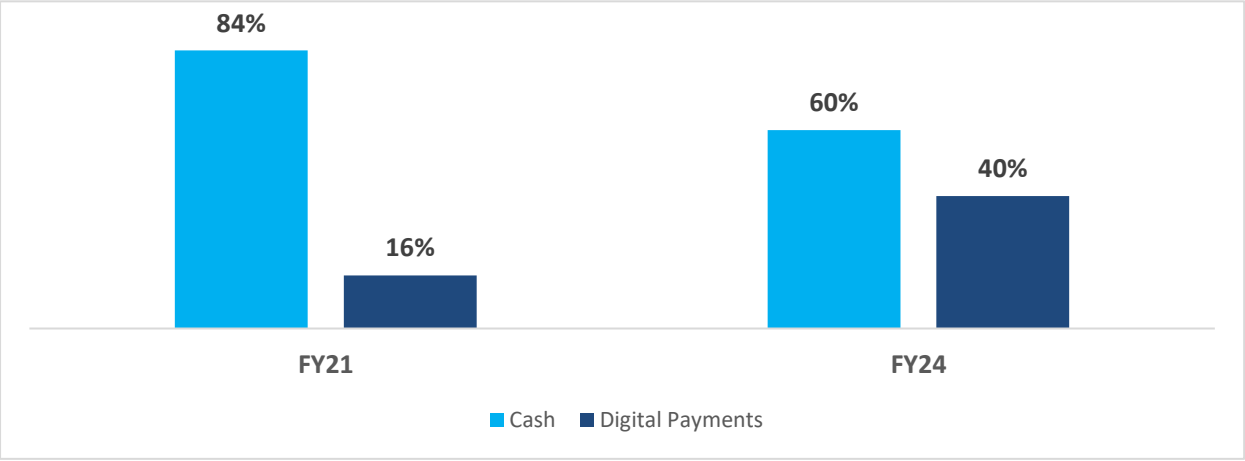
However, digital payments have surged with increased smartphone usage and government initiatives like Digital India. Unified Payments Interface (UPI) is immensely popular, particularly for small ticket transactions. Debit and credit cards are widely used in urban areas, especially for larger purchases and

online shopping, though debit cards are more common due to lower credit card penetration. Additionally, mobile wallets and QR code payments have grown in popularity, particularly for small merchants and microtransactions. With a strong push towards a cashless economy, digital payments continue to shape India's evolving payment landscape, balancing convenience, and accessibility.

5.6. Cash Transactions in India: Analyzing the Declining Trend

Cash spending within Private Final Consumption Expenditure (PFCE) in India has been on a downward trend, primarily due to the rapid adoption of digital payment methods and increasing financial inclusion. The cash payment method for PFCE was around 84% in FY2021. Over the past few years, several factors have driven the shift from cash to digital transactions, starting with demonetization in 2016, which forced consumers and businesses alike to adopt cashless alternatives. The expansion of mobile internet, affordable smart phones, and initiatives like Digital India has further accelerated this trend. Unified Payments Interface (UPI), launched in 2016, has played a pivotal role in making digital payments seamless and widely accessible across both urban and rural areas, thereby reducing cash dependency in day-to-day spending. Moreover, the COVID-19 pandemic was a major catalyst, as concerns about physical cash handling led to increased adoption of contactless payment methods. Government incentives, cash back offers, and discounts provided by various digital wallets and FinTech companies have further encouraged this shift. In sectors such as retail, food delivery, and transportation, digital payments have become the preferred mode, contributing to a significant decline in cash spending within PFCE. The cash payment method in FY2024 was around 60% of the total PFCE spent in India. As digital infrastructure continues to improve, India is expected to move closer to a digitally dominant consumption economy, further decreasing the role of cash in consumer spending.

Exhibit 68: Methods of PFCE Spent in India, FY2021-FY2024



Source: Pradip Bhuyan, RBI, Cash Usage Indicator (CUI) in India

6. PAYMENT CARD MANUFACTURING : MARKET DYNAMICS

6.1 Industry Composition (Global & Domestic)

The payment card manufacturing industry plays a critical role in the global financial ecosystem by producing physical cards used in payments, identification, access control, and loyalty programs. Here's a breakdown of the international industry composition:

Industry Structure & Value Chain:

The industry is composed of multiple players across the end-to-end value chain, including:

Card Manufacturers: Card manufacturers are responsible for producing physical payment cards such as debit, credit, and prepaid cards, typically made from PVC, metal, or eco-friendly materials like recycled plastics. Their core activities include printing the card design, lamination for durability, embedding EMV chips for secure transactions, and personalizing each card with the cardholder's name, number, and security features like magnetic stripes or holograms.

The global payment card manufacturing industry is dominated by a few large players with deep technological expertise and secure chip leadership. Thales (France, formerly Gemalto), IDEMIA (France), and Giesecke+Devrient (Germany) lead the market worldwide, offering advanced EMV, contactless, and identity card solutions. In the U.S., CPI Card Group is a prominent manufacturer with a growing emphasis on eco-friendly and recycled cards, while Eastcompeace (China) plays a key role in the China market with a broad product portfolio spanning payment, telecom, and government cards.

In India, the industry is evolving into a strong domestic ecosystem, driven by government-backed initiatives such as RuPay, Jan Dhan Yojana, and Aadhaar-linked programs, alongside the rising demand for debit and credit cards from private and public sector banks. Local manufacturers such as Seshaasai Technologies, Manipal Payment & Identity Solutions, are emerging as important suppliers, specializing in EMV/DI, contactless, biometric, and smart card personalization services. At the same time, global leaders like IDEMIA and G+D have established a significant presence through local subsidiaries and partnerships, supplying secure ICs, EMV operating systems, and offering high-end personalization solutions. This has created a hybrid industry structure where both domestic & global firms cater to high-volume issuance, ensuring India's card manufacturing industry continues to scale with both reach and sophistication.

Chip & Module Suppliers: Chip & Module Suppliers play a critical role in the payment card ecosystem by providing the embedded chips used in EMV (Europay, Mastercard, Visa) cards and contactless (NFC) cards. These chips are secure microcontrollers designed to store encrypted data and perform cryptographic functions, enabling secure payment transactions through both contact and contactless interfaces. The chips typically include:

Secure Elements (SEs): Tamper-resistant modules that securely store payment credentials.

Secure Microcontrollers (MCUs): Execute cryptographic algorithms for authentication and encryption.

Dual-Interface Chips: Support both contact-based and NFC/contactless transactions.

NFC Controllers: Enable wireless communication for tap-and-go payments.

Key players in this segment include Infineon Technologies (Germany), a global leader in security ICs and a major supplier of EMV and NFC chips for payment and identity applications; STMicroelectronics (Switzerland), which offers a wide range of secure microcontrollers and NFC-enabled chips used in smart payment cards; and NXP Semiconductors (Netherlands), a pioneer in NFC technology and a leading provider of chips for contactless cards and mobile wallets. These suppliers play a vital role in ensuring that payment cards meet global security standards while offering enhanced convenience and safety for end-users.

India is largely import-dependent for secure chips and modules, with suppliers like Infineon, Samsung, NXP, and STMicro being primary providers to Indian card manufacturers. Some domestic R&D efforts (under "Atmanirbhar Bharat" and "Make in India") aim to localize chip production, but the ecosystem remains nascent.

Personalization & Fulfillment Providers: play a crucial role in the final stages of the payment card lifecycle by customizing cards to meet issuer-specific requirements and ensuring secure delivery to end-users. Their services include embossing or printing the cardholder's name, encoding data onto EMV chips and magnetic stripes, and integrating additional security features such as holograms or CVV codes. In addition to personalization, these providers manage secure fulfillment processes, which involve packaging the cards with associated materials (e.g., PIN mailers, welcome kits) and overseeing logistics and delivery to ensure that cards reach customers safely and on time. Their role is vital in maintaining card security, regulatory compliance, and a smooth user experience at the point of issuance.

In India, banks and fintech issuers frequently outsource card personalization and fulfillment to certified service bureaus to manage the large-scale issuance requirements of both retail banking and government programs. Domestic players such as Seshaasai Technologies, provide these services, ensuring compliance with EMV standards and secure handling of customer data. Fulfillment services also extend to specialized domestic programs, including RuPay card issuance, Aadhaar-enabled payment systems, and government benefit disbursement schemes, which create unique demand drivers for the Indian market and differentiate it from global ecosystems that are primarily bank-driven.

Card Issuers (Clients): are the organizations that provide payment cards to end-users, typically in partnership with global payment networks. These issuers are responsible for account management, transaction authorization, billing, and customer service.

Banks and Financial Institutions form the largest group of card issuers. They collaborate with major payment networks such as Visa, Mastercard, , RuPay, American Express, and Discover to offer branded credit, debit, and prepaid cards. Examples include global and regional banks like JPMorgan Chase, Citi, Bank of America, Barclays, HDFC Bank, and ICICI Bank.

In recent years, fintech companies have emerged as significant issuers in this space. Neobanks and digital wallet providers now frequently issue their own branded physical cards, targeting digitally savvy customers and underserved markets. Notable examples include Revolut, N26, Paytm, Nubank, and Cash App, which offer card-based access to digital accounts and financial services.

These issuers play a central role in the payment ecosystem by driving customer acquisition, managing risk, offering rewards programs, and ensuring a seamless user experience across physical and digital channels.

In India, the demand for payment card manufacturing is driven by a diverse set of stakeholders across banking, fintech, and government programs. Large banks such as SBI, HDFC Bank, ICICI Bank, Axis Bank, Kotak Mahindra, and various public sector banks account for the bulk of debit and credit card issuance. At the same time, fintechs and neo-banks including Paytm, PhonePe, Razorpay, Slice, Jupiter are increasingly issuing co-branded prepaid and credit cards, often in partnership with traditional banks and global networks. On the government side, initiatives such as Aadhaar-linked cards, Jan Dhan Yojana accounts, RuPay debit cards, and state welfare or benefit disbursement cards have created

substantial additional volumes and unique demand patterns. These issuance programs are underpinned by major payment networks—Visa, Mastercard, American Express, Diners Club, and NPCI's domestic RuPay—which dominate transaction enablement and certification, anchoring the broader card ecosystem in India.

Key Industry Segments

The payment card market is segmented by card type, material, and regional dynamics.

Card Type: The payment card market is diversified by card type, each offering varying levels of security, functionality, and user experience. EMV chip cards are the most dominant globally, favored for their robust encryption and fraud protection capabilities. Magnetic stripe cards, once standard, are now in decline due to weaker security features and ongoing global EMV migration. Contactless cards, including dual-interface and NFC-enabled options, are rapidly gaining adoption for their speed, convenience, and hygienic tap-to-pay functionality. Metal cards occupy the premium segment, offering enhanced durability and a prestigious user appeal, often linked to high-end credit products. Biometric cards, which incorporate fingerprint authentication directly on the card, represent an emerging technology focused on enhancing transaction security and personal identity verification.

In India, the market reflects both global trends and local specificities. Following the RBI mandate for 100% EMV migration, chip-based cards have become the standard, replacing magnetic stripe usage. Contactless NFC-enabled cards are gaining momentum, especially as tap-to-pay adoption is accelerated by UPI-linked payments and consumer demand for speed and ease. India also has a strong prepaid and government-linked card segment, including RuPay prepaid, welfare distribution, and transit cards, which add unique scale to the market. The metal card segment, though small, is expanding among affluent customers, with premium offerings such as HDFC Infinia Metal, Axis Magnus, IDFC Mayura and ICICI Emeralde, reflecting the growing appetite for exclusivity in India's high-net-worth consumer base.

Material: Globally, the materials used in payment card manufacturing are evolving to meet both functional and environmental demands. PVC (polyvinyl chloride) remains the traditional and most widely used material due to its durability, cost-effectiveness, and ease of processing. However, there is a growing shift toward recycled and eco-friendly plastics, driven by sustainability goals and increasing consumer awareness. These materials, often made from recycled PVC or biodegradable alternatives, are gaining traction among banks and fintechs aiming to reduce their environmental footprint. At the premium end of the market, metal and composite materials are used to create high-end cards that offer superior durability, a distinct tactile feel, and an exclusive brand image.

In India, PVC still dominates due to the cost-sensitive nature of the market and the sheer scale of mass issuance, especially for debit, prepaid, and government-linked cards. That said, sustainability-led innovation is gradually gaining traction, with major banks such as ICICI, SBI, Airtel Payments Bank rolling out recycled PVC cards. The metal card segment in India caters to the premium banking space, of high-net-worth customers through offerings such as ultra-premium credit cards from leading private banks.

Regional Dynamics: Regional dynamics in the payment card market vary significantly based on technology adoption, regulatory environments, and consumer preferences. Europe is a mature market with widespread penetration of EMV chip and contactless cards, driven by advanced payment infrastructure and regulatory compliance. The industry is also seeing increasing adoption of metal and

eco-friendly cards, as issuers respond to both premium customer demand and sustainability initiatives. In contrast, Asia-Pacific is the fastest-growing region, fueled by the rapid rise of digital banking, fintech expansion, and financial inclusion efforts across India, China, and Southeast Asia. Here, local manufacturers play a more prominent role, catering to regional preferences and large-scale issuance programs. Meanwhile, in the Middle East and Africa, the migration to EMV standards is still ongoing in several countries. Additionally, demand is supported by large-scale government welfare card programs, which are driving growth in both payment and identity card segments.

India has emerged as one of the largest and fastest-growing payment card markets by volume, driven by expanding banking penetration, fintech-led issuance, and large-scale government initiatives. A key growth factor has been the rapid adoption of RuPay, the domestic network developed by NPCI, which now accounts for more than 65% of debit card issuance in the country, supported by programs such as Jan Dhan and state welfare disbursements. At the same time, fintech-led prepaid and credit card programs from players like Paytm, Slice, and OneCard are gaining strong traction, particularly among younger, digitally savvy consumers. While UPI has become the dominant mode of digital payments, it has not displaced card demand; instead, cards continue to co-exist with UPI, serving critical use cases such as offline merchant payments, credit access, and international transactions, where UPI penetration remains limited.

6.2 Payment Card Manufacturing

The global payment card manufacturing industry is a multi-layered value chain that starts with raw material sourcing and extends all the way to card issuance and personalization. At the base of the chain are the substrates and specialty films, traditionally PVC but increasingly PETG and polycarbonate (PC) due to environmental and durability concerns. PETG and recycled PVC are gaining traction as issuers and card schemes promote eco-friendly alternatives. These materials are supplied by a fragmented set of chemical and film producers across multiple countries. For dual-interface (contact + contactless) cards, which now account for most new issuances, an antenna and inlay are required—typically consisting of etched copper or aluminum embedded in a prelaminated plastic sheet. This stage is highly concentrated, with Linxens emerging as the global leader supplying antennas, inlays, and microconnectors to nearly all major card manufacturers, supported by a small number of niche specialists.

The next critical stage involves secure ICs (microcontrollers)—the EMV chips that enable authentication and encryption. This is an oligopolistic segment dominated by Infineon Technologies, NXP Semiconductors, and STMicroelectronics, which design the chips and control the fabrication ecosystem. These chips are supplied in module form, either packaged internally by the chipmakers or via specialized OSAT (outsourced semiconductor assembly and test) providers, then loaded with a certified card operating system and payment applets. Here, three companies—Thales, IDEMIA, and Giesecke+Devrient (G+D)—control the bulk of the market through proprietary operating systems, scheme-certified applets (Visa, Mastercard, Amex, UnionPay, RuPay), and the cryptographic infrastructure needed for personalization. This software/IP layer is one of the main competitive moats in the industry, as scheme certification is expensive, time-consuming, and requires deep security expertise.

Globally, card body manufacturing itself—printing, lamination, milling, and chip embedding—is more geographically dispersed but still led globally by the Big 3 (Thales, IDEMIA, G+D). These firms operate high-volume plants in multiple regions, but there is also a strong base of regional and national players

such as CPI Card Group (US), Valid (Brazil/LatAm), Eastcompeace and Goldpac (China), Kona I (South Korea), and Paragon ID/Tag Systems (Europe/UK). The premium metal card niche is dominated by CompoSecure in the US

The Indian payment card manufacturing industry reflects a hybrid structure, combining the presence of global technology leaders with a strong base of domestic mid-sized manufacturers. IDEMIA operates in India by having local manufacturing and personalization facilities while G+D has only personalization facilities in India, supplying advanced EMV and NFC-enabled chip cards to leading banks, fintechs, and government programs, while also occasionally serving export demand across Asia and Africa.

Premium metal cards continue to be imported, with global specialists like CompoSecure while domestic players like Seshaasai are emerging with varied offerings in this niche segment.

The final stage—personalization and fulfillment—involves encoding the card with the cardholder's PAN, EMV keys, and other secure credentials, printing names and expiry dates, and preparing the card for delivery to the customer. This step is highly service-intensive, requires compliance with strict data residency and security standards, and is often operated by the same large vendors that manufactured the card. Because of regulatory and logistical needs, personalization centers tend to be regionally distributed, creating a "hub-and-spoke" model for global card vendors.

Market Structure (duopoly/fragmented/monopoly)

From a market structure perspective, payment card manufacturing is not a monopoly but a vertically layered oligopoly. At the top of the value chain, secure IC production and certified OS/app development are extremely concentrated, giving a small set of companies disproportionate pricing power and technological control. The antenna/inlay market is similarly concentrated, with Linxens being the dominant supplier. Card body manufacturing is more competitive, with both global and strong regional players, while personalization is fragmented but sticky, as switching providers involves security audits, scheme recertifications, and complex logistics. This means the "control points" in the industry—where margins and influence concentrate—are in secure ICs, certified OS/applets, and inlays, while card body production is closer to a commodity business unless differentiated by premium materials (eco, metal) or special security features.

Business Dynamics

In terms of geographic dominance, the intellectual property and technology leadership reside largely in Europe (France and Germany for Thales, IDEMIA, G+D; the Netherlands and Germany for NXP; Germany for Infineon), while high-volume manufacturing and personalization facilities are distributed globally. China (Eastcompeace, Goldpac) and Brazil (Valid) have strong domestic ecosystems, often protected by local procurement policies. The US market relies heavily on CPI Card Group and CompoSecure for local production, though global players also operate facilities there. Secure IC fabrication and OS development remain heavily European, while inlay manufacturing is spread but still dominated by Linxens' global footprint.

In India, technology/IP remains imported, while manufacturing and personalization capacity is strong and localized (driven by RBI's mandates and sheer domestic demand). Unlike China or Brazil, India has not built a protected chip + OS + card ecosystem, but it excels in high-volume card body production

and secure personalization. Future opportunity lies in eco-friendly innovations and regional export leadership, but secure IC and OS development remain European-controlled.

Overall, the business dynamics hinge on scheme compliance, security IP, and service integration. The shift toward contactless and dual-interface cards has increased bill of materials and favored suppliers with strong antenna and secure IC capabilities. At the same time, environmental pressures are pushing material innovation toward PETG, recycled PVC, and even fully compostable substrates, allowing vendors to differentiate and command premium pricing. Meanwhile, personalization services provide recurring, service-based revenue streams, making them strategically important for long-term client retention.

6.2 Key Trends shaping this market

Shift Toward Contactless & Dual-Interface Cards: Growing consumer demand for faster, tap-and-go transactions is accelerating the adoption of contactless and dual-interface cards. Post-pandemic hygiene concerns and increasing NFC acceptance infrastructure are further supporting this shift.

Sustainability & Eco-Friendly Materials: Environmental concerns are pushing card issuers and manufacturers to adopt recycled, biodegradable, and ocean-bound plastics. Several banks and fintechs are integrating eco-friendly cards as part of their ESG strategies.

Rise of Metal & Premium Cards: To attract high-value customers, issuers are increasingly offering metal and composite cards, known for durability and a premium aesthetic. This trend is particularly strong in North America, Europe, and parts of Asia.

Biometric Card Innovation: The integration of biometric authentication (e.g., fingerprint sensors) in payment cards is an emerging trend aimed at enhancing security without sacrificing user convenience. While still in early stages, pilot programs are growing globally.

Decline of Magnetic Stripe Cards: With the global migration to EMV standards and the superior security of chip-based solutions, magnetic stripe cards are being gradually phased out, with several networks announcing timelines for their sunset.

Regional Manufacturing & Localization: Particularly in Asia-Pacific and Africa, there is a growing preference for localized card production, driven by cost efficiencies, regulatory requirements, and the need for faster turnaround.

Increased Role of Fintechs & Neobanks: The entry of digital-first players into card issuance is reshaping the market. These players often demand faster personalization, innovative card designs, and API-based fulfillment, putting pressure on traditional manufacturers to modernize.

Security & Compliance Enhancements: Rising fraud and data breaches are driving innovation in secure chip technologies, advanced cryptographic modules, and regulatory compliance (e.g., PCI standards), impacting chip/module design and personalization processes.

6.3 Entry Barriers and Critical Success Factors in Payment Card Manufacturing

The payments card manufacturing industry faces several key entry barriers that make it challenging for new players to enter the market:

1. Capital-Intensive Equipment and Technology

- The production of payment cards, especially those with embedded technology like **EMV chips**, contactless capabilities, and biometric features, requires sophisticated manufacturing facilities. High upfront investment in **machinery, production technology, and R&D** is essential to ensure compliance with industry standards and produce secure cards.

2. Stringent Regulatory and Security Standards

- Credit and debit cards must meet strict international standards, such as **ISO/IEC 7810** (physical characteristics of cards) and **ISO/IEC 7816** (smart card standards), along with compliance with **EMV (Europay, Mastercard, and Visa)** specifications. Additionally, card manufacturers must obtain certifications from payment networks like **Visa, Mastercard, and RuPay**, which involves extensive security audits and testing procedures. These high compliance costs can be a significant entry barrier.

3. Established Industry Players and Brand Loyalty

- The industry is dominated by well-established manufacturers with long-standing relationships with **financial institutions** and **payment networks**. These incumbents benefit from economies of scale, established supply chains, and strong brand trust, making it difficult for new entrants to gain a foothold in the market.

4. Technological Expertise

- Card manufacturing involves complex processes such as **embedding chips, encoding magnetic stripes**, and incorporating advanced security features like **holograms, UV printing, and encryption technologies**. New entrants need to possess or acquire significant technical expertise to produce high-quality, secure cards, which can act as a barrier.

5. High Certification Costs

- Certifications from major card schemes (Visa, Mastercard, RuPay etc.) involve high costs for testing and compliance. These certifications are mandatory for card issuers and must be renewed periodically, adding financial and time burdens that may deter new entrants.

6. Supply Chain Management

- Card manufacturing relies on a reliable supply of specialized materials, including chips, plastics, and inks. Managing a complex and secure supply chain for such materials, often in a competitive environment, can be challenging for new players.

7. Data Security and Privacy Regulations

- Given the sensitive nature of cardholder information, new entrants must adhere to strict data security standards such as **PCI-DSS (Payment Card Industry Data Security Standard)**. This involves establishing robust data protection mechanisms, which can be costly and resource-intensive.

The payments card manufacturing industry poses high entry barriers due to significant capital requirements, stringent regulatory standards, technological expertise, and the dominance of established players.

6.2 Critical Success Factors:

Advanced Security Features: As fraud prevention and cybersecurity are paramount, manufacturers that offer innovative solutions like **biometric cards**, **dynamic CVV codes**, and **encryption technologies** gain a competitive edge. Secure, technologically advanced products increase trust with financial institutions and consumers.

Customization and Personalization: Offering customized card designs and features for banks and businesses is a critical differentiator. Manufacturers that can personalize cards with unique designs, logos, and even user-specific features (like metal cards) stand out in the competitive landscape.

Cost Efficiency: Manufacturers that can control production costs while maintaining high quality are better positioned to compete. Cost-effective production techniques and scalable operations help maintain profitability in a price-sensitive market.

Strong Supply Chain Management: Ensuring a stable supply of raw materials (e.g., plastics, metals, and microchips) is crucial. Manufacturers must secure reliable and cost-efficient supply chains, especially in the face of global supply shortages (e.g., the global chip shortage).

Sustainability Practices: As sustainability becomes a growing concern, manufacturers that offer eco-friendly alternatives, like biodegradable or recycled payment cards, are better positioned for long-term success. Payment card providers are transitioning to sustainable cards made from recycled plastic, biodegradable materials, or ocean-recovered plastics to reduce environmental impact.

Partnerships and Certifications: Establishing partnerships with key payment networks (e.g., Visa, MasterCard, RuPay) and obtaining certifications (e.g., PCI DSS) are essential for credibility. These certifications ensure the manufacturer's products meet industry standards and are recognized by major payment processors.

Adaptability to Emerging Technologies: The payment card industry is evolving with trends like **contactless payments**, **mobile wallets**, and **blockchain-based systems**. Manufacturers must stay ahead by continuously adapting to and integrating these new technologies into their product offerings.

By focusing on these factors, manufacturers can navigate the complexities of the payment card market and establish a competitive presence.

6.3. Technology Adoption: Trends and Benefits in Payment Card Manufacturing

The payment card manufacturing industry has been undergoing significant transformations with the adoption of new technologies. These innovations aim to enhance security, improve user experience, and increase sustainability. Here are the key trends and benefits shaping the industry:

1. Biometric Cards

- **Trend**: Biometric authentication, such as fingerprint recognition, is increasingly integrated into payment cards. These biometric cards allow users to authenticate transactions securely without needing PINs.
- **Benefit**: This enhances security, reducing fraud risk while providing a convenient, frictionless payment experience.

- With **biometric cards**, sensitive data stays on the card, making it more secure than traditional chip or magnetic stripe cards.

2. Contactless and Dual Interface Cards

- **Trend**: Contactless payment cards, which enable tap-and-pay transactions, are becoming the standard in many regions. Dual-interface cards that support both contact and contactless methods are also on the rise.
- **Benefit**: The primary benefit is convenience and speed, as these cards significantly reduce transaction times. Moreover, contactless payments became even more popular during the COVID-19 pandemic due to their hygienic nature.

