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As the powerhouse of South America in terms of economy and population size, Brazil is emerging from a lengthy recession and repositioning itself as the land of opportunity for business growth in South America.

The impact of upcoming elections, the humanitarian crisis in Venezuela and the severe drought in Argentina, coupled with less supportive global backdrop are forces that could threaten Latin America and, in-turn Brazil’s growth, however available data suggests that the positive economic momentum is likely to continue, going forward. Brazil also plays a major role in the region as the most popular foreign investment destination in South America and is expected to continue from strength to strength as a result of its forecasted GDP growth through to 2022.

From a manufacturing standpoint, Brazil’s manufacturing competitiveness is set to increase in the coming years and by effectively leveraging its significant labour force and access to raw materials, its already established industry sectors of automobile and aviation & aerospace production could be key benefactors. A focus on talent development, innovation and education with special emphasis on technical disciplines is crucial for Brazil to address the current skill gap of its workforce and bring it up to par with the global standards. Furthermore, the establishment of a business environment that is both conducive to the ease of doing business and appropriately regulated will reduce uncertainties for corporates looking to operate in the country and facilitate Brazil to better compete in the rapidly changing global manufacturing space.

In this report we have outlined two key themes that have the potential to further strengthen the Brazilian manufacturing sector going forward.

A. Preparing the foundation for the wider adoption of Industry 4.0 in the manufacturing sector:

Increasing awareness of the benefits of Industry 4.0 and creating a strategy for implementation of 4.0 technologies will help drive the success of Industry 4.0 in Brazilian manufacturing.

B. Fostering a future-ready manufacturing workforce:

By developing world class training capabilities Brazil can create a well-trained and future-ready workforce.

Manufacturing in Brazil is a vital thread in the economic and social fabric of the country. To continue its dominance in the region and effectively compete with the rest of the developed world, Brazil must embrace the digital disruption of Industry 4.0 and prepare for the broader impact this will have on its working population. A structured, multi-year commitment is required and the Brazilian government, local players and foreign companies all have important roles to play in creating an advanced and globally competitive business environment for Brazil.

“Brazil’s leadership in S. America will continue to depend on its traditional strengths in mining, agriculture and forestry, and livestock, coupled with its steel, aerospace, automotive, manufacturing and technology sectors. Though manufacturing’s role in the economy as well as in exports, has declined between 2000 and 2016, it is expected to recover by 2022. Further, various innovation programs such as the “National Program Startup Industry Connection”, as well the adoption of Industry 4.0 in sectors as diverse as agriculture and industrials, promise dramatic enhancements in efficiency, productivity, and quality. These, combined with a strong emphasis on training and skills development, as well as the ongoing investment in sustainability and SDGs, will be the drivers for a growing and export-oriented manufacturing sector.”

Anil Khurana
GMIS Organising Committee
PwC Partner, US & ME, and Advisor
With a population of 207 million in 2017 and a GDP of US$2.05 trillion, Brazil recorded GDP growth of just under 1% in 2017\(^1\) and going forward, the Brazilian economy is forecasted to grow at a CAGR of 2.29% from 2017 through to 2022\(^2\); driven by increasing private consumption and more buoyant investor sentiments\(^2\). Even though Brazil’s national Consumer Price Index increased from 0.43% in May 2018 to 1.43% in June 2018\(^3\) on the back of persistent currency weakness, the rate was slightly below market expectations.

To drive medium to long term growth, Brazil will need to consider significant structural reforms including policies to boost innovation and address low competitiveness, fiscal consolidation and strengthening of the financial sector.