3. Dynamic CVV and Tokenization

- **Trend**: Dynamic Card Verification Value (CVV) technology, which changes the security code on the back of the card periodically, is being adopted to reduce the risk of fraud in online transactions. Replacing sensitive card information with encrypted tokens during transactions, offers an extra layer of security in both physical and digital payments.
- **Benefit**: This technology improves online transaction security by reducing the effectiveness of stolen card data, helping protect consumers and businesses from fraud.

4. Sustainability in Manufacturing

- **Trend**: The push toward sustainability is leading to the production of eco-friendly cards made from biodegradable, recycled, or renewable materials. Companies are shifting from PVC plastic to greener alternatives.
- **Benefit**: Sustainable payment cards align with the growing environmental concerns of both consumers and businesses. Banks and financial institutions adopting green cards can enhance their brand reputation by supporting environmental goals.

5. Smart and Metal Cards

- **Trend**: The demand for premium, personalized cards, including metal cards, is increasing. These cards cater to affluent consumers and offer a luxury aesthetic.
- **Benefit**: Customization enhances brand differentiation and consumer loyalty. Metal cards, in particular, offer durability and a sense of exclusivity, catering to high-net-worth individuals.

6. Blockchain and Digital Integration

- **Trend**: Blockchain technology is being explored for its potential to enhance transaction security and transparency. Payment cards are increasingly being integrated with digital wallets and mobile payment platforms.
- **Benefit**: Blockchain could streamline transaction verification processes and reduce the need for intermediaries. Integration with digital wallets allows users to combine the benefits of physical cards with the flexibility of mobile payments, improving consumer convenience.

7. Advanced Security Protocols (EMV 3DS and PCI DSS)

- **Trend**: The adoption of EMV 3D Secure and PCI DSS protocols is crucial for ensuring robust security in online and in-person transactions.
- **Benefit**: These technologies protect against fraud, reduce chargebacks, and ensure compliance with international security standards. They are essential for building trust with consumers and reducing liability for financial institutions.

The adoption of advanced technologies in payment card manufacturing is not only improving security and convenience but also responding to consumer demand for personalization and sustainability. As these trends continue to shape the market, manufacturers that embrace these innovations are likely to enjoy a competitive edge.

7. DIVERSIFICATION OPPORTUNITIES FOR PAYMENT CARD MANUFACTURERS

7.1. Aadhaar: Transforming E-Governance in India

The Aadhaar system in India has initiated a fundamental transformation in e-governance, injecting efficiency and transparency into the delivery of public services. Introduced in 2009, Aadhaar functions as a unique identification mechanism, assigning a distinctive 12-digit number to residents, linking their biometric and demographic information. This digital identity acts as an access point to a wide array of government services, including financial operations, healthcare, and social welfare programs.

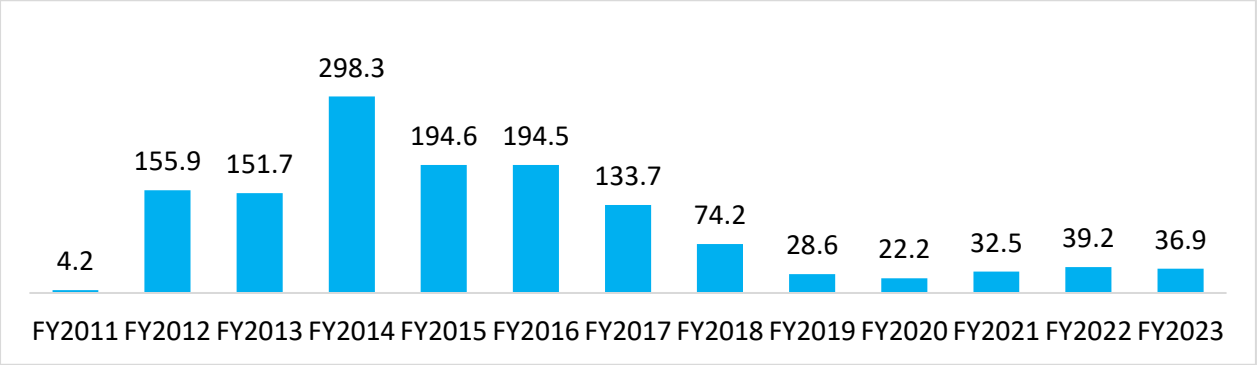
7.1.1 Aadhaar: Understanding the Significance

1. **Direct Benefit Transfers (DBT)**: Aadhaar's key role has been in reducing **leakages** in welfare distribution. By linking Aadhaar to bank accounts, subsidies (like LPG and food rations) are directly transferred to beneficiaries, minimizing fraud.
2. **Financial Inclusion**: Aadhaar has played a significant role in expanding **financial inclusion**. It simplified the **Know Your Customer (KYC)** process for banks, enabling millions of previously unbanked individuals to open accounts through initiatives like the **Pradhan Mantri Jan Dhan Yojana (PMJDY)**.
3. **Digital Identity**: Aadhaar acts as the foundation for **India's digital identity ecosystem**, facilitating secure and paperless transactions in banking, mobile verification, and tax filings, making public services more accessible.
4. **Privacy and Security**: While Aadhaar has faced scrutiny over privacy concerns, the government has strengthened **data protection regulations** to ensure its responsible use, and the **Supreme Court of India** ruled that Aadhaar is not mandatory for certain services, while allowing it for government welfare and tax purposes.

In summary, Aadhaar has become a cornerstone of India’s efforts to improve governance, promote digital inclusion, and create an efficient welfare delivery system. Despite challenges, it remains a pivotal tool in shaping the country's socio-economic framework.

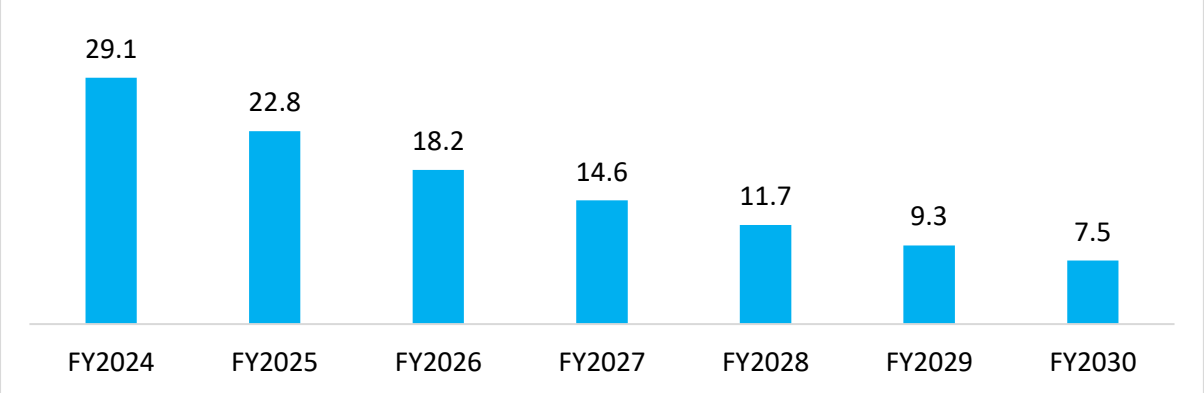
7.1.2 Aadhaar Market: Analyzing Size and Growth Trends

Exhibit 69: Total Number of Aadhaar Cards Generated across India from FY 2011 to FY 2023 (Million)



Source: UIDAI, Frost & Sullivan Analysis

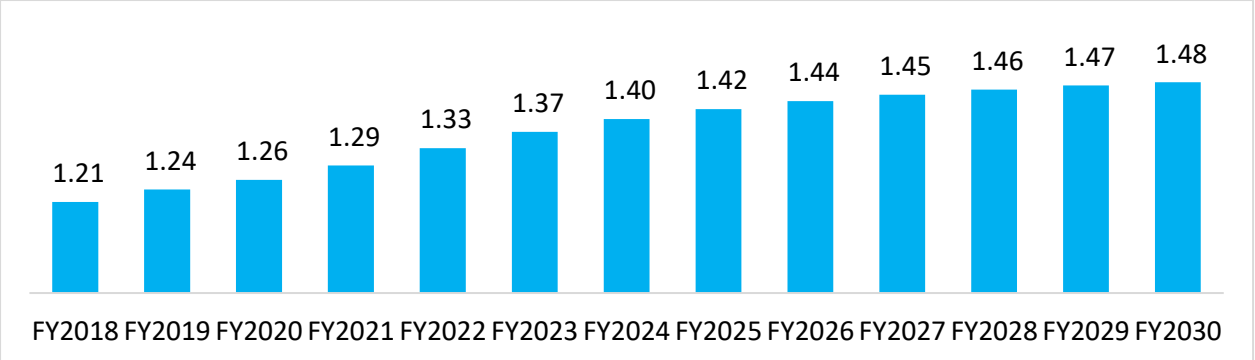
Exhibit 70: Total Number of Aadhaar Cards Expected to be Generated across India from FY2025 to FY2030F (Million)



Source: UIDAI, Frost & Sullivan Analysis
Note: FY2024-2030 is Forecasted

In recent years, the number of Aadhaar cards issued annually in India has seen a notable decline. This trend is primarily attributed to the widespread penetration and near-saturation of Aadhaar coverage across the country. In the fiscal year 2024 and 2025, approximately 29.1 and 22.8 million Aadhaar identification cards respectively are expected to be generated in India. The highest number of Aadhaar cards were produced in the fiscal year 2014 within the documented timeframe. As of financial year, ending March 2025, a total of approximately 1.42 billion Aadhaar cards have been generated.

Exhibit 71: Total Aadhaar Cards in Force (billion), India, 2019 – 2029F



Source: Frost & Sullivan analysis
Note: FY2024-2030 is Forecasted

The total number of Aadhaar cards in circulation in India increased from 1.21 billion in 2018 to 1.37billion in 2023. As per projections this is expected to increase to 1.47 billion by 2029.

7.1.3 Aadhaar Manufacturing: Ensuring Quality and Leveraging Technology

The Aadhaar card, a critical component of India's identification ecosystem, is produced and distributed on a massive scale. Ensuring the quality of Aadhaar card manufacturing while utilizing cutting-edge technology is essential for maintaining the integrity, durability, and functionality of the cards.

1. Quality Assurance in Aadhaar Card Production

- **Durability and Security**: The Aadhaar card's physical form must meet stringent standards for durability and security. Cards are designed to withstand wear and tear and are embedded with advanced security features such as **QR codes** and **holograms** to prevent tampering or duplication. These features ensure that the card remains a secure and trusted identity document.

- **Accuracy and Precision**: Each Aadhaar card is produced with high precision, ensuring that critical details, including biometric data (fingerprints and iris scans), are accurately captured and linked to the cardholder. The quality control process ensures that the printed information is legible, and the data securely integrated into the Aadhaar system.

2. Leveraging Technology for Efficiency

- **Digital Printing and Automation**: The production process for Aadhaar cards leverages **digital printing technologies** and **automation** to manage high-volume output with minimal errors. Automated systems enhance the efficiency of card issuance, reducing processing time and ensuring consistency across millions of cards.

- **Data Security Measures**: Aadhaar manufacturing involves strict data protection protocols, with **end-to-end encryption** of personal data. Information collected during card production is securely stored and only accessed by authorized entities, ensuring compliance with India's **data protection laws**.

3. Scaling and Distribution

- **Mass Production Capabilities**: To meet the needs of over a billion people, Aadhaar card manufacturing facilities use high-capacity production systems that can handle large volumes without compromising quality. Each card is produced swiftly and distributed efficiently, ensuring timely delivery to citizens across India.

- **Customization for Specific Needs**: In some cases, Aadhaar cards are customized to meet specific regional requirements or to include additional details such as digital signatures, which further enhances their functionality.

4. Continual Upgradation

- **Technological Advancements**: As Aadhaar evolves, so does the technology behind its manufacturing. Upgrades in biometric technology, such as enhanced fingerprint and iris scanners, ensure that the Aadhaar card remains a secure and modern identification tool. In

addition, future advancements may include **smart cards** or **contactless features**, further enhancing its usability.

- **Sustainability Initiatives**: Efforts are also being made to explore more eco-friendly materials in Aadhaar card production, aligning with broader sustainability goals without compromising the quality or security of the cards.

Aadhaar manufacturing combines stringent quality control with cutting-edge technology to ensure the secure, efficient, and scalable production of India's most crucial identity card. As technology continues to advance, the Aadhaar card will remain a cornerstone of India's digital and identification infrastructure.

7.2 Biometric Cards Market

7.2.1. Analyzing key factors fueling expansion

Rise in adoption of contactless payment methods

The surge in demand and acceptance of contactless payment methods has been a significant trend in recent years, driven by the proliferation of mobile wallets, faster and more convenient ways of transactions, and promotional incentives. Advancements in technology have made contactless payments more secure and versatile, which is further accelerated by the advent of biometric payment cards. EMV chip technology, tokenization, and biometric authentication methods (such as fingerprint or facial recognition) are breakthroughs in payment technology that offer additional layers of security to contactless transactions, improving consumer confidence in using these methods.

Furthermore, biometric payment cards are designed to work seamlessly with contactless payment terminals, enabling users to tap their cards to make purchases quickly and securely. By leveraging the existing infrastructure for contactless payments, biometric cards may easily integrate into the payment ecosystem, making them a natural extension of the strengthening trend toward contactless transactions. Moreover, the robust growth in contactless and cashless transactions has driven the demand for various modes of payment, which is expected to accelerate the growth of the biometric payment card market. According to the World Bank Group, two-thirds of adults across the world are making or receiving digital payments, with the share in developing economies increasing from 35% in 2014 to about 57% in 2021. Also, in developing economies, around 71% have an account at a bank, other financial institution, or with a mobile money provider, up from 63% in 2017 and 42% in 2011. Hence, these aforementioned factors are projected to contribute to the expansion of the biometric payment card market.

Growth in regulatory support and government initiatives

Globally, governments are increasingly focused on data protection and privacy regulations, such as the European Union's General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA). Biometric payment cards, with their advanced authentication methods, may often help financial institutions comply with these regulations by proposing secure and privacy-improving payment solutions. Regulatory support for biometric authentication technologies may provide transparency and guidance to organizations on how to embrace these solutions in a manner that

esteems user privacy and data security. Hence, compliance with data protection regulations is expected to propel the growth prospect for biometric payment card market share.

Furthermore, governments and regulatory bodies in numerous countries are actively working to endorse financial inclusion and access to banking services for underserved populations. Biometric payment cards have the prospective to support these initiatives by offering secure and convenient payment solutions that do not depend on conventional banking infrastructure. Through leveraging biometric authentication, governments may further facilitate the delivery of financial services to unbanked and underbanked individuals, empowering them to participate more fully in the digital economy. Thus, the rapid growth in financial inclusion initiatives is expected to accelerate the biometric payment card industry.

7.2.2. Key Market Trends

Technological Advancements

- Biometric payment cards utilize advanced authentication methods, such as fingerprints and iris scans, enhancing security during transactions. This shift towards biometric technology is largely driven by consumer demand for more secure and convenient payment methods.
- The integration of biometric sensors into cards allows for seamless contactless payments, eliminating the need for PINs and making transactions faster
- Metal biometric cards combine the feel of metal with advanced biometric authentication, offering enhanced security by using fingerprint recognition directly on the card. This innovation addresses growing concerns in relation to fraud and security while maintaining the luxury appeal of metal

Shifts in Consumer Preferences

- A significant trend is the increasing consumer inclination towards biometric authentication over traditional methods like PIN codes. For instance, a survey indicated that 81% of consumers preferred fingerprint biometrics for security.
- The demand for contactless transactions is also rising, as biometric cards can offer higher transaction limits compared to standard NFC cards, which are often capped

7.2.3. Sector risks and obstacles

Challenges in the Biometric Card Industry

Privacy Concerns

The collection and storage of biometric data raise significant privacy issues. Users may be apprehensive about how their data is used and protected, especially in light of rising data breaches. Ensuring compliance with data protection regulations, such as GDPR, and implementing robust security measures to safeguard biometric data is crucial to establishing user trust and stimulating widespread adoption.

Implementation Costs

The initial costs associated with developing and deploying biometric systems can be high. This includes expenses related to technology upgrades, training personnel, and ensuring compliance with regulatory standards. Businesses must carefully evaluate the long-term benefits of implementing biometric cards against the upfront costs to determine the feasibility and potential return on investment.

Technical Limitations

Biometric systems are not infallible; issues such as failure to enroll (where a user's biometric data cannot be captured effectively) can lead to user frustration. Additionally, challenges like spoofing (using fake biometrics) pose security risks that need continuous technological advancements to mitigate. Ongoing research and development are necessary to improve the accuracy, reliability, and resilience of biometric systems, ensuring a seamless user experience and robust security.

System Compatibility

The lack of standardization across different biometric systems can lead to compatibility issues, making it difficult for businesses to implement solutions that work across various platforms. Establishing industry-wide standards and protocols for biometric systems can help address this challenge, enabling interoperability and facilitating the widespread adoption of biometric cards.

8. INDIA BFSI COMMUNIATIONS & FULFILMENT MARKET

8.1. BFSI Communications Solutions Market in India – A direct beneficiary of growing financial industry in the country

In India, the prevalence of BFSI (Banking, Financial Services, and Insurance) communications, including insurance policies, statements, emails/SMS, web/mobile communications, and agreements/certificates, is on the rise as financial institutions adapt to changing consumer preferences and regulatory requirements. Insurance policies and statements are essential for customer record-keeping and transparency, ensuring clients understand their coverage and financial status. Simultaneously, the use of digital communication methods, such as emails and SMS, has become increasingly common for notifications, alerts, and customer service interactions, particularly as mobile penetration and internet usage expand across the country. Web and mobile platforms enable real-time access to financial information and transactions, fostering greater engagement and convenience for users. Additionally, agreements and certificates serve as critical documentation for various financial products, reinforcing trust and compliance in a heavily regulated industry. Overall, the evolution of BFSI communications reflects a significant shift towards integrating digital solutions while maintaining the reliability of traditional documents in India's diverse financial landscape.

8.2. BFSI Fulfilment Market Overview

8.2.1 Prevalence of BFSI Fulfilment Solutions in India

1. Bank Passbooks:

- **Continued Relevance in Rural and Semi-Urban Areas**: Bank passbooks remain widely used in India, particularly in rural and semi-urban areas. A large segment of the population,

especially older customers and those with limited digital literacy, relies on physical passbooks for tracking transactions. According to the **Pradhan Mantri Jan Dhan Yojana (PMJDY)** initiative, which has brought millions of unbanked citizens into the formal banking sector, many new account holders still prefer passbooks over digital statements due to familiarity and trust in tangible records.

- **Legal Requirement**: Many banks are required by law to provide passbooks to savings account holders, which further drives their prevalence. This is particularly common for basic savings accounts, which continue to be a major product offered to rural customers.

2. Bank Forms:

- Keeping in mind the regulatory requirement for wet signatures on some forms such as Loan agreements., Mortgage documents and Know Your Customer (KYC) documents there would be a continued requirement for these forms across banks.
- **High Demand in Branch-Based Banking**: Bank forms for account opening, loan applications, and other transactions are still critical in branch-based banking operations. Although many processes are moving online, branch banking remains dominant, especially in regions where internet penetration is lower. Physical forms are a trusted and practical solution for customers in rural areas.
- With banks consolidating their vendors there would be need to have vendors with a national presence to fulfil the stationery needs of their branches spread across the country
- **Limited Digital Adoption**: While urban areas are witnessing a shift toward digital forms, rural and less tech-savvy customers continue to rely on physical forms for various banking processes. This dual demand is sustained by the fact that many government schemes, such as **PMJDY**, require filling out forms to access financial services.

3. Bank Brochures:

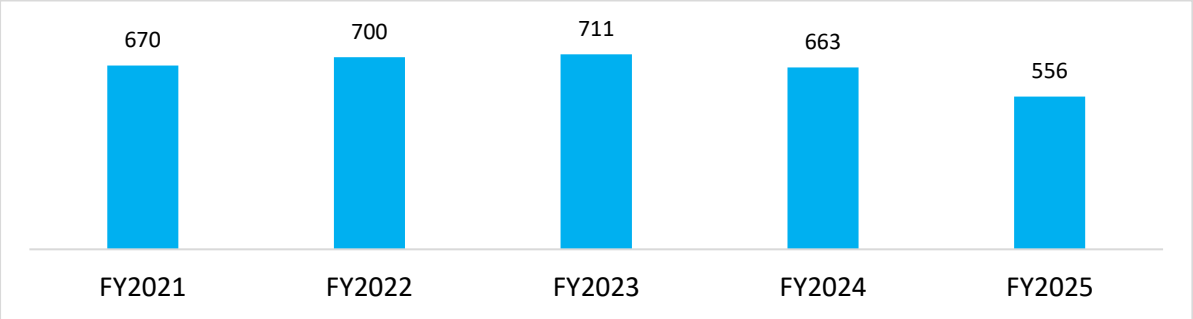
- **Marketing Tool for Financial Products**: Printed brochures remain an essential marketing tool for banks to educate customers about new products, such as loans, insurance, and savings schemes. In regions where digital penetration is lower, brochures provide a clear and concise way to communicate product details. Brochures are frequently distributed in branches, fairs, and community events to raise awareness of banking services.
- **Targeting Non-Digital Customers**: While banks are increasing their digital outreach, many still produce physical brochures for customers who prefer printed materials. This is especially true for financial products that require detailed explanations, such as insurance policies, fixed deposits, and loans.

While the Indian banking sector is evolving rapidly with digitalization, physical bank passbooks, forms, and brochures remain prevalent, especially in rural and semi-urban areas. The combination of regulatory requirements, customer trust, and branch banking dominance ensures the ongoing use of these traditional banking materials, even as the shift towards digital services accelerates.

8.3. Cheque Books in India

In India, banking cheque books remain an integral part of the financial ecosystem, especially for businesses and government transactions. Despite the surge in digital payment methods, cheque books continue to hold relevance due to their perceived security and trustworthiness, particularly for high-value transactions. Businesses, institutions, and individuals in rural and semi-urban areas still rely on cheques for their financial dealings. Innovations such as the Cheque Truncation System (CTS) have modernized cheque processing, enhancing efficiency and reducing clearing times. The future of cheque books in India will likely see a continued role, coexisting with the expanding digital payment landscape.

Exhibit 72: Paper based Clearing Volume (Mn), Cheque Truncations System (CTS) (NPCI Managed), India, FY2021-2025



Source: NPCI, data for FY25 is from Apr 2024–Feb 2025

As the data in the exhibit above suggests, cheques continue to be one of the most significant instruments of payment in the country. The total volume of cheques through Cheque Truncation System (CTS) (NPCI managed) in India grew by 4.4% in FY22, and further grew by 1.6% in FY23. In numbers, the volume of transactions involving cheques grew from 670 million in FY21 to 711 million in FY23 but declined to 663 million in FY24.

Why Bank Cheque Books continue to be relevant -

The growth drivers of bank cheque books in India are influenced by several factors, despite the increasing prevalence of digital banking. Here are the key drivers:

Continued Relevance of Cheques

- **For secure and high value transactions**: Cheques are considered a secure method for conducting transactions, especially for high-value payments. Unlike cash, which can be lost or stolen, cheques are linked to a bank account and can be tracked, making them a preferred choice for businesses and individuals alike.

- **Documentation and record keeping for business transactions**: Many businesses still rely on cheques for payments, as they provide a formal record of transactions. This is particularly important for large payments, where a cheque serves as documentation that can be useful in disputes or for accounting and legal purposes.

- **Customer Demand and certain demographics**: There remains a significant customer base that prefers using cheques over digital methods, either due to lack of access to technology or

personal preference. Further, certain demographics like older generations, may be less comfortable with digital banking, continue to use cheques for their financial transactions. This demographic often prefers the tangible nature of cheques over digital alternatives.

- **Rural Areas:** In many rural regions, where digital literacy and access to technology may be limited, chequebooks remain a popular payment method. Residents often rely on cheques for transactions due to their familiarity and the lack of digital banking infrastructure.

- **Increase in number of bank accounts being opened and debit cards being issued:** The increasing number of bank accounts being opened and the rising issuance of debit cards in India are contributing positively to the demand for cheque books. As more individuals and businesses enter the formal banking system, there is a growing reliance on various payment instruments, including cheques, to manage financial transactions.

  For many businesses, especially small and medium-sized enterprises (SMEs), cheques remain a preferred method of payment for larger transactions due to their traceability and official documentation. Additionally, with more individuals holding bank accounts, there is a wider base of customers who may require cheque books for personal use, such as for making payments in areas where digital transactions are less prevalent.

  The rising issuance of debit cards also complements this trend, as it encourages customers to maintain active relationships with their banks, leading them to explore additional banking services, including cheque books. This overall growth in formal banking engagement fosters a higher demand for traditional instruments like cheques, ensuring their continued relevance alongside digital payment methods.

Regulatory Support

- **Banking Regulations:** The Reserve Bank of India (RBI) has established guidelines that encourage banks to provide chequebooks to customers, including provisions for issuing chequebooks with a larger number of leaves upon request. This regulatory support helps maintain the availability and utility of cheques in the banking system and particularly important for segments of the population that may not be fully comfortable with digital banking solutions.

- **Standardization:** The introduction of standardized cheque formats, such as the CTS 2010 standard, enhances the efficiency of cheque clearing processes. This standardization helps banks streamline operations and improve customer satisfaction, thereby promoting the use of cheques.

- **Recent mandate to expeditiously clear cheques:** The Reserve Bank of India (RBI) has recently introduced a mandate for banks to clear cheques more expeditiously, aiming to reduce the time taken for cheque settlements. This move is part of the RBI's broader strategy to enhance the efficiency of the payments system in India. The mandate requires banks to process cheques quickly, particularly through the Cheque Truncation System (CTS), which electronically processes cheques, minimizing delays caused by manual handling.

  This new directive is expected to have a positive impact on cheque issuance in India. Faster clearance times will enhance customer confidence in cheque-based transactions, leading to an

increase in the demand for cheque books. The mandate will benefit businesses, especially small and medium-sized enterprises (SMEs), which rely on cheques for payments, as it will improve cash flow management by reducing payment delays. Additionally, the streamlined processing will further reduce the risk of cheque fraud, improving overall financial security in the banking system.

Integration with Digital Banking

- **Phygital Banking**: The integration of physical cheque usage with digital banking services (phygital banking) allows customers to enjoy the benefits of both worlds. Banks are investing in technology that supports cheque processing while also enhancing digital services, thus appealing to a broader customer base.

- **Financial Inclusion**: Cheques continue to play a role in promoting financial inclusion, especially among underserved segments like small and medium enterprises (SMEs). By providing access to cheque facilities, banks can help these businesses engage in formal financial transactions.

While digital banking is on the rise, the continued use and growth of bank cheque books in India are driven by their security, regulatory support, customer demand, and integration with evolving banking technologies.

Industry Challenges and threats for growth in cheque books as a banking instrument

The growth of bank chequebooks in India faces several challenges and threats due to the rise of digital banking. Here are the key issues impacting their usage:

- **Shift to Digital Payments:** With the advent of digital payment methods like UPI (Unified Payments Interface), mobile wallets, and online banking, consumers are opting for faster and more convenient transaction methods. This shift has led to a decline in the frequency of cheque usage, particularly for everyday transactions.
- **Government Initiatives**: The Indian government's push towards a digital economy, including initiatives like Digital India, promotes cashless transactions, impacting the cheque book market.
- **Younger Generation Preferences:** Younger consumers, who are more tech-savvy, prefer digital solutions for their banking needs. This demographic shift is contributing to a reduced demand for traditional banking tools like cheques, as they favor instant and seamless digital transactions.
- **Reduced Reliance on Cheques**: Some businesses and individuals are moving away from cheques due to the convenience and speed of digital transactions. This trend is particularly noticeable among SMEs, which are increasingly adopting digital payment methods for their operations.
- **Standardization and Security Measures**: The introduction of the CTS 2010 standard by the RBI has led to changes in the format and security features of chequebooks. Banks are required to issue only CTS 2010 compliant chequebooks, which may create logistical challenges and delays in distribution to customers.
- **Potential Invalidation of Non-Compliant Cheques**: The RBI has set deadlines for the adoption of CTS 2010 standards, after which non-compliant chequebooks may be considered invalid or cleared at less frequent intervals. This has led to a need for customers to replace their existing chequebooks, which may not be happening at the desired pace.

In summary, with the RBI initiation to faster clearance of cheques and that cheque is the only instrument which is contingent, deferrable and enforceable, cheque would see a continued role, coexisting with the expanding digital payment landscape. However, the growth will be muted due to the shift to digital payments, regulatory changes requiring standardization and security upgrades, and operational challenges in the distribution and clearing of chequebooks.

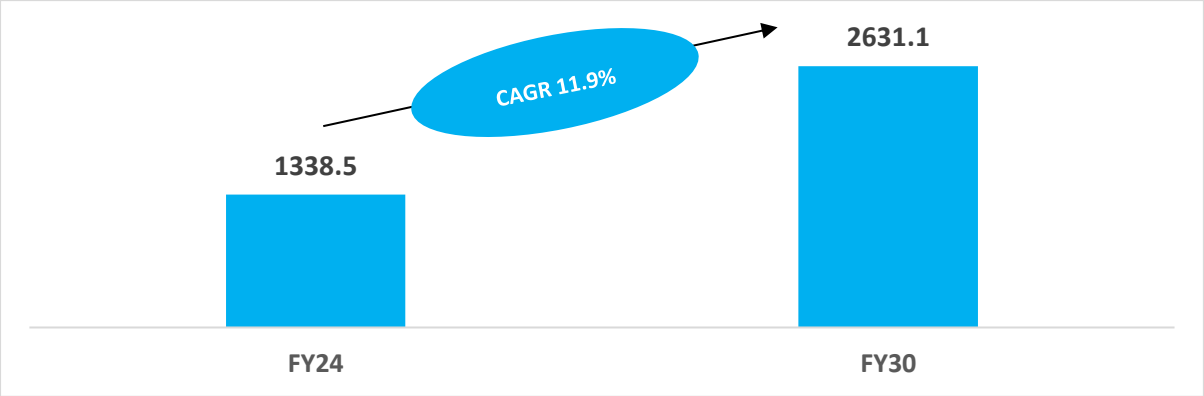
9. IOT SOLUTIONS: RFID MARKET

9.1. Global RFID Industry Overview

Radio Frequency Identification (RFID) is a wireless communication technology utilizing electromagnetic coupling to identify objects. The RFID market comprises of tags, readers, and middleware, with further categorization into active and passive types. Frequency-based segmentation includes Low, High, and Ultra-high frequency RFID. RFID uses electromagnetic fields to automatically identify and track tags attached to objects.

The global RFID market, valued at approximately INR 1,338.5 billion in 2024, is projected to grow at a 11.9% CAGR and reach INR 2,631.1 billion by 2030. RFID technology offers real-time visibility of object location, status, and movement, enabling businesses to enhance inventory tracking, identify inefficiencies, and improve operational efficiency.

Exhibit 73: Global RFID Market (INR Bn), Global, FY2024-2030F



Source: Frost & Sullivan *Note: FY2025-2030 is Forecasted*

The COVID-19 pandemic accelerated RFID adoption in retail, e-commerce, and healthcare sectors, facilitating contactless solutions and supply chain optimization. Beyond inventory management, RFID applications extend to supply chain visibility and omnichannel offerings such as buy online/pick up in store, ship from store, and self-checkout. A major use case of RFID technology by corporates around the world is for tracking corporate assets, furniture, office equipment, and servers.

There's been an increased RFID adoption since 2018, particularly in retail. For example, Inditex, parent company of Zara, implemented RFID for garment tracking in its inventory management system.

9.2. RFID Ecosystem (Chip, tag, reader/antenna manufacturers, software, label/printer providers), Technology Components & Manufacturing Segments

Radio Frequency Identification (RFID) technology comprises essential elements: Antenna, Transceiver, Tags, and a database. The Antenna and Transceiver combine to form the RFID reader, which serves as an intermediary between RFID tags and the database. Tags, also known as Transponders, transmit data to the reader. The database, the final component in this ecosystem, connects to the RFID reader for data storage. Additionally, middleware software processes information gathered from RFID readers.

The integration of RFID tunnels, gates, encoders, packing, and point-of-sale (POS) systems is supplementing the RFID landscape and infrastructure, making it more robust and versatile.

The RFID ecosystem encompasses various systems and frequencies, which dictate the technology's capabilities. RFID systems typically operate at low, high, ultra-high, and extremely high frequencies. Higher frequencies correlate with increased screening ranges for readers. As an example, high-frequency RFID systems can detect objects from distances of 4-5 meters.

The RFID ecosystem's primary stakeholders include hardware vendors, software vendors, system integrators, and consultants.

Hardware vendors comprise manufacturers of Readers, Inlays, converters, and resellers. Inlay manufacturers produce tags, antennas, and chips, while converters integrate inlays into tags or labels. Peripheral vendors supply additional components for system installation, such as portals, reader and antenna mounting hardware, and motion sensors.

Software vendors provide database management systems, middleware, application software, and interfaces for existing applications.

System integrators design RFID systems by selecting appropriate hardware and software components. They handle installation and integration of these systems into existing infrastructure.

Consultants offer specialized expertise in areas including business requirements, documentation, technical aspects, facilities, and training.

RFID Technology Components

RFID (Radio-Frequency Identification) technology comprises three main components that work together to automatically identify and track tags attached to objects:

- **RFID Tags:** These are embedded with a microchip and antenna and are attached to or embedded in items to be tracked. Tags can be Passive (no internal power source; powered by the reader’s signal), Active (battery-powered for longer range and autonomous communication), or Semi-passive (battery-powered but only activated when in range of a reader).

- **RFID Readers:** These devices emit radio waves to detect and power passive tags or communicate with active tags. They can be handheld, fixed, or embedded into other systems, and serve as the interface between the tags and backend infrastructure.
- **Middleware & Software:** This layer processes and integrates the data collected by RFID readers into enterprise systems. It handles functions such as filtering tag reads, event management, authentication, and analytics for real-time tracking, inventory control, and process automation.

Together, these components form the backbone of RFID solutions across industries like retail, logistics, manufacturing, healthcare, and security.

Key Manufacturing Segments

The RFID manufacturing ecosystem is composed of several specialized segments, each contributing to different stages of the technology stack:

- Chip Manufacturers: These companies design and produce the integrated circuits (ICs) that power RFID tags. The chips store data and enable communication with readers. Leading players in this segment include NXP Semiconductors, Impinj, and STMicroelectronics.
- Inlay & Label Manufacturers: In this stage, RFID chips are assembled with antennas and substrates to form inlays, which are then embedded into labels or cards. These inlays serve as the functional RFID tag. Key companies include Avery Dennison, Smartrac (a part of Avery Dennison), and Linxens.
- Reader Manufacturers: These firms develop RFID readers, which can be handheld, fixed, or embedded into equipment and infrastructure. Readers are responsible for powering the tags (in passive systems), reading data, and transmitting it to backend systems. Prominent manufacturers include Zebra Technologies, Honeywell, and Impinj.
- Software Providers: These companies offer RFID middleware and enterprise software platforms that manage and analyze data from RFID systems. Their solutions enable real-time asset tracking, inventory control, supply chain visibility, and data analytics. Some software providers are standalone, while others are integrated with hardware vendors.

Together, these segments form a comprehensive value chain that enables the deployment of RFID solutions across industries like retail, logistics, healthcare, manufacturing, and security.

Key Players in the RFID Industry

The global RFID market is shaped by a mix of specialized hardware manufacturers and integrated solution providers. NXP Semiconductors (Netherlands) is a market leader in RFID chips, particularly known for its advanced NFC and UHF tag solutions used across payment, access control, and supply chain applications. Impinj (USA) is a leading provider of UHF RFID solutions, with a strong presence in retail and logistics sectors through its chips, readers, and cloud software platform. Zebra Technologies (USA) is a major player in RFID reader and

printer hardware, offering end-to-end solutions for asset tracking and warehouse management. Avery Dennison (USA) is one of the world's largest manufacturers of RFID inlays and labels, serving a wide range of industries including apparel, logistics, and healthcare. Its subsidiary, Smartrac (Netherlands), specializes in NFC and UHF tags for advanced applications like smart packaging and product authentication. Alien Technology (USA) is recognized for its cost-effective UHF tags and readers, catering to high-volume, price-sensitive deployments. Together, these companies drive innovation and large-scale adoption of RFID technology across global markets.

Seshaasai (India) is one such regional player, specializing in RFID tag manufacturing and encoding.

Business Dynamics & Major Trends shaping RFID Technology market

RFID technology is experiencing rapid adoption across a wide range of industries due to its ability to automate tracking, improve accuracy, and enhance operational efficiency. In retail, RFID is widely used for inventory management, theft prevention, and omnichannel fulfillment, with major retailers like Walmart mandating RFID tagging across more product categories. In logistics and supply chains, RFID enables real-time visibility and warehouse automation. The healthcare sector relies on RFID for asset tracking, patient identification, and medication safety, while manufacturers use it for process automation and quality assurance. Additionally, RFID plays a key role in access control and contactless payments, embedded in ID badges, transit cards, and bank cards.

A significant trend is the growing dominance of passive UHF RFID, which offers longer read ranges at a lower cost—particularly valuable in high-volume applications like retail and logistics. At the same time, RFID is increasingly being integrated with IoT platforms and blockchain networks, enabling enhanced traceability, anti-counterfeiting, and supply chain transparency. The RAIN RFID Alliance, founded by Impinj, Intel, AIM, and Google, is promoting global adoption of passive UHF RFID through standardization and ecosystem development.
Technological advancements are also driving chip miniaturization and smart label innovation, making RFID more cost-effective and suitable for smaller, lower-value items. As sustainability becomes a priority, demand for eco-friendly and recyclable RFID tags is growing, particularly in consumer goods and fashion. From a regional perspective, Asia-Pacific—especially China India and Taiwan—leads in large-scale tag and reader manufacturing due to cost advantages, while North America and Europe remain leaders in premium RFID chips, enterprise software, and system integration.

9.3. Market trends, growth drivers, opportunities, and challenges; Importance of offering solutions to customers through tags

Market Trends

Passive UHF RFID Tags: These tags are battery-less and transmit energy through the RFID scanner. Passive UHF RFID tags are typically used in smaller case operations and provide longer read ranges. They are cost-effective with quicker data transfer speeds. Their demand stems from efficient and scalable solutions in large-scale operations such as supply chain management, retail inventory management, and asset tracking. The capability of passive UHF tags to handle simultaneous reading of multiple tags further enhances their appeal.

Supply chain optimization: RFID technology facilitates tracking and tracing of goods from warehouse to transportation. RFID tags contribute to minimizing errors, reducing costs, and ensuring timely product delivery.

Advancements in RFID technology: Recent developments in RFID technology include improved read ranges, greater data storage capabilities, and more compact sizes. Additionally, reader technology advancements are resulting in enhanced accuracy, faster reading speeds, and the ability to process a higher volume of tags simultaneously. These improvements are opening up new applications across various industries.

RFID in retail and ecommerce: RFID technology assists retailers in streamlining inventory management, reducing shrinkage, and enhancing overall customer shopping experiences. Examples include smart shelves that monitor stock levels and initiate reorders, and automated checkout systems utilizing RFID tags for quicker and more convenient transactions.

Key Growth enablers for the segment include:

1. **Increased Demand for Real-Time Tracking & Inventory Management**: RFID technology is widely adopted in industries like retail, logistics, healthcare, and manufacturing for efficient asset tracking, real-time inventory management, and supply chain optimization. Businesses benefit from improved operational efficiency, reduced labor costs, and minimized inventory inaccuracies.
2. **Integration with IoT & Digital Transformation**: The growing integration of RFID with IoT devices enables seamless data sharing, enhanced automation, and intelligent decision-making. As companies increasingly focus on digital transformation, RFID technology is becoming essential for enhancing visibility in operations, boosting productivity, and offering predictive analytics.
3. **Regulatory Mandates and Industry Standards**: Sectors like healthcare, pharmaceuticals, and food & beverage are subject to strict regulatory standards for product traceability, safety, and anti-counterfeiting measures. RFID ensures compliance with these regulations, thus driving its widespread adoption in critical industries.
4. **Decreasing Costs of RFID Technology**: Advancements in RFID hardware, including tag miniaturization and lower production costs, have made RFID systems more

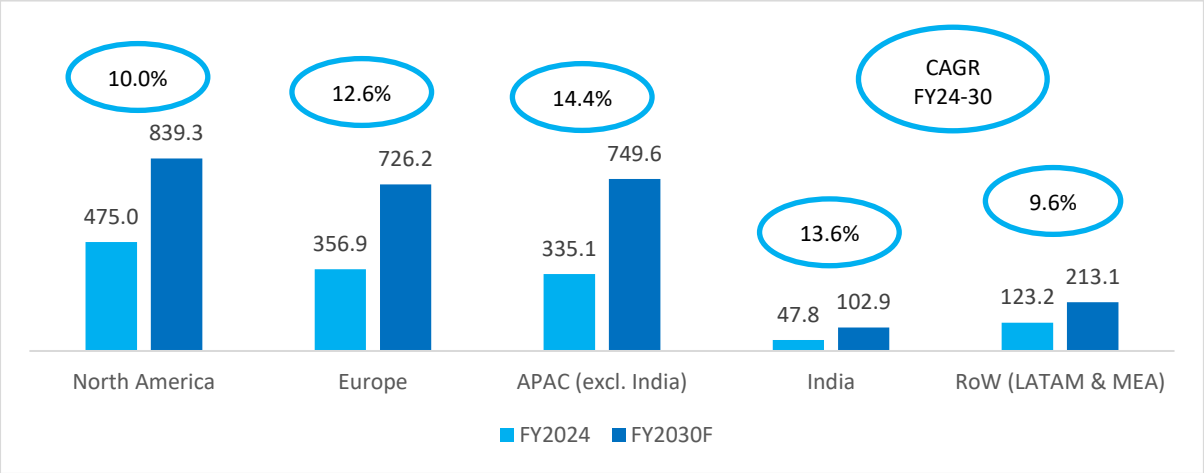
affordable. This reduction in the cost barrier has allowed small and medium-sized enterprises (SMEs) to leverage RFID, expanding the market further.

5. **Rise of E-commerce and Omnichannel Retail**: The rapid growth of e-commerce and omnichannel retail models demands real-time inventory visibility, faster order fulfillment, and efficient supply chain operations. RFID technology helps retailers track goods from warehouse to delivery, improving overall customer satisfaction.
6. **Advancements in RFID Technology**: Continued R&D has led to improvements in RFID's read range, accuracy, and environmental durability. Enhanced capabilities such as RFID sensors and active RFID systems are expanding its application in high-value asset tracking, environmental monitoring, and smart infrastructure.
7. **Expansion of RFID in Emerging Markets**: Emerging economies are increasingly adopting RFID solutions across industries like automotive, logistics, agriculture, and government services. These regions are driving growth as RFID supports modernization initiatives and industrial automation efforts.

These enablers position RFID as a critical technology for improving operational efficiency, reducing errors, and driving innovation in various sectors.

9.4. RFID Market: Split by Regions

Exhibit 74: RFID Market (INR Bn) by Regions, FY2024-2030F



Note: 1 USD = 82.5 INR (2023), 1 USD = INR 83 (2030) *Source: Frost & Sullivan*

Note: FY2025-2030 is Forecasted

The RFID market in North America is expected to grow from INR 475.0 billion in FY24 to USD 839.3 billion in FY30 growing at a CAGR of 10%. The North American market is characterized by robust adoption across diverse industries such as retail, healthcare, logistics, and defense, driven by the region's advanced technological infrastructure and focus on automation. In the retail sector, major players like Walmart utilize RFID for inventory optimization, enhancing stock accuracy and customer satisfaction. The healthcare industry increasingly deploys RFID for patient tracking, equipment management, and ensuring medication authenticity. Growth in e-commerce is boosting RFID adoption in logistics and supply chain management, where real-time tracking and automation have become critical. Integration with technologies like IoT further enhances the utility of RFID in achieving smarter and more efficient operations. Additionally, the U.S. government supports RFID adoption in defense applications for asset tracking and security. Other key drivers include the increasing use of RFID in

cashless payment systems and a regulatory push towards digital transformation. North America's emphasis on research and development ensures the region remains a leader in RFID innovation, with a growing focus on sustainability, such as the use of eco-friendly tags.

The RFID market in Europe is expected to grow from INR 356.9 billion in FY24 to INR 726.2 billion in FY30 growing at a CAGR of 12.6%. The RFID market in Europe is experiencing significant growth, driven by its widespread adoption across sectors such as retail, manufacturing, automotive, healthcare, and logistics. A key trend in Europe is the integration of RFID with Industry 4.0 initiatives, particularly in manufacturing and automotive sectors, where RFID enhances automation, asset management, and supply chain visibility. For example, major European automotive manufacturers use RFID for tracking components throughout the production process, ensuring seamless logistics and inventory control. The healthcare sector in Europe is also embracing RFID for tracking medical equipment, improving patient safety, and ensuring compliance with stringent regulations for pharmaceuticals and medical devices. The European Union's regulatory framework, particularly around food safety and pharmaceutical traceability, has been a strong growth driver, pushing industries to adopt RFID for compliance. Additionally, sustainability is a growing focus, with eco-friendly RFID tags becoming more prevalent as companies strive to meet environmental goals. The shift towards contactless technologies and the digital transformation of industries further contribute to the accelerating growth of the RFID market in Europe.

The RFID market in APAC is expected to grow from INR 335.1 billion in FY24 to INR 749.6 billion in FY30 growing at a CAGR of 14.4%. The RFID market in the Asia-Pacific (APAC) region, is experiencing rapid growth, driven by technological advancements and increasing demand across various sectors, including retail, logistics, healthcare, and manufacturing. China, Japan, and South Korea are leading the charge, with China seeing widespread adoption in sectors such as retail, manufacturing, and transportation, where RFID is used for inventory management, supply chain optimization, and asset tracking. In Japan, RFID technology is integral to the development of smart cities and contactless payments, with a strong emphasis on improving urban mobility and streamlining public services. The region's rapid urbanization and expansion of e-commerce are key growth drivers, as businesses seek to enhance supply chain transparency, reduce operational costs, and improve customer experience through real-time tracking and automation. Additionally, the automotive industry in Japan and South Korea increasingly relies on RFID for inventory management and component tracking in production lines. As the APAC region continues to embrace digital transformation, the demand for RFID is further fuelled by government initiatives promoting technological adoption, coupled with the rise of sustainable solutions, such as eco-friendly RFID tags. The growing focus on security and fraud prevention in sectors like retail and logistics is also contributing to the expanding market for RFID in the region.

The RFID market in India is expected to grow from USD 47.8 billion in FY24 to INR 102.9 billion in FY30 growing at a CAGR of 13.6%. Demand for RFID is expected to increase in India along with organised retail, logistics supply chain, automotive, manufacturing, health care, and public transit sectors. The retail sector leads this transformation, with RFID being used for inventory management, enhancing supply chain efficiency, and reducing theft, as retailers look to meet the demands of an increasingly digital and customer-centric economy. The logistics and transportation sectors are also significant contributors, particularly with initiatives like the FASTag for toll collection, which has seen wide adoption across India's road networks. Additionally, RFID technology plays a crucial role in the

manufacturing sector as India moves towards Industry 4.0 with increasing automation and smart factory solutions. The government of India has been a key driver of RFID adoption, particularly with projects aimed at modernizing the country's infrastructure, such as the development of multi-modal logistics parks and the implementation of smart city projects. These initiatives, coupled with an increased focus on digital transformation, have led to enhanced tracking, better inventory management, and improved operational efficiency in both public and private sectors. The growing e-commerce sector in India also boosts RFID demand, as logistics companies require efficient tracking and real-time data for last-mile delivery. In RFID manufacturing, chip bonding is the cornerstone of tag functionality, bridging the gap between semi-conductor handling and practical application. As industries increasingly adopt RFID, domestic production of RFID components and systems becomes essential to address several economic, strategic, and operational challenges. Advancements in chip bonding will play a key role in enhancing performance, reducing costs, and enabling new use cases. Building domestic capabilities in this area would reduce the need for importing finished RFID products or components and enhance supply chain resilience.

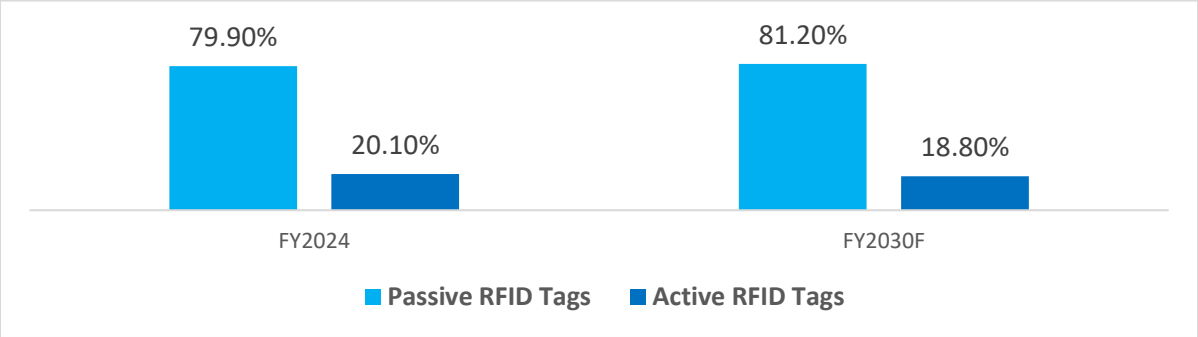
The RFID market in Middle East & Africa is expected to grow from INR 123.2 billion in FY24 to INR 213.1 billion in FY30 growing at a CAGR of 9.6%. The RFID market in the Middle East & Africa (MEA) is experiencing steady growth, driven by increasing adoption across sectors such as retail, logistics, oil & gas, and smart city projects. The Middle East, in particular, is seeing significant investments in smart cities and infrastructure development, where RFID plays a key role in optimizing transportation, access control, and security. For instance, countries like the UAE and Saudi Arabia are integrating RFID technology into their urban infrastructure for enhanced traffic management and public safety, while also adopting RFID for asset management in government services and large-scale events. In the retail sector, RFID is gaining momentum for inventory management, product authentication, and loss prevention, as businesses look to enhance customer experiences and improve operational efficiency.

In Africa, RFID adoption is being driven by the need for improved supply chain management and traceability, particularly in industries such as agriculture, healthcare, and logistics. For example, RFID is being used to track livestock and manage agricultural supply chains more efficiently. The oil and gas sector in countries like Nigeria and Angola is also embracing RFID for asset tracking and monitoring, improving safety and compliance in remote and hazardous environments. Another notable trend in Africa is the increasing use of RFID in healthcare for tracking medical supplies and patient data, which is essential for improving service delivery and addressing logistical challenges in healthcare systems. The growth of e-commerce and digital transformation across the region is further bolstering the demand for RFID, as businesses seek to streamline operations and improve transparency in inventory and delivery management.

The market in MEA is also supported by government initiatives focused on modernization and digitalization, as well as the expanding use of RFID in sectors requiring secure and efficient identification, such as banking, transportation, and hospitality. Additionally, RFID's potential in enhancing security and anti-counterfeiting measures is driving its uptake, particularly in the luxury goods market. Overall, the RFID market in MEA is expected to grow steadily, with key growth drivers including urbanization, technological advancements, and sector-specific needs for operational optimization and security

9.5. RFID Market: Split by RFID Tags Type

Exhibit 75: Global RFID Tags Market (USD Bn), Global, FY2024-2030F



Source: Frost & Sullivan *Note: FY2025-2030 is Forecasted*

The global RFID tag market is primarily divided into active and passive RFID tags, both of which serve distinct roles across various industries. These two types of tags differ in terms of functionality, cost, range, and application, and each is seeing unique growth drivers and trends in the global market.

Passive RFID Tags Market

The passive RFID tags market globally is estimated to be USD 13 billion in FY24 and is expected to grow to USD 25.7 billion in FY30 growing at a CAGR of 12.1%. The passive RFID tags market is by far the largest segment in the RFID industry due to their cost-effectiveness, simplicity, and widespread adoption across various sectors. These tags operate without a battery, drawing power from the RFID reader's signal to transmit data. This makes them ideal for applications such as inventory management, asset tracking, and supply chain logistics, where low-cost, high-volume deployment is essential.