### A dual economy occurs when there are two distinct economic sectors within one country, divided by different levels of development, technology and patterns of demand. As a dual economy, income disparity and political uncertainty are causes of concern moving forward for Brazil:

- **Private household consumption in Brazil formed a major share of the country’s GDP (63.4%) in 2017 although a weak educational system and lack of value-add jobs have the potential to constrain private consumption growth in the future\(^4\).**
- **Social and economic development policies such as Programa de Aceleração do Crescimento (PAC), have had some impact on boosting income and reducing poverty\(^2\) however critics of this point to the heavy impact it had on public finances as Brazil dipped into a recession. Income disparity between regions and classes remains widespread across Brazil. For example, in 2014 the average monthly income in Maranhão was US$181 compared to US$770 in the capital region of Distrito Federal\(^4\).**
- **Since 2016, Brazil has weathered a period of significant political uncertainty. Presidential elections, scheduled to take place in October 2018 are unlikely to significantly temper current investor sentiments or momentum provided that the next government focuses on stamping out corruption and increasing the ease of doing business in Brazil\(^2\).**

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A macroeconomic snapshot

Source: IMF, World Economic Outlook Database, April 2018
Key exports from Brazil, 2010-16 (%)

<table>
<thead>
<tr>
<th>Year</th>
<th>Value (US$ billion)</th>
<th>Commodity</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>207</td>
<td>Mineral Products</td>
<td>34%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foodstuffs</td>
<td>26%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Machines</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vegetable Products</td>
<td>9%</td>
</tr>
<tr>
<td>2016</td>
<td>191</td>
<td>Mineral Products</td>
<td>36%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Foodstuffs</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Others</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vegetable Products</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transportation</td>
<td>16%</td>
</tr>
</tbody>
</table>

Note: Others include Metals, Animal Products, Chemical Products, Paper Goods etc.
Source: OEC (the Observatory of Economic Complexity)

Top 5 Export Partners (2016)

1. China (19%)
2. USA (13%)
3. Argentina (7%)
4. Netherlands (6%)
5. Germany (3%)

Source: UN Comtrade

Commodities drive Brazil’s exports, but low demand and fluctuation in prices are causes of concern going ahead:

- In 2017 Brazil was the 26th largest exporter in the world⁶. Owing to Brazil’s rich natural resources, commodities made up a substantial 28% of the total export value in 2016 led by soybeans (US$19.4 billion), iron ore (US$14.1 billion), raw sugar (US$10.8 billion) and crude petroleum (US$9.6 billion)⁶.
- Although the financial crisis did have a negative impact on exports, with total exports falling from US$207 billion in 2010 to US$191 billion in 2016⁶, 2017 saw exports recover to pre-crisis levels of US$217.7 billion⁷.
- Going forward, Brazil could look to reduce its dependence on commodity exports and increase its share of value-added exports (such as manufactured products) in order to hedge against any issues such as a fall in commodity prices or decreasing demand from large import partners such as China².
- The share of transportation related exports from Brazil has increased in recent years indicating growth in the overall manufacturing sector. In 2010, transportation exports made up 9% of the total export value. This had grown to 12% by 2016. Sub-sectors within transportation such as cars, vehicle parts, planes & helicopters were key drivers of this growth⁶.
As a springboard into other South American markets, and with cost competitive exports, Brazil is an attractive investment destination. However, red tape, corruption and high taxes act as deterrents:

- Brazil has not been immune to volatility in foreign investor flows which, coupled with political instability saw FDI inflows dropping between 2014 and 2016. Nevertheless, in 2017, FDI inflows into Brazil were US$62.7 billion, an 8.3% increase compared to the previous year.

- Going forward, a growing workforce, together with increasing local consumption will enable Brazil to continue to attract substantial FDI.

- The leading investor countries in 2017 were the USA (18.3%), British Virgin Islands (15%), Luxembourg (7.1%) and Germany (5.3%) with major investment sectors being electricity & gas (20.9%), agriculture & mineral extraction (9.7%), commerce excluding vehicles (9.1%), transportation (7%) and vehicles & engines (6.5%).

- Brazil also acts as a gateway to other South American markets by positioning itself as a test market for foreign companies looking to enter or expand in the region. In addition, a weaker Brazilian Real (BRL) provides cost competitiveness and is especially advantageous in price-sensitive export categories.