One of the key trends driving growth in the passive RFID tag market is the increasing adoption in retail. Retailers are using passive RFID tags to streamline inventory management, enhance customer experiences, and reduce shrinkage. The automotive and pharmaceutical industries also leverage passive RFID for parts tracking and drug traceability, respectively, benefiting from the ability to tag large quantities of products at a low cost.

Another growth driver is the integration with IoT. The rise of IoT-enabled systems has made passive RFID tags a critical part of connected supply chains and smart inventory management systems. As industries across the globe adopt digital transformation, the demand for passive RFID tags continues to grow. Additionally, government mandates and regulations, especially in sectors like healthcare (for tracking medical devices and pharmaceuticals), also contribute to market expansion.

The passive RFID market is expected to continue growing due to cost-efficiency, wider adoption in asset management, and increasing demand for supply chain visibility.

Active RFID Tags Market

In contrast, active RFID tags are gaining traction due to their higher range and ability to transmit signals independently, powered by a battery. These tags are particularly useful in applications requiring real-time tracking and monitoring, such as in logistics, security, and asset management, where high-value or critical assets need to be tracked over long distances.

The growth of the active RFID market is closely tied to developments in logistics and supply chain management, where businesses are increasingly investing in real-time tracking to optimize inventory, reduce errors, and improve operational efficiency. Active RFID tags are widely used in

environments where continuous data monitoring is essential, such as for high-value goods, personnel safety, or vehicle tracking in the transportation sector. The healthcare industry is another significant user of active RFID, particularly for patient monitoring, tracking medical equipment, and ensuring the security of pharmaceuticals.

Key drivers for the active RFID market include the rising demand for real-time data, automation in manufacturing processes, and increased investment in smart logistics. These drivers are amplified by the growth of smart cities, where RFID technology plays a central role in transportation management, asset tracking, and public safety applications. Furthermore, advancements in battery technology and miniaturization are making active RFID tags more affordable and effective for a wider range of applications.

The active RFID market is expected to expand rapidly as industries continue to demand more sophisticated and real-time tracking solutions. As the Internet of Things (IoT) and big data technologies evolve, the need for advanced RFID systems capable of providing constant, reliable data will further drive the market's growth.

Both the active and passive RFID markets are set to benefit from the growing demand for automation, digitization, and data-driven solutions across industries worldwide. While passive RFID continues to dominate due to its low cost and simplicity, the active RFID market is seeing significant growth driven by applications that require real-time tracking, security, and high-performance systems. As these technologies evolve, the global RFID market is poised to witness innovation in how these tags integrate into broader IoT ecosystems, creating new growth opportunities in sectors ranging from retail and logistics to healthcare and manufacturing.

9.6. RFID across Industry Verticals: Application & Growth enablers

9.6.1 RFID in Retail

Early 2000s — Early Days

- Walmart mandated all its vendors tag items with RFID. This mandate created hype about the RFID growth prospect in retail. However, the technology did not gain traction because of RFID tag price and performance.

2013 Onwards — Gradual Uptake

- As performance levels of tags improved, the retail industry witnessed many pilots/implementation, especially by large retailers Macy's, Herman Kay, and Tesco, worldwide. This uptake lowered RFID tag prices.

2015 Onwards — Online shopping as a catalyst

- Online shopping witnessed a considerable increase, especially in growing economies such as India, driving retailers to adopt RFID technology. The technology helped retailers manage their inventories efficiently.

2020 & Beyond — Future of Retail

- The future of retail shopping might witness cashierless checkout and lower billing time at stores, with click-and-collect shopping models gaining popularity, Sustainable tags are likely to be in huge demand in the future.

RFID automatically identifies objects, which makes retrieving information about each object in retail easier & faster than using technologies, such as barcodes. In the retail industry, RFID tags can attach or integrate with any product at the manufacturing stage. RFID would be able to store data of various parameters of a product, such as brand, cost, dates of manufacturing and expiry, supplier information, and categories of information available around the product. The information that RFID tags collect can feed into SCM systems as a valuable IoT tool for end users.

The main benefits of including RFID in the retail sector are as follows:

- Sharing accurate information with the SCM ensures the better management of goods.
- Ensuring the traceability and trackability of assets aids in the better delivery of products.
- Product security improves.

It enables evaluation of the entire supply chain.

RFID as a critical growth enabler in Garment Retail

The growth of RFID (Radio Frequency Identification) technology in the garment retail sector has been significant, driven by the need for greater efficiency, inventory accuracy, and supply chain transparency. RFID enables retailers to track individual items throughout the supply chain, from manufacturing to the retail floor, enhancing inventory management, reducing theft, and improving customer experience. RFID is a critical component in the larger adoption of IoT in retail, enabling stores where products, shelves, and checkout systems are interconnected. This integration paves the way for innovations like fitting rooms, where RFID-enabled mirrors suggest products, and automated checkouts, further improving the overall customer experience. Global companies like Zara, Uniqlo, and Nike have pioneered RFID adoption in their operations, leading the way for other retailers to follow suit.

1. **Zara (Inditex):** Zara has been one of the most prominent adopters of RFID technology in the garment retail sector. The company integrated RFID in its stores to track items from the warehouse to the sales floor. Zara uses RFID tags on its clothing, which helps store employees quickly locate items, replenish stock, and improve in-store operations. This initiative contributed to faster inventory management and a better shopping experience for customers. Zara's RFID rollout extends across its global network, including over 2,000 stores.

2. **Uniqlo (Fast Retailing):** Uniqlo has implemented RFID technology to enhance its inventory tracking capabilities across various markets. The RFID tags are embedded in clothing items, allowing for real-time inventory visibility. This helps the company maintain optimal stock levels, reduce out-of-stock scenarios, and boost sales. Uniqlo's stores in Japan and globally have benefitted from this technology, which also supports their e-commerce operations by providing accurate online inventory data.

3. **Nike:** Nike has embraced RFID as part of its omnichannel strategy. By tagging products with RFID, Nike improves its inventory visibility and accuracy across its stores and warehouses. This real-time tracking allows the brand to offer features like "Buy Online, Pick Up in Store" (BOPIS) more efficiently, and it ensures that customers can quickly find the products they need. Nike's adoption of RFID contributes to its seamless customer experience and operational efficiency, both online and offline.

4. **Decathlon:** The French sporting goods retailer Decathlon is a major user of RFID technology. The company introduced RFID to all of its products, making inventory management faster and more accurate. Decathlon's RFID strategy covers more than 1,000 stores globally and millions of product SKUs. This has allowed Decathlon to manage large volumes of inventory while maintaining lean staffing, as RFID tags help employees perform store audits and restocking faster and more precisely.

5. **Target:** In the U.S., Target undertook one of the largest RFID initiatives in North America by implementing RFID technology in its supply chain in 2016. The company tagged a wide range of products, including apparel, with RFID tags to improve inventory accuracy and stock management. Target's RFID implementation helped reduce stockouts, streamline the restocking process, and enabled smoother online order fulfillment.

Contracts and Partnerships

Many RFID technology providers have partnered with global retail giants to facilitate the deployment of RFID in garment retail:

- **Avery Dennison:** A global leader in RFID solutions, Avery Dennison has been a major supplier of RFID tags and labels for companies like Zara, Nike, and Decathlon. The company provides scalable RFID solutions that are tailored to the retail industry's needs, helping companies track their products throughout the supply chain.

- **Impinj:** A provider of RAIN RFID solutions, Impinj has worked with large retailers to enhance their inventory management systems. The company offers RFID readers, chips, and software that enable real-time tracking of goods. Impinj's solutions have been used by companies like Macy's in the U.S. to improve stock accuracy and reduce inventory discrepancies.

- **SML Group:** SML is a global RFID technology company that works with several major fashion and apparel retailers. It provides end-to-end RFID solutions, including tags, hardware, and software for inventory management. SML has collaborated with companies like Levi's and American Apparel to implement RFID in their retail operations.

The adoption of RFID in garment retail continues to grow as retailers recognize its value in improving inventory accuracy, reducing shrinkage, and enhancing the overall customer experience. With major global brands leading the charge, RFID technology is set to become a standard tool in the retail industry's digital transformation journey.

Walmart as a Pioneer in the adoption of RFID technology in Retail

Walmart has integrated RFID across its supply chain to enhance inventory management, improve operational efficiency, and provide better visibility into its products from suppliers to stores. By leveraging RFID, Walmart has streamlined its operations, reduced stock shortages, minimized human errors, and optimized its omnichannel retailing efforts.

Examples of Walmart's Use of RFID

1. **Apparel and Retail Categories:**

    - **Expansion to New Product Categories:** Walmart first introduced RFID in its apparel category in 2010, using RFID tags to track individual items from distribution centers to store shelves. This program was highly successful, improving inventory accuracy and reducing the number of lost or misplaced items. As a result, in 2020, Walmart announced plans to expand RFID usage to additional product categories beyond apparel, including consumer electronics, home goods, and toys. These categories, which often experience frequent stockouts or misplaced inventory, are expected to benefit from enhanced visibility and faster replenishment times.

    - **Inventory Efficiency in Apparel:** By tagging apparel items with RFID, Walmart improved its ability to keep shelves stocked with the right products. In a single scan, Walmart employees could count thousands of items accurately, improving efficiency and reducing the time spent on inventory checks. The faster turnaround times meant customers were more likely to find the items they needed in stock.

2. **RFID in the Grocery Supply Chain:**

    - Walmart is exploring RFID's potential in its grocery supply chain, especially for perishable items like meat and produce. RFID can help track the freshness and movement of these products from farm to store shelves, ensuring that items are properly rotated, reducing spoilage, and improving food safety standards. RFID tags could potentially be used to track the temperature and handling of products in real-time, ensuring proper storage conditions throughout the supply chain.

3. **Partnerships with Suppliers:**

    - **Mandate to Suppliers:** Walmart has worked closely with its suppliers to roll out RFID technology across its supply chain. In fact, Walmart has mandated that its suppliers in certain product categories must tag items with RFID to improve overall supply chain transparency and efficiency. Suppliers of products like apparel and consumer electronics are required to use RFID tags, ensuring that items can be tracked from manufacturing through to the final point of sale.

    - **Supplier Contracts:** Walmart's RFID initiative has included contracts with major RFID technology providers such as Impinj and Avery Dennison. These companies supply Walmart and its vendors with the RFID hardware and software needed to tag and track products. Impinj's RAIN RFID chips, in particular, have been widely used in Walmart's product tracking system, while Avery Dennison provides RFID-enabled tags and labels for a wide variety of items sold at Walmart.

4. **RFID-Enabled Self-Checkout and Theft Prevention:**

    - Walmart is experimenting with using RFID technology to improve the customer checkout experience and reduce shrinkage (theft or loss of merchandise). RFID could potentially be integrated into self-checkout stations, allowing customers to scan multiple items at once simply by placing them near an RFID reader, speeding up the

checkout process. In addition, RFID can help Walmart identify theft, as tagged items that are not properly checked out could trigger alarms at the store exits.

5. **RFID in E-commerce Fulfillment:**
    - **Order Fulfillment and Inventory:** As Walmart has expanded its e-commerce platform, RFID technology has been instrumental in ensuring accurate order fulfillment. RFID helps Walmart track products across its network of distribution centers and stores, ensuring that online orders are fulfilled quickly and efficiently. Walmart uses RFID to track inventory in real-time, ensuring that products listed as "in stock" on its website are available for immediate shipment or in-store pickup.

Contracts and Collaborations

1. **Partnership with Avery Dennison:**
    - **Overview:** Walmart has partnered with Avery Dennison, a global leader in RFID technology, to implement RFID tags and labels across its supply chain. Avery Dennison provides Walmart and its suppliers with the RFID labels used to track products in categories like apparel, consumer electronics, and home goods.
2. **Collaboration with Impinj:**
    - **Overview:** Walmart has partnered with Impinj, a leading provider of RAIN RFID technology, to implement RFID solutions across its supply chain. Impinj's RFID chips and readers are used to track products at various stages of the supply chain, from supplier warehouses to distribution centers and store shelves.
    - **Key Projects:** Impinj has supplied Walmart with RFID technology for tracking apparel, electronics, and other categories. This partnership enables Walmart to leverage real-time data to optimize inventory management and supply chain efficiency. The contract between Walmart and Impinj supports the company's long-term goal of improving supply chain visibility and reducing operational costs.

Impact of RFID on Walmart's Operations

1. **Increased Inventory Accuracy:** Walmart's RFID deployment has led to improved inventory accuracy, allowing the company to maintain a near-perfect understanding of what items are available in each store. This has resulted in fewer stockouts, improved customer satisfaction, and more efficient use of warehouse and shelf space.
2. **Faster Replenishment and Reduced Stockouts**: RFID technology enables Walmart to quickly identify when products need restocking, allowing for faster replenishment and reducing the risk of out-of-stock situations. This has been particularly beneficial for high-demand items in categories like apparel, consumer electronics, and seasonal goods.
3. **Lower Operational Costs:** By automating inventory tracking and reducing the need for manual checks, Walmart has been able to lower labor costs and reduce the time it takes to

manage inventory. This automation has also reduced human errors in the supply chain, further improving efficiency.

4. **Improved Customer Experience:** RFID allows Walmart to ensure that products listed as available on its website or in stores are indeed in stock, improving the overall customer experience. Customers are less likely to encounter out-of-stock items, and Walmart can fulfill online orders more accurately and quickly.

5. **Reduced Theft and Shrinkage:** The use of RFID has also helped Walmart reduce theft and shrinkage, as the technology provides a detailed audit trail of every product, from the supplier to the point of sale. This enhanced visibility has made it easier for Walmart to detect and prevent theft, both in stores and along the supply chain.

Future of RFID at Walmart

Walmart's continued investment in RFID suggests that the company sees significant long-term value in the technology. As RFID becomes more integrated into Walmart's supply chain and retail operations, the company is likely to expand its use to additional product categories and further enhance its inventory management capabilities. Walmart's leadership in RFID adoption has set a benchmark for other retailers, demonstrating how the technology can drive operational efficiencies, improve customer experiences, and support large-scale retail operations in an increasingly omnichannel world.

9.6.2 RFID in EV Battery Charging

For EV charging, RFID cards are used to make it easy to pay for charging at charging points. An RFID card enables the user to start a charge at a public charging point by tapping his card against a reader. The card contains unique data that is transmitted to the charging station, allowing it to identify the user and initiate the charging process. Manufacturers are now working on options of having RFID enabled charges (7.5KW) for home installations to be activated through and RFID keyfob inked to the charging reader. The synchronization between the RFID keyfob and the EV charging reader involves a process that enables the charging system to identify the user, grant access, and initiate charging.

9.6.3 RFID in Access Control & Payments

RFID technology is increasingly being utilized in events to enhance access control and payment processes. By integrating RFID into event management, organizers can streamline operations, improve attendee experiences, and provide secure payment options.

RFID wristbands, cards, or badges can be used for contactless entry into events. Attendees simply scan their RFID-enabled device at entry points, significantly reducing wait times compared to traditional ticketing systems. RFID systems allow event organizers to monitor attendance in real-time, tracking the flow of attendees and managing crowd control more effectively.

RFID-enabled wristbands or cards can be prepaid instrument s or can be linked to attendees' payment accounts, enabling cashless transactions at food stalls, merchandise booths, and other vendors. This simplifies the payment process and enhances convenience. Attendees can make purchases by simply

tapping their RFID wristbands or cards at point-of-sale (POS) terminals, reducing queues and improving the overall event experience.

9.6.4 RFID as a critical growth enabler in Solar energy sector

The growth of RFID (Radio Frequency Identification) technology in the solar energy sector is a relatively new but rapidly emerging trend. RFID is being increasingly used in solar energy projects to enhance the efficiency and traceability of solar panels, improve supply chain management, ensure compliance with quality standards, and reduce operational costs. As the solar industry expands globally, RFID plays a crucial role in improving asset tracking, enhancing monitoring systems, and ensuring accurate data management in large-scale solar farms. Several global companies have begun integrating RFID into their solar operations, partnering with RFID technology providers to streamline their processes.

Key Benefits of RFID in Solar Energy

1. **Asset Tracking and Inventory Management:** In large-scale solar farms, managing thousands of solar panels and associated equipment is a complex task. RFID tags affixed to individual solar panels and components allow companies to monitor their movement, installation status, and operational performance. This ensures better control over inventory, reduces the risk of loss or theft, and enhances the lifecycle management of assets.

2. **Supply Chain Visibility:** RFID enhances supply chain transparency by tracking solar panel production, shipping, and installation in real-time. This ensures compliance with industry standards and improves accountability at every stage, from manufacturing to deployment on-site.

3. **Quality Assurance and Maintenance**: By tagging solar panels and components with RFID, companies can track the history of each component, including manufacturing details, certifications, and performance data. This is critical for maintenance operations, as it allows operators to identify underperforming panels and track warranty information more efficiently.

4. **Data Collection and Performance Monitoring**: RFID-enabled sensors can be integrated into solar panels to collect performance data such as energy output, temperature, and environmental conditions. This real-time data is crucial for optimizing energy production and identifying issues before they cause system failures.

Examples of RFID Adoption in Solar

1. **First Solar**: One of the world's largest solar panel manufacturers, First Solar, has incorporated RFID technology into its manufacturing processes. First Solar uses RFID to track the production and shipment of its solar modules, ensuring that each panel meets strict quality standards. By tagging its panels with RFID chips, First Solar can trace each unit's manufacturing details and optimize supply chain logistics, improving overall efficiency in deploying solar modules to projects worldwide.

2. **Trina Solar**: Trina Solar, a major Chinese manufacturer of photovoltaic (PV) modules, has implemented RFID technology in its supply chain management. Trina Solar uses RFID tags to track its products from production to installation, ensuring traceability and improving logistics. The RFID tags allow the company to monitor panel performance in real-time and collect data that aids in preventive maintenance and optimization of energy generation.

3. **SunPower**: A leading solar panel manufacturer and energy services provider, SunPower has leveraged RFID technology to track the lifecycle of its solar modules and ensure compliance with sustainability standards. The use of RFID helps SunPower monitor each panel's performance, detect issues early, and maintain efficient maintenance practices. SunPower's focus on high-quality solar solutions is enhanced by the data that RFID provides, ensuring optimal performance over the long term.

4. **JinkoSolar**: JinkoSolar, another global leader in solar panel manufacturing, uses RFID technology to improve the traceability of its products. By embedding RFID tags in solar panels, JinkoSolar can track each module's journey through the production process, shipment, and installation. The company also uses RFID data to maintain inventory control and ensure that its solar panels meet regulatory and performance standards.

RFID in Solar Farm Construction and Operation

1. **Enel Green Power**: Enel, a multinational energy company, has integrated RFID technology in some of its solar farm projects. By using RFID-enabled tags on solar modules and equipment, Enel can optimize its operations and maintenance processes, ensuring that solar farms operate at maximum efficiency. RFID allows Enel to track the performance of individual panels, which helps in monitoring energy output and identifying any underperforming modules that need attention.

2. **Duke Energy**: Duke Energy, one of the largest energy holding companies in the U.S., has explored the use of RFID technology in its solar projects to improve asset tracking and maintenance processes. By implementing RFID, Duke Energy can streamline the management of its solar farms, improve inventory control, and ensure that the panels meet performance and compliance standards throughout their lifecycle.

Partnerships and Contracts in RFID for Solar

- **SMARTRAC (Avery Dennison):** SMARTRAC, now part of Avery Dennison, is a leading RFID solutions provider that has partnered with several solar companies to integrate RFID technology into their operations. The company offers RFID tags designed for harsh outdoor environments, making them suitable for long-term use in solar farms. SMARTRAC's RFID solutions help solar companies enhance traceability, performance monitoring, and maintenance practices.

- **Impinj**: Impinj, a global leader in RFID technology, provides RAIN RFID solutions that are used in solar energy projects for asset tracking and monitoring. Impinj's RFID readers and tags can be embedded into solar panels and other equipment to enable real-time tracking and data collection, improving the management of solar assets.

- **Power Factors**: Power Factors, a provider of asset performance management solutions for renewable energy, has collaborated with RFID providers to integrate RFID technology into its solar farm management systems. By using RFID, Power Factors can provide real-time data on the condition and performance of solar panels, helping solar farm operators optimize energy production and reduce maintenance costs.

As the solar industry continues to expand globally, the adoption of RFID technology is expected to grow. Governments and organizations are increasingly focused on the efficient management of renewable energy projects, and RFID offers a scalable solution for optimizing solar farm operations. Furthermore, the push for higher transparency and traceability in solar supply chains, particularly in compliance with sustainability and ethical standards, will drive further investment in RFID technology.

9.6.5 Exports Sector

The growth of RFID (Radio Frequency Identification) technology in the export sector has been fuelled by its ability to provide real-time tracking, enhance supply chain visibility, ensure compliance with international trade regulations, and improve overall operational efficiency. Exporters worldwide are adopting RFID to streamline logistics, reduce human error, authenticate products, and combat issues like counterfeiting and theft. As global trade becomes increasingly complex, RFID has emerged as a critical tool for ensuring smoother international transactions, improving inventory management, and delivering better transparency to customers and regulatory authorities.

Key Drivers of Growth in RFID for the Export Sector

1. **Enhanced Supply Chain Visibility:** RFID provides real-time tracking of goods across international borders, ensuring that exporters can monitor shipments from the point of origin to the final destination. This helps reduce delays, minimize risks, and ensures that products are delivered on time.

2. **Compliance with Trade Regulations:** Many countries have strict regulations regarding the import and export of goods, particularly in industries like pharmaceuticals, electronics, and food. RFID ensures that exporters can provide accurate shipment information, which is crucial for customs clearance and meeting compliance requirements.

3. **Counterfeit Prevention and Product Authentication:** RFID tags are increasingly used to verify the authenticity of goods, especially for high-value exports like luxury goods, pharmaceuticals, and electronics. This helps protect against counterfeit products entering international markets, which is a significant concern for exporters and consumers alike.

4. **Efficiency in Logistics and Automation:** RFID allows exporters to automate inventory management, loading, and shipping processes. This reduces the chances of human error, speeds up operations, and minimizes the time spent on manual processes, leading to faster delivery times and reduced operational costs.

5. **Integration with IoT and Blockchain:** RFID's integration with Internet of Things (IoT) and blockchain technologies has further fueled its adoption in the export sector. This

combination allows for granular tracking of shipments and creates tamper-proof records, improving transparency, security, and compliance in global trade.

Examples of RFID Adoption in the Export Sector

1. Pharmaceutical Exporters Using RFID for Compliance:

- **Overview:** The pharmaceutical industry has embraced RFID for exporting medicines and other healthcare products, particularly to meet stringent international regulations for tracking and verifying the authenticity of drugs.
- **Key Projects:** Companies like Pfizer and Johnson & Johnson have implemented RFID to ensure that their exported pharmaceutical products meet the compliance requirements of various countries, such as the Drug Supply Chain Security Act (DSCSA) in the United States. RFID is used to track and verify the origin of drugs, ensuring authenticity throughout the supply chain.
- **Impact:** The adoption of RFID in pharmaceutical exports has improved compliance with global regulations, reduced counterfeit risks, and enhanced visibility in the supply chain. This has also led to better customer confidence in the quality and authenticity of drugs in international markets.

2. Zebra Technologies and UK Exporters:

- **Overview:** Zebra Technologies, a leading provider of RFID technology, has been instrumental in deploying RFID solutions for UK exporters. RFID tags are used to track goods as they move from production sites to export hubs and international destinations, ensuring accurate tracking and inventory management.
- **Key Projects:** Zebra has worked with several UK exporters to implement RFID for better supply chain management. In particular, RFID is used to streamline customs documentation, enabling faster processing and fewer delays at international borders.
- **Impact:** UK exporters using RFID have seen improvements in inventory management, faster customs clearance, and enhanced traceability of goods. The technology has helped UK businesses better meet international standards for trade compliance and export regulations.

3. Australian Livestock RFID Tracking for Export:

- **Overview:** Australia, one of the world's largest exporters of livestock, uses RFID to track cattle and sheep from farms to international markets. RFID tags attached to livestock provide data on their origin, health status, and movements, ensuring compliance with import regulations in countries like the European Union and Japan.
- **Key Projects:** The National Livestock Identification System (NLIS) in Australia mandates RFID tagging for all exported livestock. This system ensures traceability, reducing the risk of disease outbreaks and improving the transparency of animal exports.

- **Impact:** The use of RFID in livestock exports has improved traceability, ensured compliance with international animal welfare regulations, and reduced the risk of livestock diseases spreading across borders. Australian exporters have benefited from improved market access to regions with strict import regulations.

4. FedEx:

- **Overview:** FedEx, a global leader in logistics and shipping, uses RFID to track exported goods, particularly high-value and sensitive products like electronics, pharmaceuticals, and industrial equipment.
- **Key Projects:** FedEx has implemented RFID in its international shipping operations, allowing real-time tracking of export shipments. RFID tags attached to packages provide data on their location, handling, and environmental conditions, ensuring that exporters can monitor shipments closely throughout the export process.
- **Impact:** FedEx's use of RFID has resulted in more efficient export operations, faster customs clearance, and improved tracking of high-value goods. This has enhanced customer satisfaction and reduced the risk of lost or damaged goods during international transit.

Future Trends in RFID for Exports

1. **Greater Use of Blockchain and IoT Integration:** RFID's integration with blockchain and IoT will continue to grow, offering enhanced security, traceability, and transparency in global trade. Exporters will increasingly adopt these technologies to ensure that shipments are tracked and verified throughout the supply chain, reducing fraud and delays.
2. **Expansion into New Industries:** While RFID has already gained significant traction in sectors like retail, pharmaceuticals, and electronics, more industries such as automotive, agriculture, and chemicals are expected to adopt RFID for exporting goods. This will be driven by the need for better compliance and traceability in increasingly regulated global markets.
3. **Government and Industry Collaboration:** Governments and industry bodies around the world are likely to encourage the use of RFID in exports by implementing new regulations and standards for product tracking and traceability. This will further drive the adoption of RFID technology in global trade.