- Although, Brazil is considered to be an open economy, current issues like extensive bureaucracy, a complex taxation system and privatization of national entities often act as deterrents for foreign investors.
The evolution of Brazilian manufacturing

In 2016, Brazil’s manufacturing sector was the 9th largest in the world in terms of world share of Manufacturing Value Add (MVA)\textsuperscript{10} and was estimated to be worth US$208 billion in 2017\textsuperscript{11}. Over the next five years, Brazil’s MVA is forecasted to grow at a CAGR of 1.2% reaching a value of US$222 billion by 2022\textsuperscript{11}. The manufacturing sector is a vital contributor to Brazil’s economy, representing 11.8% of the country’s GVA in 2017\textsuperscript{11}, with ‘Sustainable Resources’ and ‘Demand Environment’ ranked the highest drivers of manufacturing as reported in the World Economic Forum’s Readiness for the Future of Production Report\textsuperscript{12}. However, to sustain long-term growth in this sector, Brazil needs to focus on overcoming challenges in the form of its weaker institutional framework, regulatory inefficiencies, corruption and political instability\textsuperscript{12}.

**Figure 1: Brazil’s Manufacturing sector is recovering since 2017 after seeing decline in 2010-17**

Manufacturing Value Added, 2010-22 (US$ billion)

Source: BMI

**Figure 2: Brazil’s manufacturing’s share of GVA has declined since 2010 with the economy shrinking post recession**

Contribution of Manufacturing to GVA (in US$ billion)

Source: World Bank Data

Note: Manufacturing and Agriculture, forestry & fishing GVA are based on current US$ whereas Services GVA is based on constant 2010 US$.
Source: World Bank Data
The Brazilian industrial sector (which includes manufacturing, mining & quarrying, construction and public utilities) accounted for 21% of the country’s total employment in 2017. According to the World Economic Forum’s ‘Readiness for the Future of Production Report 2018’, Brazil is ranked 73rd on ‘Human Capital’ and 45th on ‘Technology and Innovation’, amongst 100 countries globally. Despite a large workforce (109 million in 2017), Brazil’s human capital faces challenges and lags behind in capabilities related to digital skills, engineering, critical thinking and other key areas which are pivotal for future growth in the manufacturing sector.

The passing of Law No. 13,467/2017 which entered into force in November 2017 had the key purpose to solve what has traditionally been another key challenge for Brazil – the country’s outdated and rigid labour laws. The law pertains to managing the workforce and managing costs related to implementing mandatory minimum wages, social security contributions and generous fringe benefits. Examples of the changes include the ability for workers to work different length shifts (i.e. part time) and under more temporary arrangements, relaxing what is considered to be ‘worked time’ and incentivizing dialogue and negotiation over labour claims. By increasing flexibility in Brazil’s regulatory framework to mirror present-day employment relations, this law should increase the global competitiveness of Brazil as a manufacturing destination.

Figure 3: Brazil’s employment in the industry sector remained consistent from 2010 to 2017
Contribution of Industry Sector to total employment (%)
The automotive industry is a major manufacturing sector in Brazil with US$14.7 billion worth of vehicles being exported in 2017. Key export markets are primarily other South American markets including Argentina (US$8.7 billion), Mexico (US$1 billion) and Chile (US$909.1 million). After a prolonged period of decline, the Brazilian automotive industry saw signs of recovery in 2017 and is now forecast to grow at 7% CAGR between 2017 and 2022 due to a stabilizing demand for new cars, an increase in export volumes and new investments made by foreign players such as Jaguar Land Rover (JLR). Production turnover in 2017 was US$64.1 billion with total vehicle production growing by 20.1% with an output of 2.26 million cars and 430,204 commercial vehicles. Further, the automotive value chain in Brazil extends beyond assembly having well developed supply chains, and now building design and development capabilities as well. An increase in vehicle production, therefore, has a positive impact across the value chain. Automobile manufacturers are concentrated around the south and southeastern regions of Brazil with a regional cluster in São Paulo serving as a base market for more than 400 auto parts suppliers. Despite historical bottlenecks of overcapacity and weak profitability, the majority of foreign manufacturers remain committed to their long term expansion plans and continue to invest heavily into Brazil. For example, in 2017 JLR constructed a new US$300 million factory, while Volkswagen has pledged investments of US$2 billion for the development of new models in Brazil and Daimler plans to invest US$750 million in a commercial vehicle chassis manufacturing unit from 2018-22.

Source: UN Comtrade

The Brazilian aircraft and spacecraft manufacturing sector exported US$4 billion worth of aircraft, spacecraft and parts in 2017, with the United States as the largest export destination (US$2.5 billion), followed by China (US$404.1 million) and the Netherlands (US$203.6 million). Production turnover for the overall industry grew at a CAGR of 9.9% in the period 2012-2017 to reach BRL 27.6 billion (US$7.4 billion) in 2017 with aircraft accounting for the largest share (45%) followed by engines & parts (31%) and spacecraft (24%). As one of only five countries in the world to manufacture commercial jets, Brazil also produces regional jets, turboprops, military aircrafts, helicopters, agriculture use aircraft and other general aviation aircraft. The sector is heavily commanded by Embraer SA, the largest Brazilian aerospace company who currently produce 68.7% of the total aircraft, spacecraft and aviation parts in the country. Smaller Brazilian companies however are linked in to Embraer’s supply chain as component suppliers for both production as well as for maintenance and the overhaul of fleets. In 2017, over 37,000 people were employed in this sector. The region of São José dos Campos is the largest aerospace hub in the country. Whilst still fairly niche, the aircraft and spacecraft sector in Brazil has a world-class design-to-build set of capabilities with the opportunity for further expansion through effective implementation of Industry 4.0. The space industry in Brazil is further set to benefit from the fast-growing market for low-cost satellite launches with US companies Boeing and Lockheed Martin eager to tap into the market when Brazil’s Alcantara Space Centre near the equator opens as a commercial spaceport in the coming years.

Source: UN Comtrade
Iron and steel

Figure 6: Brazil’s Crude Steel Production, 2010-17
(million tonnes)

Source: BMI Research

In 2016-2017, Brazil had the 3rd largest iron ore reserves in the world, consisting of 23 billion tonnes of crude ore and 12 billion tonnes of iron content. Carajás mine in the state of Pará and Alegria mine in Minas Gerais are currently the two biggest iron ore mines in the country.

Brazil’s Iron and Steel Industry began in 1557 with Afonso Sardinha establishing the first ever metallic iron factory in the country side of the state of São Paulo. Brazil was world’s 5th largest net steel exporter in 2016 and exported steel to over 100 countries worldwide. In 2016, leading export destinations for Brazilian iron ore and concentrate were China (US$10.4 billion), Japan (US$1.8 billion) and Germany (US$783 million).

From 2010 to 2017, Brazil’s mine production of iron ore grew at a CAGR of 2.5% to reach 440 million tonnes whereas the country’s crude steel production grew at a CAGR of 0.6% to reach 34.3 million tonnes in 2017. Brazilian mining giant Vale is the largest producer of iron ore and iron ore pellets in the world and Companhia Siderúrgica Nacional, Usiminas and Gerdau SA are three of the major Brazilian steel-makers. Going forward, growth is expected to accelerate with crude steel production reaching 37.8 million tonnes in 2022, with a CAGR of 1.9% between 2017 and 2022.
Sustainability in Brazil