The continued growth of RFID in the export sector promises to revolutionize global trade by providing enhanced visibility, better compliance with international regulations, and improved operational efficiency for exporters.

9.6.6 RFID in Logistics

The use of RFID (Radio Frequency Identification) technology in logistics has grown significantly over the past decade, driven by the increasing demand for real-time visibility, supply chain efficiency, and accurate inventory tracking. RFID technology allows for the automatic identification and tracking of items, improving asset management, streamlining operations, and reducing human errors. The logistics sector has adopted RFID across various processes, from warehouse management and transportation to last-mile delivery. Major global companies have been leveraging RFID to optimize

their supply chains and enhance customer service, while several key contracts and partnerships have shaped the growth of RFID in this field.

Key Benefits of RFID in Logistics

1. **Manage inventory and supply chain traceability:** RFID-based source tagging involves embedding RFID tags into products at the point of manufacture. This technique enables tracking and identification throughout the supply chain, from production to retail, and provides numerous benefits that enhance efficiency, visibility, and security. RFID tags allow for real-time monitoring of inventory levels, making it easier to keep track of stock as items move through different stages of the supply chain. Manufacturers, distributors, and retailers can see exactly where each tagged item is located. By providing **accurate data on inventory levels**, RFID-based source tagging helps in maintaining optimal stock levels, reducing the chances of stockouts or excess inventory.
2. **Enhanced Security:** RFID helps in reducing theft, misplacement, and counterfeiting in the supply chain by providing detailed tracking of every asset. Goods can be traced back to their source, and unauthorized tampering or diversion can be detected.
3. **Efficient Warehouse Management:** RFID enables automated tracking of products entering and leaving a warehouse. This automation minimizes errors during the picking, packing, and shipping processes and speeds up warehouse operations.
4. **Optimized Transportation:** RFID tags on containers, trucks, and shipments provide real-time updates on the location and condition of goods in transit. This helps in route optimization, reducing delivery times, and improving overall logistics efficiency.

Examples of RFID Adoption in Logistics

1. **Amazon:** Amazon, a global leader in e-commerce and logistics, uses RFID technology to enhance its warehouse management and fulfillment operations. RFID tags are used to track goods throughout Amazon's vast network of warehouses and distribution centers, allowing for faster and more accurate order processing. RFID also supports Amazon's same-day and next-day delivery services by ensuring real-time visibility of items, thus improving delivery efficiency and reducing errors in order fulfillment.
2. **DHL:** DHL, a global logistics company, has embraced RFID technology in various aspects of its supply chain. DHL uses RFID to track shipments, monitor the condition of goods in transit, and optimize warehouse operations. The company has implemented RFID in its "Smart Warehouse" concept, where RFID tags are attached to pallets and containers to provide real-time tracking of assets and inventory. DHL's use of RFID improves inventory management and enables faster order processing, particularly in high-volume operations.
3. **Maersk:** Maersk, the world's largest container shipping company, has implemented RFID to track containers throughout its global shipping network. RFID tags allow Maersk to monitor the movement and condition of containers in real time, providing detailed information on their location, temperature, and handling conditions. This has helped Maersk improve the visibility and security of goods during transport, especially for high-value or temperature-

sensitive products. RFID also assists in optimizing container logistics and reducing delays in port operations.

4. **FedEx:** FedEx uses RFID technology to streamline its logistics and supply chain management. The company has implemented RFID to track packages and shipments in its sorting facilities, ensuring that items are processed quickly and accurately. RFID technology helps FedEx improve delivery speed and accuracy, especially in its international shipping operations. By using RFID, FedEx can provide customers with real-time tracking information, which enhances the overall shipping experience.

RFID in Cold Chain Logistics

1. **UPS:** In cold chain logistics, RFID plays a critical role in tracking the temperature and condition of sensitive goods such as pharmaceuticals, perishable food items, and vaccines. UPS, one of the largest logistics companies in the world, has integrated RFID technology into its cold chain logistics operations. By tagging temperature-sensitive shipments with RFID-enabled sensors, UPS can monitor the temperature and environmental conditions of goods in real-time, ensuring they are transported and stored under optimal conditions.

2. **Pfizer (COVID-19 Vaccine Distribution):** During the global COVID-19 pandemic, RFID played a vital role in the distribution of vaccines, which required precise temperature control during transportation. Pfizer used RFID tags with temperature sensors to monitor the condition of its COVID-19 vaccines throughout the supply chain. RFID-enabled tracking allowed Pfizer and its logistics partners to ensure that vaccines were kept within the required temperature range from manufacturing to administration, helping to prevent spoilage and ensure the safety of the vaccines.

Contracts and Partnerships in RFID for Logistics

1. **Savi Technology and the U.S. Department of Defense (DoD):** Savi Technology, a provider of RFID-based asset tracking solutions, has a long-standing contract with the U.S. Department of Defense to track military assets worldwide. The DoD uses RFID to monitor the location and condition of shipments, equipment, and supplies as they move through its global logistics network. This partnership enables the DoD to enhance supply chain visibility and ensure timely delivery of critical military resources.

2. **Zebra Technologies and Marks & Spencer (M&S):** Zebra Technologies, a global leader in RFID solutions, partnered with British retailer Marks & Spencer (M&S) to implement RFID across its logistics operations. M&S uses RFID tags on products and in its distribution centers to enhance inventory management and supply chain transparency. The partnership has allowed M&S to reduce inventory discrepancies and improve stock availability both in-store and online.

3. **Avery Dennison and Decathlon:** Avery Dennison, a major provider of RFID tags and labels, partnered with French sports retailer Decathlon to implement RFID in its global logistics operations. Decathlon uses RFID to track products from production through distribution to retail stores, improving supply chain efficiency and inventory accuracy. The RFID system

enables Decathlon to conduct rapid stock audits, optimize product replenishment, and enhance the overall customer experience by ensuring product availability.

4. **Impinj and Tata Consultancy Services (TCS):** Impinj, a leading RFID technology provider, collaborated with Tata Consultancy Services (TCS) to implement RFID solutions in logistics and supply chain management for various global clients. The partnership has focused on integrating RFID into warehouse and distribution center operations to improve asset tracking, inventory control, and overall logistics efficiency.

Future Growth and Opportunities

The future of RFID in logistics is bright, with the technology poised to play an even greater role as supply chains become more complex and globalized. Several factors will drive RFID adoption in logistics, including:

1. **E-commerce Growth:** As e-commerce continues to expand, the need for efficient inventory management and fast delivery will push more companies to adopt RFID in their logistics operations.

2. **Automation and AI Integration:** RFID will increasingly be integrated with automation systems, artificial intelligence (AI), and the Internet of Things (IoT) to create smart supply chains. This will allow for better forecasting, predictive maintenance, and real-time decision-making in logistics.

3. **Sustainability Initiatives:** RFID can help companies reduce waste, improve energy efficiency, and minimize their environmental impact by optimizing transportation routes and inventory levels. Sustainability-focused supply chains will drive the need for RFID solutions to track and reduce carbon footprints.

9.7 RFID Localisation in India

Radio Frequency Identification (RFID) localization in India is gaining significant momentum as the country seeks to build a robust ecosystem for indigenous development, production, and adoption of RFID technology. This initiative aligns with the broader vision of *Aatmanirbhar Bharat* (Self-Reliant India) and addresses the growing need for secure, efficient, and locally manufactured RFID systems across industries.

Importance of RFID Localization:

1. **Reducing Import Dependency**: India has traditionally relied on imports for high-quality RFID components such as tags, antennas, and readers. Localization aims to reduce this dependency, ensuring self-sufficiency.
2. **Cost Reduction**: By manufacturing RFID systems locally, the cost of production and deployment can be significantly lowered, making the technology more accessible for small and medium enterprises (SMEs).
3. **Enhanced Security**: Locally developed RFID systems reduce the risk of external data breaches and cybersecurity concerns, especially in critical sectors like defense, banking, and government projects.

4. **Sectoral Integration**: Localization supports the growing demand for RFID applications in sectors such as transportation (e.g., FASTag for toll collection), logistics, retail, agriculture, and healthcare.

Initiatives Driving RFID Localization:

1. **PLI Scheme**: The Production Linked Incentive scheme incentivizes local manufacturers to invest in production
2. **National IoT Policy**: The government's push for IoT adoption includes the promotion of RFID technology to improve logistics, inventory management, and asset tracking.
3. **Make in India Program**: Encourages foreign and domestic investment in RFID manufacturing through tax incentives, ease of doing business, and access to resources.
4. **Public-Private Collaboration**: Partnerships between Indian startups, research institutions, and global players foster innovation and knowledge sharing in RFID development.

India's efforts in RFID localization are expected to:

- **Enhance Efficiency Across Industries**: Local production will drive widespread adoption in logistics, healthcare, public transportation, and supply chain management.
- **Promote Technological Independence**: Build a strong foundation for related technologies such as the Internet of Things (IoT), smart sensors, and automated systems.
- **Boost Exports**: Position India as a major hub for affordable, high-quality RFID systems, catering to both domestic and global markets.

Through focused investments, policy support, and public-private collaboration, India is poised to emerge as a leader in RFID technology, contributing to both national growth and technological advancement.

9.8. Challenges in the RFID Sector

While RFID (Radio Frequency Identification) technology is experiencing rapid growth, it faces several challenges and threats that could impact its adoption and expansion. Some of the key threats and challenges include:

Privacy and Security Concerns

As RFID technology can track and collect data wirelessly, privacy concerns have arisen, especially in sectors such as retail and healthcare. Unauthorized reading of RFID tags, data breaches, and misuse of personal information are potential threats that could deter consumer and organizational trust in RFID systems. Ensuring secure encryption and limiting access to sensitive data is critical to overcoming these concerns.

Interference and Signal Obstruction

RFID technology relies on wireless signals, which can be prone to interference from other radio waves or physical obstructions such as metals and liquids. Signal disruption, which affects the accuracy and efficiency of RFID systems, remains a technical challenge in environments with many overlapping signals or physical barriers.

Standardization Issues

The lack of universal standards for RFID technology creates interoperability issues between different systems. Different countries or industries may adopt different RFID frequencies or protocols, making it difficult for global companies to implement consistent systems across regions or sectors.

Environmental Factors

RFID systems can be vulnerable to extreme environmental conditions such as high temperatures, humidity, and chemical exposure. Tags and readers may malfunction or degrade in harsh environments, reducing the technology's effectiveness in industrial and outdoor settings.

High Implementation Costs

One of the biggest challenges to the widespread adoption of RFID is the high initial cost of deploying the technology. This includes the cost of RFID tags, readers, infrastructure, and system integration. For many businesses, especially small and medium-sized enterprises, these costs can be prohibitive, slowing down the adoption rate.

Consumer Resistance

In sectors like retail, consumers may be wary of RFID due to concerns over tracking and data misuse, fearing that their personal information or purchasing behaviors may be used without their consent. This perception can lead to resistance against RFID-enabled products and services.

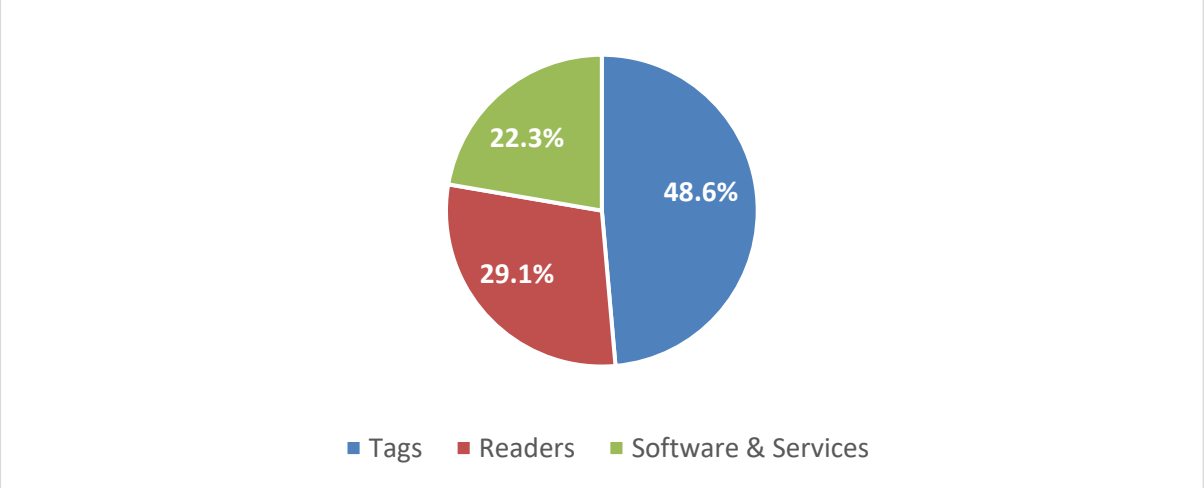
Technological Alternatives

RFID faces competition from other emerging identification and tracking technologies like Near Field Communication (NFC), Bluetooth Low Energy (BLE), and QR codes, which offer similar functionalities at lower costs or with fewer privacy concerns. These alternatives could slow the adoption of RFID, especially in sectors where lower-cost options are more practical.

Addressing these challenges will be crucial for the RFID market to continue its growth trajectory, requiring advancements in technology, improved regulations, and broader industry collaboration.

9.9. RFID Market, Split by Products (Tags, Software and services, Readers)

Exhibit 76: RFID Market, Product Wise Split (%), FY2024



Source: Secondary Sources, Frost & Sullivan Analysis

The tags segment accounted for approximately 48.6% of the total RFID market value in FY2024. Tags are fundamental components in RFID solutions and constitute a significant portion of the market due to their extensive use across multiple applications in large quantities; consequently, this segment captured the largest market share in 2024. The number of tags deployed significantly exceeds the quantity of readers and software utilized in a comprehensive RFID system within an organization. Furthermore, as the number of assets increases, the number of installed tags grows correspondingly; however, existing readers can often scan new tags without requiring replacement. This is why the market size for tags is the largest within the RFID ecosystem.

9.10 Competitive Landscape

Top Vendors and Industries served

Perfect ID is a provider of identification and tracking solutions, with a strong focus on RFID (Radio Frequency Identification) technology. The company offers a range of RFID tags, readers, and software solutions tailored to industries such as logistics, healthcare, retail, and manufacturing. Perfect ID's RFID technology enables real-time tracking and automation of assets, inventory, and equipment, improving efficiency and accuracy across operations. Known for its durable and high-performance RFID systems, Perfect ID helps businesses enhance visibility, reduce errors, and optimize workflows with secure and scalable RFID solutions.

Infotek Software Solutions is a technology provider specializing in innovative software and hardware solutions, with a strong presence in **RFID (Radio Frequency Identification)** technology. The company offers a comprehensive range of **RFID systems**, including **RFID tags, readers,** and **custom software integration** to support industries like **logistics, retail, healthcare,** and **manufacturing**. Infotek's RFID solutions enable real-time tracking, inventory management, and automation, helping businesses improve operational efficiency and accuracy. With a focus on delivering scalable and secure RFID technology, Infotek empowers organizations to optimize their asset management and streamline workflows across various sectors.

Avery Dennison is a global leader in labeling and packaging materials, renowned for its innovative solutions that enhance brand visibility and operational efficiency. The company has a significant presence in RFID (Radio Frequency Identification) technology, particularly through its RBIS (Retail Branding and Information Solutions) division, which focuses on apparel and retail applications. Avery Dennison's RFID solutions enable retailers and brands to improve inventory accuracy, enhance supply chain visibility, and streamline operations in the apparel industry. By integrating RFID technology into tags and labels, Avery Dennison helps businesses automate tracking processes, reduce shrinkage, and optimize stock management. The RBIS division is committed to driving digital transformation in the retail space, offering solutions that support sustainability and improve the overall customer experience through enhanced product information and seamless inventory management.

Printographiks is a specialized provider of printing and labeling solutions, with a significant focus on **RFID (Radio Frequency Identification)** technology. The company offers a range of **RFID labels, tags,** and **integrated printing solutions** designed to enhance inventory management, asset tracking, and operational efficiency across various industries, including **retail, logistics,** and **manufacturing**. Printographiks leverages RFID technology to enable businesses to automate data capture and improve

accuracy in their tracking processes. Their RFID solutions help clients reduce shrinkage, optimize supply chain operations, and enhance overall visibility of assets. With a commitment to innovation and quality, Printographiks continues to play a vital role in advancing RFID applications, helping organizations streamline their operations and achieve greater efficiency.

9.12. Market threats and challenges

Emerging Alternative technologies: Technologies like Near Field Communication, Bluetooth Low Energy, and IoT could potentially limit the RFID market. For instance, Internet of Things (IoT) offers advanced capabilities in real-time monitoring, location tracking, and predictive analytics. IoT-enabled devices are capable of providing more comprehensive information than traditional RFID systems.

Cybersecurity risks: While RFID technology offers significant benefits in enhancing operational efficiency and data management, it also requires careful attention to cybersecurity measures. Some low-cost RFID systems may have limited encryption or authentication features, emphasizing the importance of robust security protocols in deployment. Ensuring that RFID systems are equipped to mitigate risks such as data skimming, eavesdropping, or cloning is crucial for maintaining trust in the technology. For instance, a recent analysis of Dormakaba's Saflok RFID-based keycard locks highlighted the need for continuous security enhancements in electronic locking systems.

Lack of Infrastructure: RFID systems generate vast amounts of data through tracking and monitoring. Handling such data requires robust backend data support. Businesses face challenges such as server overload and low storage capacities when proper infrastructure for RFID systems is not in place.

Complexities in adopting RFID system: Choosing a suitable RFID system for a business is crucial and requires expertise and knowledge. Integrating the RFID system with existing IT infrastructure necessitates intricate customization to ensure synchronization and seamless data flow. Handling the large volumes of data generated by RFID systems also requires specialized expertise. Companies often need to collaborate with RFID solution providers and consultants to help them adopt and maintain RFID systems, which adds to the cost factor. Consequently, small businesses and startups may lack the knowledge and resources to overcome the complexities involved in adopting RFID systems.

10. IoT SOLUTIONS : IoT GSM SIM AND eSIM MARKET

10.1 IoT Solutions: India IoT GSM SIM and eSIM Market

The IoT eSIM market globally is in its nascent stages, with industry players working together to establish uniform standards. Currently, the majority of cellular IoT devices rely on traditional physical SIM cards, while a smaller portion employs eSIMs for experimental and demonstrative purposes. This emerging technology offers several advantages: reduced energy consumption, vital for IoT devices operating on batteries for extended periods; compact hardware design, enabling integration into smaller IoT devices; and remote SIM provisioning (RSP) services that eliminate dependence on specific network operators.

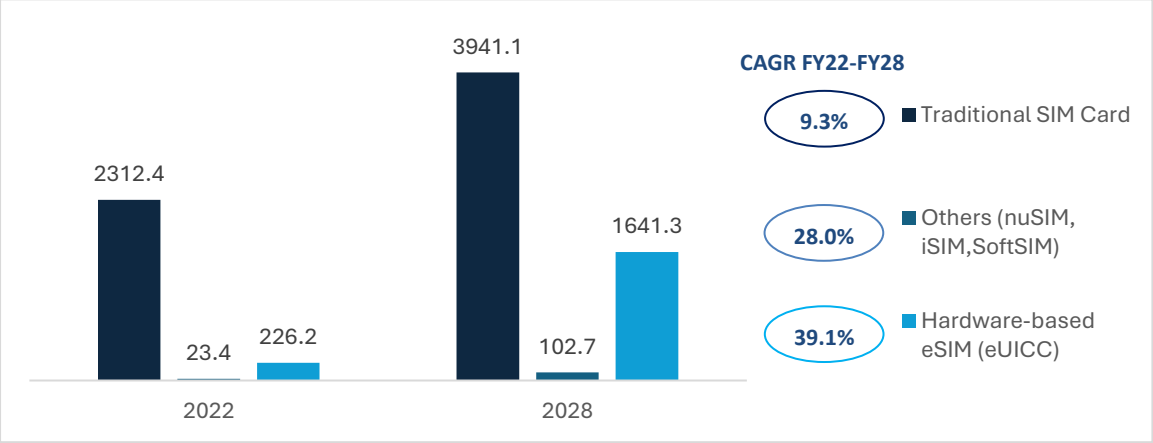
A conventional SIM card consists of an integrated circuit containing distinct subscriber data, utilized by Mobile Network Operators (MNOs) for user identification, authentication, and network access authorization. In contrast, an eSIM is a hardware component allowing MNOs to deliver updates

wirelessly. It comprises two key elements: the eUICC architecture and an RSP/SIM management platform for remote SIM provisioning. The IoT SIM card market can be categorized into three segments: conventional SIM cards, hardware-based eSIMs (eUICC), and alternative technologies (such as iSIM, nuSIM, and softSIM).

The eSIM ecosystem, encompassing eSIM providers, MNOs, MVNOs, hardware producers, and OEMs, is experiencing steady growth within the IoT sector. Stakeholders are jointly developing new specifications and security certifications for IoT-focused eSIM technology. Notable eSIM providers like Kigen, Thales, and Giesecke+Devrient (G+D) endorse the GSMA's Specification SGP.32. IoT eSIM companies are introducing innovative business models, while RSP services create expansion opportunities for global players. Although the ecosystem is diverse, with over 20 firms offering eSIM technology worldwide, the market in 2022 was primarily dominated by G+D, Thales, Idemia, Kigen, and Valid. Emerging players such as Onomondo and Deutsche Telekom are entering the market with novel offerings like softSIM and nuSIM.

10.2. Market Segmentation for Global Only (Traditional SIM, Hardware-based eSIM, Others – iSIM/NuSIM/SoftSIM)

Exhibit 77: Total IoT Connections Market Size, Global, 2022-2028F (Million)



Source: Frost & Sullivan
Note: FY2028 is Forecasted

The worldwide IoT eSIM market attained 226.2 million connections, with projections indicating a compound annual growth rate of 39.1% from 2022 to 2028.

The primary drivers of the global IoT eSIM market include demand from automotive, utility, and logistics sectors. Additionally, collaborative efforts among mobile network operators, mobile virtual network operators, original equipment manufacturers, semiconductor producers, and eSIM providers contribute significantly to market expansion. The adaptability in programming, downloading, and selecting connectivity profiles also fuels growth.

Semiconductors form the core of SIM and eSIM technology. India's favourable policies for semiconductor manufacturing would provide support for production of chips, including those for SIM and eSIM cards. This can offer significant cost advantages by localization, reducing transportation costs, and currency exchange risks. This makes Indian-manufactured SIM/eSIM cards more competitive in both domestic and international markets. India's growing semiconductor

industry presents opportunities to collaborate with local and international players which can lead to development of customized, secure chips for eSIMs, designed to meet specific use cases, including IoT, smartphones, and automotive applications.

10.3. Industry dynamics, expansion catalysts, potential prospects, and obstacles (Existing Indian government regulations regarding SIM card localization)

Market trends

Remote configuration: eSIM technology enables remote SIM profile provisioning and activation without physical store visits. It also facilitates seamless network switching for users.

Edge computing advancement: Edge computing is gaining momentum in India, with eSIM-enabled IoT devices leveraging low-latency processing capabilities. The synergy between edge computing and eSIM technology is redefining real-time data processing and enhancing decision-making.

Automotive sector integration: India's automotive industry is embracing new technologies, favoring features like infotainment, in-car entertainment, and telematics. Vehicles are increasingly equipped with embedded eSIMs to support these functionalities.

Smart city infrastructure growth: India's Smart City mission is driving eSIM technology adoption in infrastructure planning. IoT devices equipped with eSIM technology can transmit data on various urban parameters. The flexibility to switch providers makes eSIM technology crucial for adapting to evolving smart city needs and conditions.

Growth Enablers

5G expansion: eSIM adoption in India is primarily driven by 5G and IoT growth. 5G services are expected to provide enhanced connectivity for IoT applications. India boasts approximately 180 million 5G customers, with 5G availability increasing from 28.1% in Q1 2023 to 52% in Q4 2023. eSIMs can support new applications requiring ultra-low latency and high-speed connectivity.

Smartphone user increase: Rising smartphone penetration is a key factor driving eSIM and IoT SIM market growth in India. The launch of eSIM-enabled devices like iPhones and Google Pixel has been well-received by Indian consumers, popularizing eSIM technology for its seamless connectivity and flexibility.

Consumer flexibility preference: Growing consumer demand for flexible, convenient mobile service management has attracted eSIM technology to the market. The technology allows multiple carrier usage without physical SIM changes, benefiting travelers and those seeking dual SIM functionality. eSIMs also offer users the flexibility of programming, downloading, and selecting connectivity profiles.

Wearables and consumer electronics: The rising popularity of wearable devices like smartwatches, fitness trackers, and other connected gadgets is significantly driving eSIM growth. Wearables benefit from eSIM integration by enabling direct cellular connectivity without smartphone pairing. eSIMs are also expanding into other consumer electronics, including laptops, tablets, and smart cameras.

New GSMA standards: New GSMA standards for IoT eSIM (SGD .31/32), which specify remote provisioning for IoT devices, are expected to drive market growth in India.

Opportunities

Enterprise eSIM adoption: The technology enables businesses to deploy IoT solutions across diverse geographic locations. Network switching flexibility without physical presence can help organizations implement this technology in remote areas. For international operations, eSIMs offer a cost-effective alternative to traditional roaming, enabling seamless local network switching. The technology reduces costs by eliminating physical SIM card distribution and minimizing network change downtime. Additionally, eSIMs simplify device lifecycle management, facilitating efficient device updates or repurposing.

Consumer device eSIM integration: Smart electronics like fitness trackers and smartwatches are increasingly popular among consumers. Integrating eSIM technology in smart electronics presents an opportunity for seamless connectivity experiences. Moreover, it allows telecom operators and network service providers to offer enhanced customer experiences through multiple network profiles.

Telemedicine and remote healthcare: As healthcare adopts IoT in various functions, eSIM technology can enhance IoT device connectivity, enabling real-time data transmission and continuous monitoring. This creates opportunities for eSIM providers to collaborate with healthcare institutions and device manufacturers. eSIMs are becoming integral to IoT and machine-to-machine communications.

Logistics and Fleet Management:

Logistics companies rely heavily on connected vehicles for tracking, monitoring, and route optimization. Integrating eSIM technology in fleet devices enables seamless connectivity across regions and networks, ensuring uninterrupted operations. This creates opportunities for telecom operators and IoT providers to collaborate with logistics players for real-time tracking, predictive maintenance, and fuel optimization. eSIMs also reduce the dependency on physical SIM replacements when vehicles cross regions or borders.

Energy and Smart Utilities:

As the energy sector adopts smart grids and connected meters, eSIM-enabled devices can facilitate real-time monitoring and control of energy usage. Utilities can leverage eSIM technology for secure connectivity across millions of devices, improving efficiency in demand forecasting, outage detection, and preventive maintenance. eSIMs also allow energy providers to remotely switch between networks, ensuring high availability in urban as well as rural regions.

Retail and Smart Vending:

Retailers are increasingly using connected vending machines, kiosks, and digital PoS systems that require reliable data connectivity. With eSIM technology, retail IoT devices can be managed centrally, reducing downtime and improving customer experience. Retailers can dynamically switch networks to ensure smooth transaction processing, remote updates, and digital advertising delivery. This opens opportunities for eSIM providers to collaborate with retail chains and payment service providers.

Automotive and Connected Mobility:

The automotive industry is rapidly moving towards connected cars, electric vehicles, and shared mobility solutions. eSIM integration allows vehicles to stay connected across borders, supporting navigation, infotainment, telematics, and emergency services. Automakers and mobility providers can offer enhanced features like over-the-air updates, predictive maintenance, and usage-based insurance. This sector offers strong collaboration opportunities for eSIM providers with OEMs, insurers, and mobility-as-a-service operators.

Smart farming: India's agriculture sector presents an untapped market for eSIM-enabled IoT solutions. Smart farming utilizes connected devices for soil monitoring, irrigation systems, and precision farming, which can benefit from eSIM technology. eSIMs can enable real-time data collection, remote management, and network flexibility in rural areas.

Current Indian government policy for SIM localization

The Indian telecommunications regulator proposes utilizing eSIM solutions for machine-to-machine communications to bolster security and operational efficiency in multiple industries.

The adoption of eSIM aligns with the government's Digital India program, which seeks to create a technologically advanced society. The IoT policy promotes the integration of eSIM in connected devices, fostering innovation and establishing guidelines for IoT system development.

BharatNet, a significant government telecommunications initiative, aims to extend broadband access to rural regions. This project investigates technologies such as eSIM to provide connectivity in areas with limited physical infrastructure.

10.4. Worldwide connectivity options categorized by SIM card variants (Conventional SIM, Physical eSIM, Alternative solutions - iSIM / NuSIM / SoftSIM)

Traditional SIM: These are physical plastic SIM cards that have evolved in size over time. They have become more compact to accommodate small M2M and IoT devices, including point-of-sale and medical equipment. Traditional SIMs contain a single mobile network operator profile, requiring manual replacement when switching carriers.

Hardware-based eSIM (eUICC): This type of SIM is a chip soldered or surface-mounted by the manufacturer. eUICC supports over-the-air remote SIM provisioning by mobile network operators. These SIMs are utilized in both consumer and M2M/IoT sectors, such as automotive, logistics, and utilities industries.

Others – iSIM / NuSIM / SoftSIM: The integrated SIM (iSIM) is a system-on-chip that incorporates the SIM in a secure element. iSIMs are versatile and can be adapted for emerging applications, including medical devices and virtual reality headsets. This category also includes alternative technologies like softSIM and nuSIM.

10.5. Sector risks and obstacles

IoT and eSIM adoption in India is still in its nascent stages. Despite investments from telecoms and smartphone manufacturers, several challenges impede market growth.

Slower adoption compared to Global markets: As of December 2023, only 10-15% of smartphones sold in India feature eSIM functionality, contrasting sharply with the USA's 70% adoption rate.

Limited adoption among Chinese smartphones: eSIM technology is largely absent in Chinese smartphones, which dominate the Indian market. Premium brands like Google, Samsung, and Apple have integrated eSIM features, but Chinese policies discourage its use, resulting in low eSIM penetration in India.

Security concerns: eSIM technology is vulnerable to tampering and unauthorized access. A robust security framework is crucial to maintain eSIM profile integrity. Many IoT devices lack strong encryption, making data susceptible to interception and manipulation. Weak authentication mechanisms further compromise security. While high-end IoT SIM cards employ multi-factor authentication and secure protocols, budget devices often sacrifice these critical features.

Limited consumer awareness: eSIM technology is relatively new in India, and many consumers are unaware of its benefits, such as easy network switching and multi-device connectivity. This lack of understanding, coupled with limited device support, has hindered eSIM adoption as users continue to rely on traditional SIM cards.

10.6. Competitive Landscape

Thales

Thales is a global technology leader specializing in advanced solutions for digital identity, security, defense, aerospace, and transportation. With a strong emphasis on digital security and connectivity, Thales has become a major player in the **telecommunications** industry, offering cutting-edge **SIM** and **eSIM** technologies that enable secure mobile communications and connectivity across various devices and industries.

Presence in SIM and eSIM:

1. **SIM Cards:**
    - Thales (through its acquisition of **Gemalto**, a pioneer in digital security) is one of the largest global providers of **SIM cards**. Thales has been instrumental in the development and distribution of secure SIM solutions for mobile operators worldwide. Their SIM technology ensures secure authentication, data protection, and communication for mobile users across all network generations (2G, 3G, 4G, and 5G).
    - In addition to standard SIM cards, Thales offers **IoT SIM cards** that are tailored to support connectivity in Internet of Things (IoT) applications. These SIMs are designed for M2M (Machine-to-Machine) communication, offering reliability and security for connected devices in industries like automotive, smart cities, and industrial IoT.
2. **eSIM Solutions:**
    - Thales is a market leader in **eSIM (embedded SIM)** technology, which has revolutionized mobile connectivity by allowing devices to connect to mobile

networks without the need for a physical SIM card. Thales' eSIM solutions enable the remote provisioning of network credentials, simplifying the process for both consumers and enterprises to switch carriers or manage multiple subscriptions on a single device.

- The company's **GSMA-compliant eSIM platform** allows telecom operators and device manufacturers to remotely provision and manage eSIM-enabled devices, offering users greater flexibility and convenience. Thales' eSIM technology is used in a wide range of devices, including smartphones, smartwatches, tablets, and IoT devices.
- **eSIM for IoT:** Thales is at the forefront of enabling secure, scalable, and flexible connectivity for the **IoT ecosystem**. Their eSIM technology is essential for sectors such as automotive, smart cities, and healthcare, where billions of connected devices require reliable and secure mobile connectivity. Thales' **IoT connectivity management platforms** provide end-to-end solutions for remote management, security, and lifecycle support of IoT devices.

3. **Security and Scalability:**
   - Thales places a high emphasis on the **security** of its SIM and eSIM products, ensuring that sensitive user data is protected from cyber threats. Their eSIM solutions are built with advanced encryption technologies and comply with the highest international security standards.
   - Thales is committed to **innovation**, continually evolving its SIM and eSIM offerings to keep pace with advancements in mobile networks, including **5G**. Their products are designed to support the growing demand for faster, more secure, and more scalable connectivity, particularly in industries that are undergoing digital transformation.
4. **Remote SIM Provisioning (RSP):**
   - A key component of Thales' eSIM offering is its **Remote SIM Provisioning (RSP)** service. This technology allows telecom operators to dynamically provision and manage mobile network profiles over the air, enhancing user experience by eliminating the need to physically swap SIM cards when switching carriers or traveling internationally.
   - Thales' RSP solutions ensure that both **consumer devices** and **IoT** products can be seamlessly connected and managed, making it easier for enterprises to deploy large numbers of connected devices globally while maintaining robust security standards.

Thales is a leading player in the global **SIM** and **eSIM** markets, providing secure, scalable, and innovative connectivity solutions that are shaping the future of mobile communications. With their expertise in digital security and strong presence in telecom, Thales continues to enable seamless and secure mobile connectivity for consumers, enterprises, and IoT applications worldwide. As the demand for secure, flexible connectivity grows with the rise of 5G and IoT, Thales remains at the forefront, driving advancements in the SIM and eSIM ecosystems.

Giesecke+Devrient (G+D)

Giesecke+Devrient (G+D) is a global leader in providing innovative solutions for secure payments, connectivity, identities, and digital security. With over 170 years of experience, G+D operates across multiple sectors including financial services, telecommunications, public services, and enterprise security, delivering state-of-the-art technologies that protect both physical and digital assets.

Products and Service Offerings:

G+D's product and service portfolio spans several core areas:

1. **Digital Payments and Banking**
2. **Digital Identity and Authentication**
3. **Mobile Security and Connectivity**
4. **Enterprise and Data Security:**

Presence in SIM and eSIM:

G+D is a market leader in both **traditional SIM** and **eSIM** technologies, playing a pivotal role in the evolution of secure mobile connectivity.

1. **SIM Cards:**
    - G+D has a longstanding history of providing **high-security SIM cards** to telecom operators globally. Their SIM solutions enable mobile connectivity and ensure secure voice, data, and SMS services. These solutions are widely adopted across all generations of mobile networks (from 2G to 5G).
    - G+D also delivers specialized **M2M (Machine-to-Machine) SIM** cards that enable secure, reliable communication for IoT devices in industries like automotive, healthcare, smart cities, and industrial automation.
2. **eSIM Solutions:**
    - **eSIM (embedded SIM)** technology is a key focus for G+D, which is revolutionizing the way devices connect to mobile networks. G+D's **eSIM management platform** allows remote provisioning and management of network profiles, eliminating the need for physical SIM cards and enhancing flexibility for end users and device manufacturers.
    - G+D's eSIM solutions cater to a wide range of devices, including smartphones, smartwatches, tablets, and IoT-enabled products. Their eSIM technology is compliant with **GSMA** specifications, ensuring global compatibility with mobile operators and devices.

- By enabling **over-the-air (OTA)** updates and provisioning, G+D's eSIM platform provides telecom operators with the ability to seamlessly manage subscriptions and offer enhanced customer experiences.

3. **IoT Connectivity Solutions:**
    - G+D's **eSIM for IoT** is designed to support a growing ecosystem of connected devices, offering robust, scalable, and secure connectivity solutions for sectors like automotive (connected cars), smart homes, industrial IoT, and healthcare.
    - Their **AirOn platform** offers remote lifecycle management of IoT devices, ensuring secure and reliable network connectivity even for large-scale device deployments.
4. **Security and Innovation:**
    - G+D is at the forefront of **SIM security**, developing new encryption techniques and secure elements to safeguard user data and communication. Their solutions are compliant with the highest security standards, ensuring robust protection against hacking and unauthorized access.
    - G+D continuously invests in **R&D** to innovate in areas like **5G SIMs**, **multi-IMSI SIMs**, and **next-generation connectivity** for emerging technologies like **autonomous vehicles** and **smart infrastructure**.

G+D's expertise in both **SIM** and **eSIM** technologies positions it as a leader in the global telecommunications and connectivity markets. With a strong focus on security, innovation, and scalability, G+D enables secure, seamless mobile connectivity across a wide range of consumer devices and IoT applications. As the industry continues to evolve with 5G and IoT, G+D remains at the forefront, driving secure, flexible connectivity solutions for the future.

IDEMIA

IDEMIA is a global leader in augmented identity and digital security, specializing in solutions that secure, authenticate, and manage identities across multiple industries. The company serves governments, financial institutions, telecommunications providers, and enterprises worldwide, delivering cutting-edge solutions in biometrics, identity verification, and secure digital transactions.

Products and Service Offerings:

IDEMIA offers a wide range of products and services tailored to enhance security and identity management. These can be categorized into several key areas:

1. **Digital Identity and Authentication**
2. **Financial Services Solutions**
3. **Government and Public Security**
4. **Telecommunications and Connectivity**

Presence in SIM and eSIM:

IDEMIA is a leading player in the **SIM** and **eSIM** sectors, providing state-of-the-art technologies that ensure secure mobile connectivity. With a focus on future-ready solutions, IDEMIA is instrumental in transforming how devices connect to mobile networks.

1. **SIM Cards:**
    - IDEMIA has been a long-standing leader in providing **traditional SIM cards** to telecom operators worldwide. Its SIM solutions enable secure mobile connectivity, facilitating voice, data, and SMS services across global networks.
    - The company offers specialized **IoT SIMs**, designed for low-power and low-data applications, supporting secure and efficient machine-to-machine (M2M) communications in various industries, including automotive, healthcare, and smart cities.
2. **eSIM Solutions:**
    - **eSIM (embedded SIM)** technology is a key focus area for IDEMIA, as it enables remote provisioning and management of mobile network profiles without the need for a physical SIM card. This technology is pivotal in the growing market of connected devices, including smartphones, smartwatches, laptops, and IoT devices.
    - IDEMIA's eSIM platform enables telecom operators to deliver enhanced flexibility to consumers by allowing them to switch carriers and manage multiple network profiles on a single device without physical SIM swapping. This is critical in improving user convenience and device interoperability.
    - IDEMIA's eSIM solutions are compliant with global standards, ensuring that they work seamlessly across different mobile operators and devices. The company partners with major OEMs, device manufacturers, and mobile network operators to deploy secure and scalable eSIM technology.
3. **Remote SIM Provisioning (RSP):**
    - IDEMIA provides **remote SIM provisioning** services for both SIM and eSIM-enabled devices, allowing users to activate and manage mobile subscriptions remotely. This service is essential for connected devices, particularly in the context of the **Internet of Things (IoT)** ecosystem, where millions of devices need secure and scalable connectivity solutions.
    - Their **IoT connectivity management** platform helps enterprises efficiently manage large-scale device deployments by providing secure provisioning, monitoring, and management of IoT devices.
4. **Security and Compliance:**

- IDEMIA's SIM and eSIM solutions are designed with **advanced security features** to protect user data and ensure compliance with international standards, including **GSMA specifications** for eSIM.
- These solutions also offer **over-the-air (OTA)** management capabilities, enhancing user convenience by enabling updates and configurations without requiring physical access to the device.

IDEMIA's leadership in the **SIM** and **eSIM** sectors underscores its commitment to secure, scalable, and flexible mobile connectivity solutions. With its cutting-edge eSIM technology, IDEMIA is playing a key role in the transformation of mobile communications, catering to the increasing demand for secure, seamless connectivity across a wide range of devices, from smartphones to IoT-enabled equipment. IDEMIA continues to innovate in identity, security, and connectivity, empowering consumers and enterprises alike in the connected digital era.

11. Other Adjacent Markets

11.1 Social Schemes Cards in India

Social Schemes Cards in India are designed to facilitate Direct Benefit Transfers (DBT) for various welfare schemes initiated by the government. These cards serve as a mechanism to ensure that financial assistance, subsidies, and entitlements reach the intended beneficiaries directly, thereby reducing leakage, fraud, and delays. The introduction of social schemes cards is part of the broader digital transformation agenda of the Indian government, aimed at promoting transparency, accountability, and efficiency in the disbursement of social welfare benefits.

Key features of social schemes cards include:

- **Identification of Beneficiaries**: The cards are linked to a unique identification system, typically the **Aadhaar** system, which helps verify the identity of beneficiaries and ensures that only eligible individuals receive benefits.
- **Seamless Transactions**: The cards can be used for cashless transactions at designated service points, making it easier for beneficiaries to access services without needing to withdraw cash.
- **Integration with Bank Accounts**: Funds transferred through DBT are directly credited to beneficiaries' bank accounts linked to their social schemes cards, enhancing financial inclusion.

Key Initiatives

1. **Launch of the DBT Scheme**: The Direct Benefit Transfer initiative was launched in 2013 to streamline the delivery of government benefits. The use of social schemes cards has been a critical component of this initiative, enabling beneficiaries to receive financial support directly into their bank accounts.

2. **Aadhaar Linking**: The Indian government has mandated the linking of social schemes cards with the Aadhaar identification system to ensure transparency and reduce the possibility of fraud. This initiative has led to significant advancements in the identification and verification process for beneficiaries.

3. **Expansion of Schemes**: Various government schemes have been linked to social schemes cards, including the **Pradhan Mantri Jan Dhan Yojana (PMJDY)** for financial inclusion, the **Pradhan Mantri Kisan Samman Nidhi (PM-KISAN)** for direct income support to farmers, and the **Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA)** for rural employment. This expansion has increased the utility of social schemes cards across diverse sectors.

4. **Digital Payments Infrastructure**: The government has invested in building robust digital payments infrastructure, enabling beneficiaries to make cashless transactions using their social schemes cards. Initiatives like **Digital India** and **Financial Literacy Programs** have promoted the use of digital payment methods among rural and marginalized communities.

Drivers of Adoption

1. **Government Policy and Support**: Strong political will and commitment from the government have driven the adoption of social schemes cards. The push for digital payments and financial inclusion has created a conducive environment for beneficiaries to embrace these cards.

2. **Increased Financial Inclusion**: Social schemes cards are linked to bank accounts, promoting financial inclusion among marginalized sections of society. With access to banking services, beneficiaries can participate in the formal economy and gain greater control over their finances.

3. **Transparency and Efficiency**: The use of social schemes cards enhances transparency in the disbursement of benefits, reducing the risk of corruption and leakage. Beneficiaries can track their entitlements, leading to increased confidence in government programs.

4. **Technology Adoption**: The growing penetration of smartphones and the internet, coupled with the rise of digital payment solutions, has facilitated the adoption of social schemes cards. Mobile apps and online platforms allow beneficiaries to manage their cards and access services easily.

Challenges to Growth and Adoption

1. **Digital Divide**: Despite efforts to promote digital literacy, there remains a significant digital divide between urban and rural populations. Limited access to technology, particularly in remote areas, hampers the effective use of social schemes cards.

2. **Aadhaar-related Issues**: While the Aadhaar system has facilitated identity verification, concerns about data privacy, security, and the potential exclusion of individuals who do not have Aadhaar have been raised. Instances of system errors or failures to link Aadhaar with bank accounts can lead to delays in benefit disbursement.

3. **Awareness and Education**: Many beneficiaries, especially from rural backgrounds, may lack awareness or understanding of how to use social schemes cards effectively. Continuous education and outreach programs are necessary to ensure that beneficiaries are informed about their rights and how to access benefits.

4. **Infrastructure Challenges**: The lack of adequate infrastructure, such as reliable internet connectivity and banking facilities in rural areas, poses a significant barrier to the widespread adoption of social schemes cards. This can lead to challenges in conducting transactions and accessing services.

5. **Fraud and Misuse**: Despite measures in place, there are concerns about fraudulent activities and misuse of social schemes cards. Ensuring robust security protocols and monitoring mechanisms is essential to prevent exploitation of the system.

Social schemes cards play a pivotal role in India's efforts to enhance the efficiency and transparency of the Direct Benefit Transfer system. While there have been significant advancements in their adoption and utilization, addressing the challenges of digital literacy, infrastructure, and data privacy is crucial for maximizing their potential. Continued government support, coupled with efforts to bridge the digital divide, will be essential to ensure that the benefits of social schemes cards reach the most vulnerable sections of society.

11.2 Eco-Friendly and Sustainable Cards

Eco-friendly and sustainable cards represent a growing trend in the payment industry aimed at reducing environmental impact and promoting sustainability. These cards are typically made from biodegradable materials, recycled plastics, or other sustainable resources, and are designed to minimize waste and carbon footprints. As consumer awareness of environmental issues rises, financial institutions are increasingly offering eco-friendly card options to meet the demand for greener products while promoting sustainable practices in the banking and payments sector.

Key features of eco-friendly and sustainable cards include:

- **Sustainable Materials**: These cards are often crafted from materials such as recycled PVC, biodegradable materials, or plant-based plastics, reducing reliance on traditional plastic production and minimizing environmental harm.

- **Green Initiatives**: Many eco-friendly cards are linked to programs that support sustainability efforts, such as planting trees for each card issued or offering rewards for eco-conscious spending.

- **Transparency and Traceability**: Issuers often provide information on the environmental impact of the cards, allowing consumers to make informed choices about their spending habits and the sustainability of their financial products.

Key Initiatives

1. **Launch of Eco-Friendly Cards by Banks**: Several Indian banks and financial institutions have launched eco-friendly debit and credit cards. For example, **HDFC Bank** introduced its eco-friendly debit card made from recycled PVC, aiming to reduce plastic waste.

2. **Sustainable Banking Initiatives**: Many banks are adopting sustainable practices as part of their corporate social responsibility (CSR) strategies. This includes the promotion of eco-friendly cards alongside other green banking initiatives, such as promoting digital transactions to reduce paper waste.

3. **Collaboration with Environmental Organizations**: Some financial institutions have partnered with environmental organizations to promote sustainability. For instance, certain banks offer programs where a portion of transaction fees from eco-friendly cards is donated to environmental causes, such as reforestation or wildlife conservation.

4. **Awareness Campaigns**: Banks and financial institutions are actively conducting awareness campaigns to educate consumers about the benefits of using eco-friendly cards. These campaigns emphasize the importance of sustainability and encourage customers to make environmentally conscious choices.

5. **Innovations in Card Technology**: Recent innovations have led to the development of cards that not only reduce environmental impact but also incorporate technology for enhanced security and usability. Some eco-friendly cards feature contactless payment options and advanced security features while remaining sustainable.

Drivers of Adoption

1. **Growing Consumer Awareness**: Increased awareness of environmental issues and climate change has led consumers to seek out sustainable products. Eco-friendly cards appeal to environmentally conscious consumers who prefer to align their spending habits with their values.

2. **Corporate Social Responsibility (CSR)**: Financial institutions are recognizing the importance of CSR and sustainability in their business strategies. By offering eco-friendly cards, banks can enhance their brand reputation and attract customers who prioritize sustainability.

3. **Government Support**: The Indian government has been promoting green initiatives through various policies and schemes. This support encourages banks and financial institutions to adopt sustainable practices, including the issuance of eco-friendly cards.

4. **Technological Advancements**: Advances in materials science and production technology have made it easier for banks to create sustainable payment cards. Innovations in biodegradable materials and recycling processes have contributed to the development of eco-friendly card options.

5. **Reward Programs**: Many eco-friendly card programs are linked to rewards or benefits that encourage sustainable spending habits. This incentivizes consumers to choose eco-friendly options over traditional cards.

Challenges to Growth and Adoption

1. **Cost of Production**: The production of eco-friendly cards can be more expensive than traditional plastic cards, which may lead to higher fees for consumers. This cost factor can deter some customers from opting for eco-friendly options.

2. **Limited Awareness**: Despite growing awareness of sustainability issues, many consumers remain unaware of the availability and benefits of eco-friendly payment cards. Efforts to educate the public about these options are essential to drive adoption.

3. **Infrastructure and Supply Chain Issues**: The supply chain for sustainable materials may not be as developed as that for conventional plastics, leading to potential availability issues. This can hinder banks' ability to produce and distribute eco-friendly cards at scale.

4. **Consumer Behavior**: Traditional consumer habits, such as a preference for established payment methods and reluctance to change, can pose challenges to the widespread adoption of eco-friendly cards. Overcoming inertia requires effective marketing and education.

5. **Regulatory Hurdles**: The regulatory environment can impact the adoption of sustainable cards. Clear guidelines and standards for eco-friendly materials and production processes are necessary to ensure consumer confidence and support growth in this sector.

Eco-friendly and sustainable cards are emerging as a viable solution to address environmental concerns in the payments industry. With increasing consumer awareness and government support, these cards present an opportunity for banks to align their offerings with the growing demand for sustainability. However, overcoming challenges related to cost, awareness, and infrastructure will be crucial for maximizing the impact of eco-friendly cards in the Indian market. Continued collaboration between financial institutions, consumers, and environmental organizations will be essential to drive the adoption of sustainable payment solutions in the future.

11.3 LED Cards

LED Cards are innovative electronic cards that incorporate Light Emitting Diode (LED) technology to display dynamic visual content. These cards blend traditional card designs with modern electronic capabilities, making them visually striking and engaging. LED Cards can be used for various purposes, including marketing promotions, event invitations, or as digital business cards. The ability to display animations, graphics, and text allows these cards to capture attention and convey messages in a memorable way.

Key features of LED Cards include:

- **Dynamic Displays:** Equipped with built-in LED lights, these cards can create animated effects, changing colors, and scrolling text, enhancing their visual appeal.

- **Customizable Content:** Users can often personalize the displayed content, including logos, messages, or images, tailoring the cards for specific purposes or branding.

- **Battery-Powered:** LED Cards typically operate on small batteries, making them portable and convenient for various applications.
- **Rechargeable Options:** Some models feature rechargeable batteries, allowing for sustainable use without needing frequent replacements.

Key Initiatives

1. **Adoption by Businesses:** Companies across various sectors have started integrating LED Cards into their marketing strategies. Retailers, event planners, and service providers are leveraging these cards to promote their brands creatively.
2. **Launch of LED Business Cards:** Several startups and tech firms have introduced LED business cards that enable professionals to present their contact information in an interactive format. These cards often incorporate QR codes for easy access to digital profiles.
3. **Event Marketing:** LED Cards have gained popularity in the event marketing space, where organizers use them for invitations or promotional giveaways. Their eye-catching design makes them ideal for attracting attention at trade shows, conferences, and exhibitions.
4. **Collaborations with Influencers:** Some brands have partnered with influencers to promote LED Cards, showcasing their innovative features and creative applications in real-world scenarios, which has helped raise awareness and interest.
5. **Technological Innovations:** Ongoing advancements in LED technology and card manufacturing processes are improving the performance, durability, and design of LED Cards, making them more accessible and appealing to consumers.

Drivers of Adoption

1. **Increased Demand for Unique Marketing Solutions:** As businesses seek innovative ways to stand out, the demand for unique marketing materials like LED Cards has grown. Their dynamic visuals can capture attention and enhance brand recognition.
2. **Technological Advancements:** Improvements in LED technology and miniaturization of components have made it feasible to create thinner, lighter cards with longer battery life, facilitating broader adoption.
3. **Consumer Engagement:** LED Cards offer a memorable and interactive experience for recipients, increasing the likelihood of retention and engagement. This appeals to businesses aiming to make lasting impressions.
4. **Customizability:** The ability to personalize LED Cards for specific events, promotions, or branding allows businesses to tailor their messages effectively, driving interest and adoption.
5. **Shift Towards Digital and Interactive Media:** As consumers increasingly gravitate toward digital and interactive experiences, LED Cards fit into this trend, providing a bridge between traditional print materials and modern digital engagement.