- Brazil has a strong commitment to the UN 2030 Agenda for Sustainable Development and the 17 Sustainable Development Goals (SDGs).
- In 2016 Brazil established the National Commission for the Sustainable Development Goals to simultaneously create a mechanism to support the promotion, implementation and monitoring of this agenda.
- SDG 9 is to build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. To address SDG 9, the Brazilian Government has a number of initiatives focused on driving research and industrialization including significantly increasing funding to 70% of the 2,000 research laboratories that exist within more than one hundred universities in Brazil.26
- Brazil also has a strong framework of tools to foster innovation, including The National Program Startup Industry Connection. This identifies challenges and gaps within industry and maps them to startups that can bring solutions. This program had received US$10 million in funding by 2017.26
- Brazil partners with Germany on driving research in manufacturing through the ‘Brazilian German Collaborative Research Initiative in Manufacturing Technology’. The main goal of the partnership is the sustainable strengthening of the industrial sector through basic and applied research and exchange of knowledge and researchers. Both Germany and Brazil also collaborate through a joint commission to focus on the environment, climate change and sustainability and the bio-economy.27
- Environmental sustainability is a growing area of concern for Brazil. 90% of Brazilians perceive air pollution, climate change, bio-diversity loss or water availability as very serious problems. This is 30% higher than the international average. 70% of Brazilians are also interested in corporate sustainability with 50% being willing to pay more for an ethical product. This is evidence that Brazil’s business sector can be both sustainable and profitable.28

Circular Economy

- The Circular economy is a key lever for achieving the UN Sustainable Development Goals, in particular SDG 13 which is a commitment to reduce emissions and tackle climate change.
- The circular economy is an economy that is designed to be as waste-free and regenerative as possible and is gaining traction in Brazil as an attractive alternative to the take-make-dispose economy. The circular economy has the potential to unlock significant opportunities for innovation and value creation across the country.
- Drivers of a circular economy in Brazil include the significant abundance of natural resources, the emergence of disruptive innovation, the large and dynamic informal economy, and the size of the market – both in terms of territory and population.
- A key area of opportunity for a circular economy in Brazil is in the Electrical and Electronics Equipment (EEE) industry. A boom in consumption of EEE in recent decades has led to significant growth in electronic waste. Circular economy principles relevant to EEE include keeping materials, components and products cycling at their highest utility at all times and recognising, valuing and recovering the energy embodied in manufactured goods.29
- Progress is being made across many parts of Brazil towards a circular economy however a major challenge to the growth is the current tax policies and legal standards that do not incentivize investments in circular economy models.
The manufacturing ecosystem in Brazil was impacted by the 2014-2016 economic crisis and the surrounding political turmoil, and it is also not insulated from the current political turbulence, corruption and mounting inequalities that plague many Latin American countries. However, a formidable workforce, increasing consumption and investments are key elements which make Brazil a strong region for future growth. In addition, a rising demand for value-added exports, both from Latin America (due to improving economic activities in Chile) and globally, together with greater private sector spending and infrastructure development projects will help further enhance the attractiveness of the manufacturing sector and the wider economy too. The current recovery – albeit gradual and steady – together with focus on policies that address talent, cost, infrastructure and regulatory challenges will help ensure that Brazil has the opportunity to be well placed for future growth and improved global competitiveness.

Figure 7: Brazilian manufacturing is recovering from the financial crisis of 2014-16, supported by domestic demand, foreign investments & industry initiatives

Key milestones in the development of Brazilian manufacturing

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
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</table>
| 2004 | PITCE (Political, Industrial, Technological & Foreign Trade Policy) was launched on 31st March, 2004 with the objective of strengthening and expanding the Brazilian industrial base by working on:  
  • Innovation, technological development, modernization, capacity expansion of Brazilian companies  
  • Strategic entry into the semiconductor, software and pharmaceutical sectors  
  • Entering into biotechnology, nanotechnology, renewable energy sectors in the future |
| 2011 | Plano Brasil Maior (Greater Brazil plan in English) was established by the federal government to focus on stimulating innovation and increasing domestic production over the period of 2011-14 by harnessing existing skills in Brazilian companies, academic institutions and society |
| 2015 | Strategic Map of Industry 2013-22 started by the Brazil National Confederation of Industry (CNI) defines objectives and programs which will transform Brazil into a highly competitive, sustainable economy by 2022  
  • The strategic map is structured around 4 key metrics which were:  
    - Improving the education scenario in Brazil  
    - Introducing pro-business initiatives  
    - Reducing legislative bottlenecks  
    - Increasing competencies through innovation |
| 2017 | BNDES (Brazilian Development Bank) launched the study “Internet of Things: An Action Plan for Brazil” to define the aspirations for IoT (Internet of Things) in Brazil, prioritize verticals for development of IoT in the country and prepare a 2018-22 Action Plan to implement the study proposals |

The future of manufacturing in Brazil will be shaped by two key themes:

A. Preparing the foundation for adoption of Industry 4.0 in the manufacturing sector: The focus here on generating awareness and creating a structured roadmap, as well as encouraging strategic investments for driving adoption of Industry 4.0 in manufacturing.

B. Fostering future-ready manufacturing workforce: The need here is to develop world class training capabilities to create a well-trained workforce for the future.
The Fourth Industrial Revolution (Industry 4.0) represents the next technological stage in manufacturing and is characterized by the adoption of technologies such as automation, 3D printing, the Internet of Things (IoT) and Artificial Intelligence (AI). This technological transformation will provide companies with greater control over processes and increase the visibility of data whilst also enabling closer relationships between companies and their suppliers and customers.

According to the World Economic Forum’s Readiness for the Future of Production Report 2018, Brazil is currently considered a ‘nascent’ economy in terms of Industry 4.0\textsuperscript{12}. Brazil does however have high potential and the next steps taken in developing its manufacturing sector will be crucial to propel it towards being a high potential and leading market of the future.

In fact, certain Brazilian sectors have already shown a propensity to embrace digital technology. The agribusiness sector is leading the way with its use of Industry 4.0 tools with 67% of agriculture properties using some form of precision technology in 2017 such as sophisticated climate changes and prediction sensors\textsuperscript{30}. Additionally, companies that have already implemented Industry 4.0 have seen promising results. This is particularly true for larger size companies like the German industrial engineering conglomerate, Thyssenkrupp AG that implemented an Industry 4.0 solution at one of their hot strip mills in their Brazilian unit to increase response time to customers\textsuperscript{31}. The main benefits identified by companies who have already adopted digital technologies such as digital automation and cloud services are ‘Reducing operating costs’ (54%), ‘Increasing productivity’ (50%) and ‘Improving the quality of products or services’ (38%)\textsuperscript{32}.

Figure 8: Primary benefits of adopting digital technologies percentage (%) of responses by companies

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing operating costs</td>
<td>54%</td>
</tr>
<tr>
<td>Increasing productivity</td>
<td>50%</td>
</tr>
<tr>
<td>Improving quality of products or services</td>
<td>38%</td>
</tr>
</tbody>
</table>

For the wider adoption of Industry 4.0 throughout the manufacturing sector, the focus needs to be on creating awareness and guiding companies through a well-defined roadmap, as well as promoting further capital and R&D investments by manufacturers.
Develop a well-defined Industry 4.0 roadmap, and generate awareness

Many Brazilian companies within the manufacturing sector are still in an early stage of migration to digitalization and still in the process of deploying the technologies to effectively harness Industry 4.0. Companies face challenges in understanding the potential benefits of the technologies and in turn justifying the cost of these technologies. The top internal barriers hindering adoption of digital technologies are ‘High implementation costs’ (83% of companies that use digital technologies) and ‘Lack of clarity in defining return on investment (32%)’

A successful Industry 4.0 strategy requires a dedicated, structured and multi-year approach that outlines clear goals for Brazil to achieve coupled with quantifiable and measurable targets. Such an initiative should include stakeholders from across government, industry, business associations, labour groups and subject experts. Stakeholders ought to be both Brazilian and foreign selected not just for their ability to create jobs or generate revenue in the short-term, but also for their long-term focus and commitment in helping bring Brazil’s Industry 4.0 vision to life.

The roadmap should include metrics across multiple dimensions, for example, workforce, infrastructure, legal and regulatory and be mapped to the areas set out in Brazil’s Strategic Map of Industry 2013-22 with a focus on how each area could accelerate digital adoption in manufacturing. The roadmap should be cognizant not just of the needs of traditionally high technology sectors such as machinery and automotive but also other sub-sectors such as textiles, agri-business and chemicals. Key targets for measuring success could include evaluating the percentage of companies aware of and/or using digital automation technology and integrated systems of engineering for development and product manufacturing as well as assessing the percentage of companies aware of/using digital technology to connect supply chains with customers and suppliers.