Challenges to Growth and Adoption

1. **Cost of Production:** The manufacturing process for LED Cards can be more expensive than traditional cards, which may deter smaller businesses or individuals from adopting this technology.
2. **Durability Concerns:** While designed to be visually appealing, LED Cards may be more susceptible to damage due to their electronic components. Ensuring durability while maintaining a lightweight design poses a challenge for manufacturers.
3. **Battery Life Limitations:** The effectiveness of LED Cards depends on battery life, which can vary based on usage. Frequent charging or battery replacements may be necessary, potentially inconveniencing users.
4. **Market Competition:** The payments and marketing industries are highly competitive, with numerous alternatives available. LED Cards must effectively differentiate themselves from traditional and digital options to gain traction.
5. **Consumer Awareness:** Many consumers may not be familiar with LED Cards or their benefits. Increased marketing and educational efforts are needed to raise awareness and drive adoption.

LED Cards represent a cutting-edge fusion of technology and design, offering unique opportunities for marketing, branding, and personal expression. As businesses and individuals seek innovative ways to engage their audiences, LED Cards are poised to become a popular choice. However, addressing challenges related to cost, durability, and consumer awareness will be crucial for maximizing their potential in the competitive landscape. With continued advancements in technology and creative applications, LED Cards are likely to play an increasingly significant role in how brands communicate and connect with their audiences.

11.4 Forex Cards

Forex Cards, also known as foreign exchange cards or travel cards, are prepaid debit cards specifically designed for international travellers. These cards allow users to load multiple currencies onto a single card, making it easier and more convenient to spend abroad without the need for carrying cash or converting currencies at exchange rates. Forex Cards are widely accepted at millions of locations worldwide, including hotels, restaurants, and retail outlets, and they often offer competitive exchange rates compared to traditional currency conversion methods.

Key features of Forex Cards include:

- **Multi-Currency Functionality**: Users can load different currencies onto the card, allowing seamless transactions in various countries without incurring multiple currency conversion fees.
- **Security**: Forex Cards are typically equipped with chip technology, offering enhanced security against fraud. In case of loss or theft, users can block the card and retrieve remaining funds easily.

- **Easy Reloading**: Many Forex Cards allow users to reload funds online or through banking apps, providing flexibility for travelers who may need additional money during their trips.
- **Expense Management**: Users can track their spending through mobile apps or online portals, helping them manage their travel budgets effectively.

Key Initiatives

1. **Increased Popularity Post-Pandemic**: With the resurgence of international travel following the COVID-19 pandemic, the demand for Forex Cards has seen significant growth as travelers seek secure and convenient payment methods.
2. **Partnerships with Fintech Companies**: Traditional banks have begun partnering with fintech firms to offer innovative Forex Cards that include advanced features like mobile wallets, instant loading, and real-time currency conversion rates.
3. **Launch of Digital Forex Cards**: Some financial institutions have introduced digital Forex Cards, which allow users to make online transactions without the need for a physical card. This innovation caters to the growing trend of online shopping and digital payments.
4. **Promotional Offers**: Banks and financial institutions have launched promotional campaigns, offering incentives such as zero issuance fees, competitive exchange rates, and loyalty rewards for Forex Card users to drive adoption.
5. **Integration with Travel Services**: Forex Cards are increasingly being integrated with travel booking platforms, allowing users to purchase flights, accommodations, and experiences directly through their Forex Cards for added convenience.

Drivers of Adoption

1. **Growing International Travel**: The resurgence in global travel has led to increased demand for Forex Cards as travelers seek convenient and secure ways to manage their finances abroad.
2. **Convenience and Flexibility**: Forex Cards offer a hassle-free alternative to carrying cash or traveler's checks, making them an appealing option for travelers who prefer to simplify their financial transactions during trips.
3. **Cost-Effectiveness**: Forex Cards typically provide better exchange rates and lower transaction fees compared to traditional currency exchange methods, making them an attractive choice for budget-conscious travelers.
4. **Technological Advancements**: Improvements in digital banking and payment technologies have made it easier for consumers to obtain and manage Forex Cards, driving adoption among tech-savvy travelers.
5. **Enhanced Security Features**: The security measures associated with Forex Cards, including chip technology and the ability to block lost or stolen cards, enhance consumer confidence and encourage usage.

Challenges to Growth and Adoption

1. **Complex Fee Structures**: Some Forex Cards come with hidden fees, such as issuance charges, loading fees, and ATM withdrawal fees. These complexities can deter potential users who may not fully understand the costs involved.
2. **Limited Acceptance**: While Forex Cards are widely accepted, there may still be instances where certain merchants do not accept them, particularly in remote areas or small businesses. This can lead to inconvenience for travellers.
3. **Regulatory Challenges**: Forex Cards must comply with regulations in various countries, which can complicate the issuance process and affect the availability of certain features.
4. **Consumer Awareness**: Many potential users may be unaware of the benefits and features of Forex Cards. Increasing education and marketing efforts are necessary to promote their advantages over traditional currency options.
5. **Currency Volatility**: Fluctuations in currency exchange rates can impact the value of funds loaded onto Forex Cards, potentially affecting travellers' purchasing power during their trips.

Forex Cards have emerged as a valuable financial tool for international travellers, offering convenience, security, and cost-effectiveness. As the travel industry continues to recover and evolve, the demand for Forex Cards is likely to grow. However, addressing challenges related to fee structures, acceptance, and consumer awareness will be critical to ensuring their long-term success. With continued innovations and enhancements, Forex Cards are poised to play an increasingly important role in simplifying travel finance and enhancing the overall travel experience for consumers.

11.5 FIDO - Fast Identity Online (Payment cum Access Control)

FIDO (Fast Identity Online) is an open standard aimed at revolutionizing online authentication, providing a secure and user-friendly alternative to traditional password-based systems. FIDO combines biometric verification (like fingerprints or facial recognition) and public-key cryptography to ensure that only authorized users can access services or make payments. FIDO cards serve dual purposes by facilitating secure payment transactions and enabling access control for digital services and physical locations, making them an essential tool in enhancing cybersecurity and user convenience.

Key features of FIDO cards include:

- **Biometric Authentication:** Users can authenticate their identity using biometrics, significantly reducing the risk of unauthorized access that comes with password use.
- **Secure Payment Transactions:** FIDO cards streamline the payment process, enabling quick and secure transactions without exposing sensitive data.
- **Cross-Platform Compatibility:** These cards can work across various devices and platforms, enhancing the user experience in a multi-device world.

- **User Privacy:** FIDO protocols do not store sensitive biometric data on servers, thus minimizing the risk of data breaches.

Key Initiatives

1. **Adoption by Major Tech Companies:** Prominent technology firms, including Google, Microsoft, and Apple, have begun incorporating FIDO standards into their products. For instance, Google has integrated FIDO authentication into its Chrome browser and Android operating system, promoting wider usage among developers and consumers.
2. **Industry Collaboration:** The FIDO Alliance, a consortium of industry leaders, has been actively promoting the adoption of FIDO standards across various sectors, including finance, healthcare, and government. The alliance works to standardize secure authentication methods and encourage interoperability between devices.
3. **Integration with Payment Systems:** Financial institutions are increasingly adopting FIDO standards for secure online transactions. Banks and payment processors are exploring ways to integrate FIDO authentication into their services to enhance security and user experience.
4. **Development of FIDO2:** The evolution of the FIDO protocol has led to the introduction of FIDO2, which enables password less authentication through web browsers and mobile applications. This initiative aims to simplify user access while maintaining high-security standards.
5. **Security Awareness Campaigns:** Various organizations have launched campaigns to educate users about the benefits of FIDO authentication and the importance of transitioning away from passwords. These initiatives focus on increasing public awareness and encouraging adoption among both consumers and enterprises.

Drivers of Adoption

1. **Increasing Cybersecurity Concerns:** With the rise in cyberattacks and data breaches, there is a growing demand for more secure authentication methods. FIDO cards address these concerns by offering robust security features.
2. **User Demand for Convenience:** Users are increasingly seeking convenient solutions for accessing services and making payments. FIDO's biometric authentication simplifies the login and payment processes, making it an attractive option for consumers.
3. **Support from Major Industry Players:** The backing of significant technology companies and the FIDO Alliance has helped accelerate the adoption of FIDO standards, leading to broader acceptance in various industries.
4. **Regulatory Compliance:** Organizations are facing increased pressure to comply with regulations related to data protection and security. Adopting FIDO standards can help businesses meet these requirements while enhancing their overall security posture.

5. **Technological Advancements:** Improvements in biometric technology and cryptography have made FIDO authentication more accessible and reliable, encouraging businesses to implement these solutions.

Challenges to Growth and Adoption

1. **Awareness and Education:** Despite its benefits, many users and organizations remain unaware of FIDO standards and their advantages. Ongoing education and awareness campaigns are crucial for driving adoption.
2. **Integration Costs:** Implementing FIDO authentication can require significant investment in new technology and infrastructure, which may deter some businesses from adopting the solution.
3. **Resistance to Change:** Organizations accustomed to traditional password systems may be hesitant to transition to FIDO authentication, citing concerns about training staff and changing existing processes.
4. **User Privacy Concerns:** While FIDO minimizes the risks associated with storing biometric data, some users may still be hesitant to use biometric authentication due to privacy concerns or a lack of understanding of how their data is protected.
5. **Standardization Issues:** As the FIDO landscape evolves, ensuring consistent implementation across devices and platforms can pose challenges, particularly in maintaining interoperability between different systems.

FIDO - Fast Identity Online represents a significant advancement in secure authentication and payment solutions, addressing the challenges posed by traditional password systems. With increasing support from major industry players and a growing focus on cybersecurity, FIDO cards are poised for widespread adoption. However, overcoming challenges related to awareness, integration costs, and user privacy will be essential for maximizing their potential in the digital landscape. As FIDO continues to evolve, it holds promise for transforming how users access services and conduct transactions securely and conveniently.

11.6 Dynamic CVV Cards:

Dynamic CVV Cards are advanced payment cards that enhance security by featuring a changing Card Verification Value (CVV) number. Unlike traditional cards with a fixed CVV, dynamic CVV cards generate a new CVV code at regular intervals or with each transaction, making it significantly more difficult for fraudsters to use stolen card information. This innovative technology adds an extra layer of security to online and card-not-present transactions, addressing one of the major vulnerabilities in card payments.

Key features of dynamic CVV cards include:

- **Changing CVV Codes:** The CVV code on the card changes at specified intervals (e.g., every hour or every transaction), making it challenging for unauthorized users to exploit stolen card details.
- **Enhanced Fraud Protection:** By ensuring that the CVV is not static, these cards reduce the risk of fraudulent transactions, especially in online shopping environments.
- **User-Friendly Technology:** Many dynamic CVV cards feature user-friendly displays or mobile applications that allow cardholders to view their current CVV easily.

Key Initiatives

1. **Launch by Major Banks and Fintech Companies:** Several major banks and fintech companies have started introducing dynamic CVV cards as part of their efforts to enhance payment security. Notable examples include Mastercard and Visa, which have developed technologies to support dynamic CVV functionality.
2. **Adoption in Digital Wallets:** Dynamic CVV technology is being integrated into digital wallets and mobile payment applications, providing users with added security when making online transactions.
3. **Consumer Awareness Campaigns:** Financial institutions are launching campaigns to educate consumers about the benefits of dynamic CVV cards, highlighting how they can help protect against fraud and identity theft.
4. **Partnerships with Technology Providers:** Banks are collaborating with technology providers specializing in payment security to develop and implement dynamic CVV solutions effectively.
5. **Regulatory Support:** With growing concerns about payment security, regulatory bodies are advocating for enhanced security measures, including the adoption of dynamic CVV technology, to protect consumers.

Drivers of Adoption

1. **Increasing Cybersecurity Threats:** The rising incidence of cyberattacks and payment fraud has heightened consumer awareness and demand for more secure payment methods, driving the adoption of dynamic CVV cards.
2. **Consumer Demand for Security:** As consumers become more informed about online security risks, they are increasingly seeking payment options that offer enhanced protection against fraud, making dynamic CVV cards appealing.
3. **Advancements in Technology:** Improvements in payment technology, such as embedded displays and mobile applications, make it feasible for banks to implement dynamic CVV solutions easily, facilitating broader adoption.

4. **Support from Financial Institutions:** Banks and fintech companies are investing in dynamic CVV technologies as part of their commitment to protecting customers, which contributes to wider acceptance among consumers.

5. **Integration with Existing Payment Systems:** Dynamic CVV cards can be integrated into existing payment networks without significant disruptions, making them easier for financial institutions to adopt.

Challenges to Growth and Adoption

1. **Consumer Familiarity:** Many consumers may still be unfamiliar with dynamic CVV technology and its benefits, which can hinder adoption. Educational efforts are necessary to build understanding and trust.

2. **Cost of Implementation:** The technology required to support dynamic CVV may involve additional costs for banks and card issuers. This could limit the willingness of smaller institutions to adopt the technology.

3. **Limited Acceptance:** Some merchants may not yet be equipped to handle transactions involving dynamic CVV cards, which could deter consumers from using them if they encounter difficulties during checkout.

4. **Regulatory Compliance:** Banks and financial institutions must ensure that their dynamic CVV solutions comply with existing regulations and standards, which can complicate the implementation process.

5. **User Experience Concerns:** If the technology is not user-friendly, it could frustrate consumers and lead to reluctance in adopting dynamic CVV cards. Ensuring ease of use is critical for widespread acceptance.

Dynamic CVV cards represent a significant advancement in payment security, addressing the vulnerabilities associated with traditional static CVV codes. By providing a more secure alternative for online and card-not-present transactions, dynamic CVV cards are well-positioned to enhance consumer trust and protect against fraud. However, overcoming challenges related to consumer awareness, implementation costs, and merchant acceptance will be crucial for maximizing the potential of dynamic CVV technology in the payments landscape. As security threats continue to evolve, the adoption of dynamic CVV cards is likely to play an increasingly important role in ensuring safe and secure payment transactions.

11.7 Mass Transit Cards / National Common Mobility Card (NCMC) in India

Mass Transit Cards are smart cards used for fare collection in public transportation systems, allowing users to pay for travel on buses, trains, and metros seamlessly. In India, the introduction of the National Common Mobility Card (NCMC) marks a significant step towards creating an integrated, cashless transportation ecosystem. The NCMC aims to provide a unified payment platform that allows users to access various modes of transport and other services using a single card, promoting convenience and efficiency.

Launched in March 2019, the National Common Mobility Card (NCMC), branded as 'One Nation One Card,' is a homegrown initiative designed to enable seamless digital ticketing and travel across multiple transportation modes, including Metro, Rail, Bus, water ferries, and parking facilities. It can also be used for payments at retail shops, e-commerce platforms, restaurants, ATMs, kiosks, fuel stations, and parking lots, all with just one card.

The NCMC initiative aims to streamline access to transportation while promoting digital payments across the country. It is compatible with transit systems that support NCMC, such as the Delhi Metro Rail Corporation (DMRC) and Paytm Transit Card.

This card offers several advantages, including driving the adoption of digital payments, reducing costs associated with managing closed-loop cards, and cutting operational expenses. It also provides transit operators with data insights that can improve business intelligence and operational efficiency. Moreover, the NCMC ecosystem aligns with the government's goal of promoting digital payments for small transactions and minimizing costs across the system.

Since its introduction, the NCMC has gained significant traction. Data from the DMRC shows that between June and December 12, 2023, more than 4.7 million commuters used the NCMC for their Metro journeys. By March 2024, approximately 48 banks had issued around 200 million NCMC-enabled cards. The Reserve Bank of India (RBI) recently allowed NCMC issuance without Know Your Customer (KYC) requirements for cards with a Rs 3,000 limit, which is expected to further drive adoption.

The ongoing expansion of the NCMC to Public Transport Operators (PTOs) nationwide continues, with a steady increase in card issuance and terminal installations each month.

India's metro network is one of the largest and busiest urban rapid transit systems globally, serving over 2.63 billion people annually across 17 major cities. As of March 2024, the country has 902.4 kilometers (560.7 miles) of operational metro lines, making it the third longest in the world after the United States and China. Since 2014, the network has nearly tripled in size, with plans to expand to 27 cities by 2025. Under the "Gati Shakti Master Plan," the Indian government envisions metro systems in 75 cities by 2027, with an estimated investment of Rs 3.0 lakh crore. With daily ridership now exceeding 10 million and expected to reach 12.5 million in the near future, the adoption of NCMC cards is set to grow in tandem with the metro network's expansion.

Key features of mass transit cards and the NCMC include:

- **Interoperability:** NCMC cards are designed to work across multiple transport systems, enabling users to travel seamlessly without needing separate cards for different services.
- **Contactless Payment:** These cards utilize contactless technology, allowing users to tap their cards on readers for quick transactions, reducing waiting times at stations and improving the overall travel experience.
- **Multiple Use Cases:** Besides transportation, NCMC cards can be used for various other services, including shopping and utility payments, enhancing their utility for users.

Key Initiatives

1. **Launch of NCMC**: The NCMC was officially launched in March 2021 by the Ministry of Housing and Urban Affairs in India. This initiative is part of the government's broader efforts to enhance urban mobility and promote cashless transactions.

2. **Pilot Projects**: Various cities, including Delhi, Bangalore, and Mumbai, have initiated pilot projects to test the NCMC system. These projects are aimed at refining the technology and ensuring smooth integration with existing transport systems.

3. **Partnerships with Financial Institutions**: The NCMC initiative involves collaborations with banks and fintech companies to facilitate the issuance of NCMC cards and integrate payment systems across various modes of transport.

4. **Awareness Campaigns**: The government and relevant authorities have launched campaigns to educate the public about the benefits of using NCMC cards, focusing on their convenience and potential for reducing travel costs.

5. **Expansion of Acceptance:** Efforts are being made to expand the acceptance of NCMC cards beyond public transport to include retail stores, parking facilities, and other urban services, thereby increasing their utility.

Drivers of Adoption

1. **Government Support:** The Indian government's backing for the NCMC initiative is a significant driver of adoption, as it seeks to modernize urban transport and promote digital payments.

2. **Convenience for Users:** The ability to use a single card for multiple transport systems and services appeals to users, simplifying the travel experience and encouraging adoption.

3. **Growth of Digital Payments:** The overall shift towards digital payments in India, accelerated by the COVID-19 pandemic, has fostered an environment conducive to adopting smart transit cards.

4. **Urbanization and Population Growth:** With increasing urbanization and the growing population, the demand for efficient and convenient mass transit solutions is rising, prompting the need for integrated payment systems.

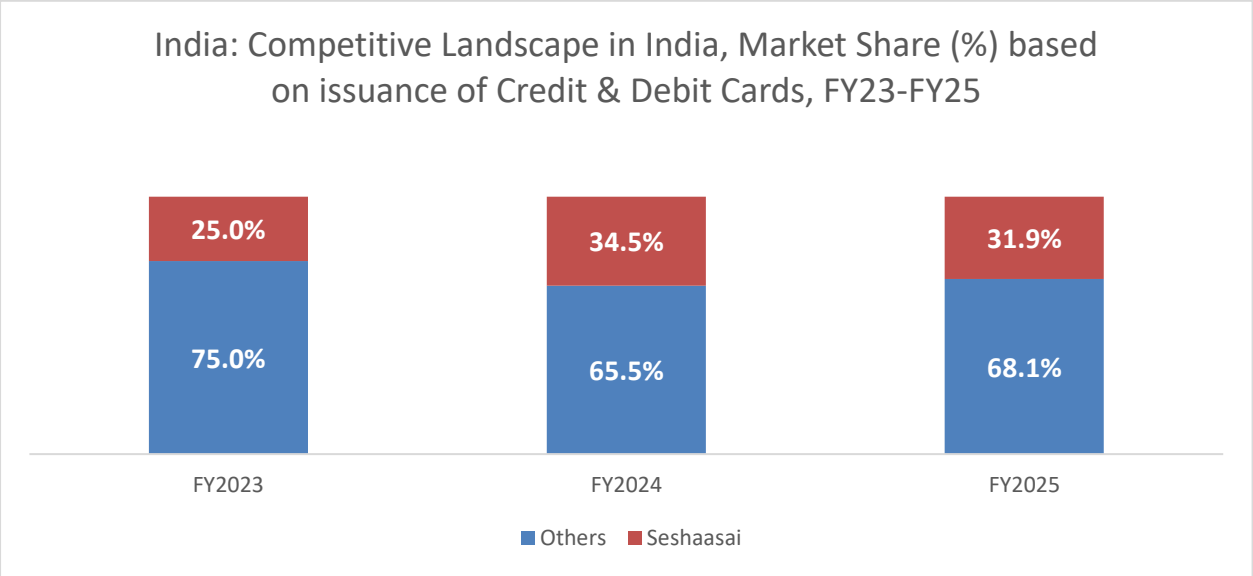
5. **Technological Advancements:** The development of contactless payment technology and smart card infrastructure supports the implementation and adoption of mass transit cards.

Mass transit cards, particularly the National Common Mobility Card (NCMC), represent a transformative shift in India’s approach to urban transportation and payment systems. By facilitating seamless travel and promoting digital payments, these cards have the potential to enhance the overall efficiency of mass transit in India. However, addressing challenges related to infrastructure, consumer awareness, and interoperability will be critical for maximizing the impact of the NCMC initiative. As urbanization continues to rise, the successful adoption of mass transit cards will be vital in creating a more connected and efficient transportation network in India.

12.COMPETITIVE LANDSCAPE

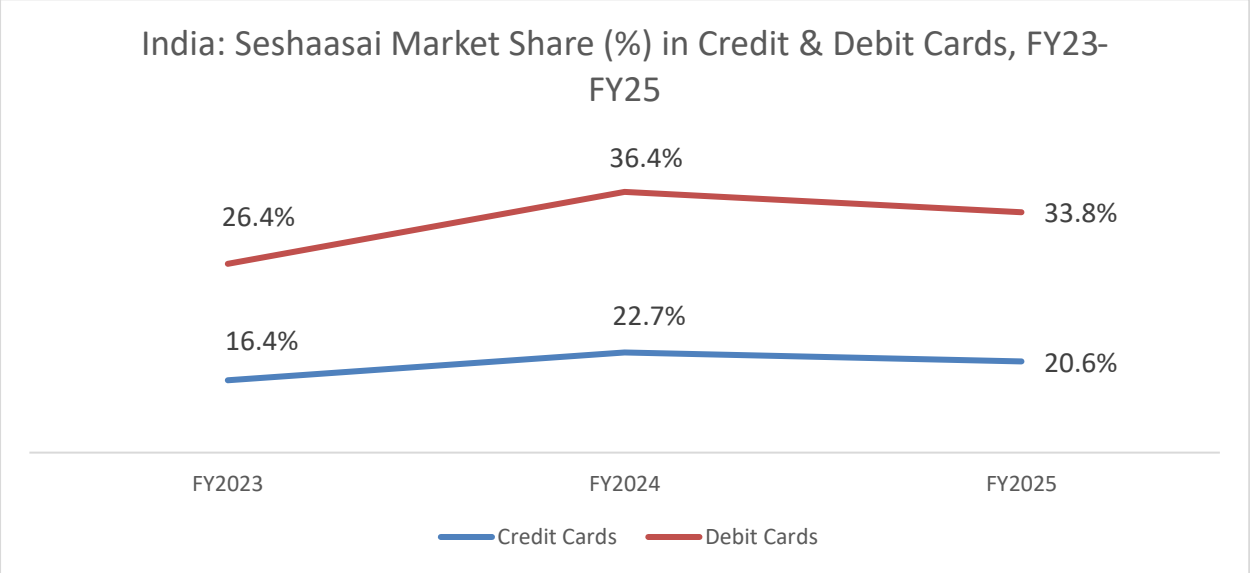
Sehsaasai Technologies, Manipal Payment and Identity Solutions (MPi) and KL-Hitech are the top Indian vendors manufacturing payment cards in India, global vendors like Idemia and G+D also operate in India.

Exhibit 78: India: Credit & Debit Cards Manufacturing Competitive Landscape, FY2023-25



Source: Frost & Sullivan

Exhibit 79: India: Seshaasai Market Share, FY2023-25



Source: Frost & Sullivan Analysis

Seshaasai's estimated market share has increased from about 25.0% in FY23 to about 31.9% in FY25 for credit and debit cards issuance in India. With this market share of about 31.9% in FY2025, Seshaasai has emerged as one of the top 2 vendors in the country in terms of credit cards and debit cards issuance.

In Fiscals 2023, 2024 and 2025, the company issued 71.93 million, 105.75 million and 86.63 million payment cards (including credit and debit cards), reflecting a CAGR of 9.7% between Fiscal 2023 and Fiscal 2025.

Besides Seshaasai issued 78.40 million and 8.23 million debit and credit cards respectively in FY25, translating into an estimated market share of about 33.8% and 20.6% respectively for debit and credit cards issuance in India for FY25.

Besides, the company also issued 2.2 million prepaid cards in FY2025.

The payment cards industry in India is fragmented on account of limited players operating at scale, and fewer that provide end-to-end service to their customers. As a result, BFSI customers are selective about the partners with which they work and typically seek out vendors who have a well-established reputation for trust and quality and are able to meet their service requirements. For card payment security, entities are required to adhere to various standards such as PCI-PIN, Payment Card Industry – PIN Transaction Security, Payment Card Industry – PIN Transaction Security – Hardware Security Module, and Payment Card Industry – Point-to-Point Encryption, over and above the Payment Card Industry Data Security Standard and Payment Application Data Security Standard. Quality control in payment card manufacturing is also a significant barrier due to complex processes and high standards. In addition, the industry is subject to a stringent regulatory regime and requires high security, data protection and data localization, owing to access to highly sensitive cardholder information. End-to-end solutioning with logistics and other value-added services to provide a seamless and hassle-free experience for financial institutions also acts as a key entry barrier for the industry and continues to be a critical success factor for vendors. Financial institutions prefer to work with partners offering one stop solutions across all services.

12.1 Top Vendors in India’s Card Manufacturing Market

Seshaasai:

Seshaasai, founded in 1993, is one of the leading and top 2 vendors in India’s payment card manufacturing market in terms of credit cards and debit cards issuances. They specialize in various smart card technologies, including magnetic stripe, NFC, RFID, EMV chip-based, and dual interface cards. Seshaasai’s production capacity and technological expertise allow them to produce millions of personalized cards for credit, debit, and prepaid card applications. As of March 31, 2025, the company has the capacity to produce 11.90 million cards in a month. The company is one of the few vendors in India to have approved facilities for manufacturing of plastic cards, metal cards, sustainable cards, biometric cards, wearables, and payment stickers.

The nature of company’s operations, particularly owing to the sensitivity of the data involved, requires elevated IT and cyber security measures at their facilities. Certified by major payment networks like Visa, Mastercard, and NPCI RuPay, Seshaasai meets rigorous security requirements, ensuring international standards for safeguarding cardholder data.

Seshaasai has 7 sites approved by IBA for secure printing (cheques, demand draft, Payorders) and 3 sites approved by Global schemes for card personalisation. The company is also one amongst the only two vendors in India with empanelled facilities for both cards and cheques at more than two locations (inferred based on list of empanelled 'Security Printers for printing of MICR Instruments' and NPCI

circular: NPCI/2025-26/RuPay/037 titled 'List of vendors approved for RuPay Card Manufacturing and Personalization' dated 23rd July, 2025). The company's pan-India network of branches and facilities ensure that they are able to service customer requirements in a timely manner.

Seshaasai introduced 'Made in India' metal and biometric cards that were approved by global payment schemes. Seshaasai also produces EMV chip-based and RFID tag-integrated intelligent magnetic strip cards in secure environments, accommodating both large and small orders with customizable authentication methods.

In the fiscal year FY2025, the company is country's one of the leading communications solutions providers to banks both, private and foreign banks, payment banks, small finance banks, public sector banks, insurance companies, asset management companies and depositories, based on number of customers serviced, as of March 31st, 2025.

As on March 31st 2025, the company has provided services to 65 banks, including public and private sector banks, foreign banks and small finance banks in India. In Fiscal 2025, the company provided services to 10 of the 12 public sector undertaking banks, 9 out of 11 small finance banks and 15 of the 21 private banks in India. The company enjoys an average of 7.3 years of relationship with their customers in the Banking sector. For the set of top ten and top twenty banking customers who have been with the company the longest, this average stands at 17.1 years and 13.2 years respectively. Fostering such relationships often involves strategies like proactive problem-solving, and a focus on consistent quality in products or services.

The company also has an extensive clientele in insurance domain. In the Fiscal Year 2025, the company served 9 out of total 32 general insurance and 12 out of total 24 life insurance companies. The company provides services across communication solutions and fulfilment solutions to their customers in the insurance domain. The company enjoys an average of 11 years and 8.4 years of relationship with their customers in the life insurance and general insurance sectors respectively. The company's extensive experience of over three decades has allowed them to gain an in-depth understanding of the market and have cemented their position as one of the leading players by leveraging their early foray in the BFSI sector.

Seshaasai is one of the top 2 payments card manufacturers in the country with a market share of about 31.9% in FY25 for credit and debit cards issuance in India. The company's estimated market share has increased from about 25.0% in FY23 to about 31.9% in FY25 for credit and debit cards issuance in India. The company is also one of the largest manufacturers of cheque leaves in India with 1,188.81 million cheques printed in FY25 alone.

The company is amongst select few players in the industry to manage the entire payments lifecycle right from data receipt to manufacturing to delivery and to end customers and ensure such offerings are at scale. The company has a long standing partnership with NPCI on RuPay Products, and has been instrumental in fostering innovation in the Indian financial ecosystem with quite a few initiatives as highlighted below –

- **First RuPay qSPARC NCMC Card**: Seshaasai delivered the inaugural RuPay qSPARC NCMC card for ICICI Bank as part of the Jan-mitra project for Ahmedabad smart city, marking a significant milestone in India's transit ecosystem.

- **Pioneering RuPay Wearables:** Seshaasai has been the first bureau to introduce different form factors for payments under the RuPay brand, marking the introduction of the whole new category viz RuPay On-the-Go wearables.
- Seshaasai has been the first company working with different issuers on the RuPay payment scheme to introduce the following payment products -
    - Payment Keychains
    - Payment Stickers
    - Payment Wristbands
- **Ticketing + Payment + Access Wristbands:** Seshaasai collaborated with NPCI to create India's first-ever open loop integrated payment and access device, enhancing fan experience with seamless cashless transactions. This has been successfully unveiled at different events viz Indian Premier League 2024, G-Easy musical concert and Global Fintech Fest 2024.
- **Establishment of Common Service Areas for NCMC Cards:** The company pioneered and was the first card bureau in the country in the creation of Common Service Areas at the personalization bureau level, enabling seamless and nationwide acceptance of NCMC cards.
- **Introduction of RuPay Metal Cards for PSU Banks:** Seshaasai became the first RuPay bureau to supply metal cards, catering to the high-end requirements of Public Sector Banks in India.
- **Innovation in NFC Solutions for UPI:** Seshaasai worked closely with NPCI to co-create NFC tags for UPI, leveraging the evolving NFC on mobile and promoting Tap and Pay in UPI.

Further, Seshaasai is one of the three vendors with approval for RuPay Card Manufacturing and Personalisation across the 'Magnetic Stripe', 'Contact', 'Contactless' and 'Wearables' offerings as highlighted in the circular titled 'List of vendors approved for RuPay Card Manufacturing and Personalization' and dated 23rd July, 2025 (Circular: : NPCI/2025-26/RuPay/037).

The company's solutions, that they offer at scale and on a recurring basis driven by their proprietary platforms, play a crucial role in enabling the operations and deliverables of the BFSI sector in India. The company's RUBIC platform is a comprehensive customer communication management (CCM) solution that generates high volumes of personalised customer communication. RUBIC's ability to efficiently process and manage vast amounts of data ensures reliability and effectiveness, making it a preferred choice for businesses seeking a powerful CCM solution. eTaTrak is an AI-powered deliverables and logistics management solution. IOMS, is an indigenously-developed order and inventory management platform which provides customers with a web-based ordering system to place orders from an approved bank-specific catalogue of items. izeIOT is designed to provide a comprehensive ecosystem. It communicates with various RFID devices, securely collects data, and delivers it to the appropriate end-use case. The company has developed its platforms to ensure they are versatile and industry-agnostic.

Decades of data processing capability of the company has enabled the transition to RFID based solution. The company's expertise in handling large volumes of data and extracting actionable insights enables it to provide advanced RFID solutions that offer numerous benefits across different industries.

The company's RFID and traceability solutions help businesses stay ahead of regulatory requirements while optimising operations. Demand for company's IoT products, including RFID devices, is expected to increase due to the regulatory mandate to ensure just in time tracking and the transient industry trend in favor of reliance upon the IoT ecosystem.

The market for the company's services is competitive. The company competes with a number of local and foreign players that provide similar services in each of the business lines in which they operate. They compete on a number of factors, including depth of service offerings, innovation, reputation, service quality, customization, price and convenience. For instance, in their communication and fulfilment solutions vertical, they compete based on technological capability, operating leverage, and knowledge of the market. For their payment solutions, they compete based on their manufacturing capacity, their ability to provide holistic products such as cards, cheques, and QR offerings, delivery turnaround time and overall account management.

The company competes on the basis of technological infrastructure, their ability to offer curated solutions and provide on-demand support.

Idemia:

IDEMIA, a multinational technology company headquartered in Courbevoie, France, specializes in identity-related security services. The company is known for its solutions in biometric identification and security, as well as secure payment systems. Additionally, IDEMIA provides biometric terminals for contactless access control, leveraging facial recognition and fingerprint recognition technologies.

In the realm of facial recognition, IDEMIA's technologies are employed in various applications, such as facilitating smooth entry at airports and stadiums, identifying individuals banned from certain venues, spotting fugitives in crowds, and verifying identities in restricted areas.

Furthermore, IDEMIA produced 3 billion identity documents worldwide in 2020, including passports, identity cards, and driving licenses. The company's research efforts have also led to advancements in payment card technology, such as embedding fingerprint recognition in the thin structure of a card and dynamically changing visual cryptograms.

Giesecke+Devrient (G+D):

Giesecke+Devrient (G+D), headquartered in Munich, Germany, is a major player in the payment card manufacturing industry, renowned for its innovations in banknote processing, smart cards, SIM cards, identification systems, and e-payments. Having expanded operations since the 1970s, G+D is now one of the world's largest supplier of banknotes and operates banknote printing facilities in Germany and Malaysia. The company also produces paper for banknotes, checks, bonds, certificates, passports, and other identification documents. G+D opened a smart card production facility in Delhi to cater to India's booming chip card market. This facility produces SIM cards for mobile communications and payment cards, with an annual capacity of over 40 million chip cards. G+D India Pvt. Ltd., established in 2001, has become one of the biggest SIM card suppliers in India, serving major mobile network operators.

Globally, G+D has shipped 1.9 billion contactless payment cards over the last five years. G+D's commitment to sustainability is evident in its pledge to replace all virgin plastic in its card products by 2030, aligning with its value-driven offerings to banks and focus on end-to-end Environmental, Social, and Governance (ESG) strategies.

KL-HiTech:

KL HI-TECH, founded in 1988 and headquartered in Hyderabad, India, the company is one of the key players in the payment card manufacturing sector. The company has an annual capacity of over 72 million banking cards per year.

In 2021, KL HI-TECH partnered with Zwipe, a pioneer in biometric payment card development, to bring next-generation biometric payment cards to its clients in India and key international markets. This collaboration aims to deliver physical cards that enable completely touchless payments through a PIN-free checkout experience, enhancing safety and hygiene for consumers.

With over 30 years of experience, KL HI-TECH has been instrumental in enabling secure payment transactions, facilitating communications, and creating digital identities. The company prides itself on its innovative approach, producing a variety of card materials such as Hololam, Metal cards, Vertical cards, Quick Read Technology, Core Edges, Biodegradable cards, and RFID cards.

Manipal Payment and Identity Solutions Limited (MPi):

Manipal Payment and Identity Solutions Limited (MPi) is a pioneering company specializing in the development and distribution of advanced payment card solutions.

MPi offers a diverse basket including banking cards (DI and EMV), smart cards, government identification cards, cheques logistics solutions and embedding chips on smart wearables. Since 2012, MPi has been one of the leading card payment technology enabler in India, having played a vital role in the transition of technology for payment cards from magstripe cards to Europay, MasterCard and Visa ("EMV") cards (chip embedded) and further to dual interface cards (chip embedded, coupled with tap and pay).

MPi has developed payment applications, which allows them to be certified by various payment networks. The company is among the first few payment card manufacturers to adopt this capability.

12.2 Vendor Comparison Across Parameters

Company Name	Product/Service Portfolio	Regional/Market Presence
Seshaasai	The company offers a range of smart cards i.e. payments cards, metal cards, dual interface cards, biometric cards, eco-friendly cards, smart card products, custom chip modules, smart wearables, RFID solutions, and merchant QR code kits, among others. Besides above products, Seshaasai also provides tech-enabled solutions to customers across industries using its proprietary software platforms like Rubic, Etatrak, IzeIOT, IOMS etc.	India, APAC, Africa, Europe
IDEMIA	They offer a range of products in biometrics, payment, connectivity, access control, identity, and travel. This includes card issuance services, payment cards, digital payment solutions, and biometric access control systems.	Europe,Middle East, Africa, Asia Pacific, North America, and South America.
Giesecke+Devrient (G+D):	EMV® chip cards, dual-interface contactless cards, eco-friendly cards, and advanced digital payment solutions like mobile payment enablement and tokenization services. G+D provides services for telecom providers, offering SIM cards, eSIMs, and IoT security solutions. G+D delivers also delivers secure identification solutions, including ePassports, national ID cards, and other authentication services	Many countries across Europe, Asia, the Americas, and Africa

KL-HiTech	Banking and biometric cards, secure print, RFID products etc.	Major banks in India and Asia
MPi Cards & Technology Pvt. Ltd.	EMV® chip cards, magnetic stripe cards, dual-interface contactless cards, and eco-friendly cards made from sustainable materials. The company also provides value-added services such as card personalization, data preparation, and secure packaging.	Asia, Middle East, Africa, and a few other emerging markets

12.3 Financial Benchmarking

Financial Benchmarking

Figures in INR Mn		Seshaasai	MPISL	IDEMIA	G+D	KL Hitech
Headquarters		**India**	**India**	**France**	**Germany**	**India**
Revenue from Operations (INR Mn)	FY2022-2023	11,462.99	7,455.90	114.82	5,552.07	1,950.51
	FY2023-2024	15582.56	10,291.72	193.57	8,083.38	2,602.60
	FY2024-2025	14631.51	NA	NA	NA	NA
Total Income (INR Mn)	FY2022-2023	11,538.39	7,576.52	119.41	5609.0	1,973.34
	FY2023-2024	15,696.71	10,487.38	197.76	8220.7	2,620.98
	FY2024-2025	14,736.17	NA	NA	NA	NA
Revenue growth (YoY) (%)	FY2023-2024	35.94%	38.03%	68.6%	117.20%	33.43%
	FY2024-2025	-6.10%	NA	NA	45.59%	NA
Gross Profit (INR Mn)	FY2022-2023	4,009.10	NA	NA	NA	NA
	FY2023-2024	5,703.51	NA	NA	NA	NA
	FY2024-2025	6,119.29	NA	NA	NA	NA
Gross Profit Margin (%)	FY2022-2023	34.97%	NA	NA	NA	NA
	FY2023-2024	36.60%	NA	NA	NA	NA
	FY2024-2025	41.82%	NA	NA	NA	NA
PAT (INR Mn)	FY2022-2023	1,080.98	669.23	45.11	862.99	35.25
	FY2023-2024	1,692.78	1,829.06	65.96	714.24	222.15
	FY2024-2025	2223.2	NA	NA	NA	NA
PAT Margin (%)	FY2022-2023	9.37%	8.83%	37.8%	15.39%	1.81%
	FY2023-2024	10.78%	17.44%	33.4%	8.69%	8.54%
	FY2024-2025	15.09%	NA	NA	NA	NA
EBITDA (INR Mn)	FY2022-2023	2,074.27	1144.94	61.68	1291.42	143.92
	FY2023-2024	3,030.10	2868.56	87.67	1115.23	387.04
	FY2024-2025	3703.65	NA	NA	NA	NA
EBITDA Margin (%)	FY2022-2023	17.98%	15.11%	51.65%	22.06%	7.38%
	FY2023-2024	19.30%	27.35%	44.33%	12.10%	14.87%
	FY2024-2025	25.13%	NA	NA	NA	NA
ROE (%)	FY2023	37.26%	NA	NA	113.02%	NA
	FY2024	39.00%	NA	NA	46.02%	NA
	FY2025	34.84%	NA	NA	NA	NA
ROCE (%)	FY2023	28.65%	NA	NA	NA	NA
	FY2024	33.47%	NA	NA	NA	NA
	FY2025	31.87%	NA	NA	NA	NA
Net Debt (INR Mn)	FY2023	2,448.61	1,096.05	NA	NA	NA
	FY2024	2,262.86	19.56	NA	NA	NA

	FY2025	2,374.74	NA	NA	NA	NA
Net Debt/ EBITDA	FY2023	1.18	0.96	NA	NA	NA
	FY2024	0.75	0.01	NA	NA	NA
	FY2025	0.64	NA	NA	NA	NA
Net Debt/ Equity	FY2023	0.84	0.57	NA	NA	NA
	FY2024	0.52	0.01	NA	NA	NA
	FY2025	0.37	NA	NA	NA	NA
Fixed Asset turnover (Gross)	FY2023	3.49	NA	NA	NA	NA
	FY2024	3.67	NA	NA	NA	NA
	FY2025	2.71	NA	NA	NA	NA
Net Working Capital (INR Mn)	FY2023	2,334.76	NA	NA	NA	NA
	FY2024	2,704.14	NA	NA	NA	NA
	FY2025	3,811.93	NA	NA	NA	NA
Net Working Capital in Days	FY2023	74.34	NA	NA	NA	NA
	FY2024	63.34	NA	NA	NA	NA
	FY2025	95.09	NA	NA	NA	NA

Source: Annual Reports, Other secondary sources
Financials in INR million. Fiscal year is April – March
Data for the respective companies - Manipal Payments, Seshaasai, Idemia, G+D and KL Hitec is for the respective financial years ending March, 2022, 2023, 2024 and 2025; Fiscal year considered for these companies is April-March
The table represents consolidated financials for the respective companies including all lines of businesses.
Revenue from operations means the revenue from operations for the year.
Total Income is calculated as addition of revenue from operations and other income for the year.
Revenue growth has been derived using the formula: [(Revenue from operations for the current fiscal year/Revenue from operations for the previous fiscal year)-1]
EBITDA = Restated profit before exceptional items and tax +Finance Cost + Depreciation and amortization
EBITDA Margin = EBITDA/Total Income
PAT = Restated profit/(Loss) for the period/year
PAT Margin = PAT/Total Income
Return on Equity (RoE) = Restated profit/(loss) for the period/year divided by Total Equity
Return on Capital Employed (ROCE) is calculated as Profit before Interest and Taxes divided by Total Capital Employed. Total Capital Employed is Total Equity plus Borrowing plus lease liabilities plus Deferred Tax Liability (net)
Net Debt = Short-term Borrowings + Long-Term Borrowings – Cash & Cash equivalents – Bank Balances + Earmarked balances with bank
Net Debt to EBITDA ratio is calculated as Net Debt divided by EBITDA for the period
Net Debt to Equity ratio is calculated as Net Debt divided by Total Equity
Gross Fixed Asset Turnover ratio =(Revenue from operations)/ (Gross Carrying Value of Property, Plant & Equipment and Right of Use Assets at the year end, Mar 31)
Net working Capital = Inventories+ Trade receivables+ Other Financial assets+ Other current assets+ Earmarked balances with bank- Trade payables-Lease Liabilities-Other Financial Liabilities-Provisions-Current tax liabilities (net) – Other current liabilities
*Net working capital days (R/off) = (Net working capital / Revenue from operations) * 365*

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CIN No: U74140TN1999PTC079226

Date: August 24, 2025

To

The Board of Directors
Seshaasai Technologies Limited (formerly known as Seshaasai Business Forms Limited)
9, Lalwani Industrial Estate,
14 Katrak Road, Wadala (West),
Mumbai, 400 031
Maharashtra, India
("The Company")

Dear Sir/Ma'am,

Re: Proposed initial public offering of equity shares of Rupees 10 each ("Equity Shares") of Seshaasai Technologies Limited (formerly known as Seshaasai Business Forms Limited) (the "Company" and such initial public offering, the "Offer")

With reference to the captioned matter, we hereby accord our no-objection and our consent to the inclusion/ reproduction of our name our name, Frost & Sullivan (India) Private Limited in relation to the Report (*as defined hereinafter)*, to our report titled "Connected Transactions: Exploring The Payment Card, Iot Rfid, And Esim Markets " dated August, 2025 (the "**Report**") and its contents or any extract thereof, being included in any document issued by the Company in connection with the Offer, including the red herring prospectus ("**RHP**") and the prospectus ("**Prospectus**") that the Company intends to file with the Registrar of Companies, Maharashtra at Mumbai (the "**RoC**") and with the Securities and Exchange Board of India (the "**SEBI**")and any relevant stock exchange(s) where the Equity Shares are proposed to be listed (the "**Stock Exchanges**"), and in any publicity material, research report, press release, presentation or other document issued in connection with the Offer (collectively, the "**Offering Materials**"). Further, we also provide our consent for the Report to be made available on the Company's website.

We also agree that such disclosures would be made only as deemed fit by the Company and the book running lead managers appointed in relation to the Offer (the "**BRLMs**") and this letter does not impose any obligation on the Company and/ or the BRLMs to make any or all the disclosures for which the consent is being sought and granted in terms of this letter.

We also give our consent to include this letter of consent and the Report as part of the section titled "*Material Contracts and Documents for Inspection*" in the DRHP, RHP and the Prospectus and any addenda, corrigenda, supplements or notices to the foregoing material documents which will be available to the public for inspection in relation to the Offer and may also be accessed online on the Company's website through a link provided in the relevant document and in any other form of access to the Report as may be required under applicable law or regulatory direction, request or order. We also consent to disclosure in the Offering Materials of the date of our appointment for the purpose of preparing/commissioning this Report. We have no objection with you sharing the Report, or any extract thereof, with any judicial authority, as required by law or regulation in relation to the Offer or pursuant to an order passed by any such regulatory or judicial authority.

We confirm that we are not, and have not in the past, been engaged or interested in the formation, or promotion, or management, of the Company. Further, we are an independent agency and neither the Company, nor its directors,

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promoters, key managerial personnel, senior management personnel and any subsidiary, nor the book running lead managers to the Offer (as listed in Annexure A), is a related party to us as per the definition of "related party" under the Companies Act, 2013 and the Securities and Exchange Board of India (Listing Obligations and Disclosure Requirements) Regulations, 2015, each as amended, as on the date of this letter.

We further confirm that there are no further consents, permissions, approvals or intimation required for reproducing the information contained in the Report in any Offering Materials, provided that it is ensured that disclaimer (as provided below) is also reproduced with such Offering Materials.

We declare that we do not have any direct/ indirect interest in or relationship with the Company or its promoters, directors or management or subsidiary or key managerial personnel or senior management personnel or book running lead managers as of the date of this letter, and also confirm that we do not perceive any conflict of interest in such relationship/ interest while issuing this Report. We confirm that we and our associates do not hold any Equity Shares of the Company.

We confirm that all information contained in the Report has been obtained by us from sources believed by us to be true and reliable and after exercise of due care and diligence by us. We further confirm that we have, where required, obtained requisite consent in relation to any information used by us in the Report.

We further confirm that the above information in relation to us is true, fair and correct and there is no untrue statement or omission which would render the contents of this consent misleading in its form or context.

We represent that our execution, delivery and performance of this consent have been duly authorized by all necessary actions (corporate or otherwise).

This letter does not impose any obligation on the Company to include in any Offering Materials all or any part of the information with respect to which consent for disclosure is being granted pursuant to this letter.

This letter may be relied upon by the Company, the book running lead managers and the legal advisors in relation to the Offer. This letter may be delivered or furnished to any governmental or regulatory authority, as may be required. Further, we also authorize you to deliver this letter of consent to the RoC pursuant to the provisions of Section 26 and 32 of the Companies Act, 2013 and rules and regulations made thereunder, or SEBI, Stock Exchanges or pursuant to an order passed by such regulatory or judicial authority or otherwise.

We hereby consent to this letter being disclosed by the Book Running Lead Managers, if required (i) by reason of any law, regulation or order of a court or by any governmental or competent regulatory authority, or (ii) in seeking to establish a defense in connection with, or to avoid, any actual, potential or threatened legal, arbitral or regulatory proceeding or investigation.

We undertake to inform you promptly, in writing, of any changes within our knowledge, to the above information until the Equity Shares commence trading on the Stock Exchanges, pursuant to the Offer. In the absence of such communication from us, the above information should be considered as updated information until the Equity Shares commence trading, on the Stock Exchanges, pursuant to the Offer.

We agree to keep the information regarding the Offer, your request and this consent strictly confidential.

All capitalized terms referred to herein, unless specifically defined therein, shall have the meanings ascribed to them as part of this letter.

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Given below is the disclaimer to be used in the Offering Materials.

*Frost & Sullivan has taken due care and caution in preparing this report (*Connected Transactions: Exploring The Payment Card, Iot Rfid, And Esim Markets *Report") based on the information obtained by Frost & Sullivan from sources which it considers reliable ("Data"). This* Connected Transactions: Exploring The Payment Card, Iot Rfid, And Esim Markets *Report is not a recommendation to invest / disinvest in any entity covered in the Report and no part of this Report should be construed as an expert advice or investment advice or any form of investment banking within the meaning of any law or regulation. Without limiting the generality of the foregoing, nothing in the Report is to be construed as Frost & Sullivan providing or intending to provide any services in jurisdictions where Frost & Sullivan does not have the necessary permission and/or registration to carry out its business activities in this regard. <client name> will be responsible for ensuring compliances and consequences of non-compliances for use of the (xxxx) Report or part thereof outside India. No part of this Frost & Sullivan Report may be published/reproduced in any form without Frost & Sullivan's prior written approval."*

Yours faithfully,

For and on behalf of Frost & Sullivan (India) Private Limited

Authorized Signatory
Name: Robin R Joffe
Designation: Managing Director and Partner - MEASA
Place: Dubai, UAE

Cc:

IIFL Capital Services Limited (formerly known as IIFL Securities Limited)
24th Floor, One Lodha Place,
Senapati Bapat Marg,
Lower Parel (West),
Mumbai 400013,
Maharashtra, India

ICICI Securities Limited
ICICI Venture House,
Appasaheb Marathe Marg,
Prabhadevi, Mumbai 400 025,

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Maharashtra, India

(IIFL Capital Services Limited (formerly known as IIFL Securities Limited), ICICI Securities Limited and SBI Capital Markets Limited referred to as the "Book Running Lead Managers" or "BRLMs")
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Annexure A

List of Co. Board of Directors

Sr. No.	Name of Director	Director Identification Number	Designation	Start Date
1	Pragnyat Lalwani	01870792	Chairman & Managing Director	September 17, 1993
2	Gautam Jain	02060629	Whole Time Director	September 17, 1993
3	Jayeshkumar Chandrakant Shah	00224935	Non-executive Director	August 19, 2024
4	Abbhijet Ghag	01993457	Independent Director	August 19, 2024
5	Sowmya Vencatesan	07108505	Independent Director	August 19, 2024
6	Mehul Suresh Shah	10740056	Independent Director	August 19, 2024