Figure 9: Internal barriers hindering the adoption of digital technologies
percentage (%) of responses by companies that use digital technologies
In addition to developing the roadmap, there is also a need to bridge the gap in terms of awareness of digitization technologies. Brazil could look to establish demonstration centers in industrial clusters and partner with technology companies to promote connectivity between technology companies and the industrial companies. The initiative for these demonstration centers will need to be driven by industry associations specific to each cluster and be supported by larger associations such as the CNI and the Brazilian Government. Companies that are more advanced in their use of Industry 4.0 tools and technology could also be driving these efforts and use their own experiences as examples of successful implementation.

Large industrial companies could be encouraged to build Centers-of-Excellence in order to increase awareness of the applications of specific technologies, especially to their suppliers and other industrial customers. A method of accomplishing these goals more efficiently and effectively is to leverage upon companies in other industries that have successfully demonstrated their use of Industry 4.0. For instance, a food processing industry could partner with agri-business companies in order to learn about how to effectively integrate into their digital supply chain.
Encourage strategic investments to boost Brazil’s attractiveness as a manufacturing destination

In an ever more competitive global economy, stagnating productivity growth is a growing concern, and Brazil is no exception. Labour productivity is a significant challenge for Brazil, which had average annual labour productivity growth of 1.4% between 2012 and 2017\(^3\), but this also highlights an opportunity to increase the competitiveness of the manufacturing sector, through investments focused on improving productivity and increasing digital technology adoption that will boost Brazil’s ability to participate in global technology-linked value chains. The potential impact of digitization on Brazil’s GDP is impressive with some forecasts estimating GDP could reach US$97 billion by 2020\(^3\).

Brazil has ambitious digital strategies to support its digital economic transformation including the Brazilian Strategy for Digital Transformation (“E-Digital”), the National IoT plan, and The Information, Communications and Cyber Security Strategy of the Federal Public Administration 2015–2018. There is however a mismatch between these ambitions and the ability of the Brazilian economy to support domestic and foreign investment into the country’s Industry 4.0 capabilities. Whilst many Brazilian companies lack the capital required to make these investments, foreign companies may have the capital but are reluctant to make these investments due to the perceived lack of competitiveness of Brazil as a manufacturing location.

As a first step, reforms in the Brazilian tax system are critical to reduce the negative impact that both its current complexity and costs have on competitiveness. Tax rates and tax regulations were the first and third most common reasons cited by company executives as being the ‘Most problematic factors for doing business’ in Brazil. Targeted tax breaks, especially towards equipment expensing tax credits, are a powerful incentive to encourage investment in certain technologies as they assist companies in overcoming the fixed costs of production and distribution. IoT would be a clear starting point as powerful enablers of Industry 4.0, as these are already aligned with the National IoT Plan and E-Digital.

In addition, following the development of an Industry 4.0 roadmap, Brazil should encourage and also seek to leverage, global connections and international partnerships. This will foster knowledge and technology transfer of Industry 4.0 essentials and could provide access to infrastructure for testing and trialing technologies. Foreign companies that bring expertise in these technologies to Brazil and make the associated capital expenditure in Brazil should be incentivized for the likely increase in productivity generated by these tools. Finally, building and strengthening alliances between companies, universities and research labs is another vital element of corporate R&D which needs to be encouraged, in order to accelerate innovation across industries that Brazil could benefit from.
**Case Study:**

**Thailand envisions long-term growth through Industry 4.0**

Thailand’s growth has stalled in recent years, leading the government to fear that the country is stuck in a ‘middle-income trap’ where it is unable to progress due to stagnating foreign investment, slow growth and industrial paralysis. In order to overcome these challenges, the government created the Thailand 4.0 plan in May 2016, a holistic economic development programme, which aims to evolve the economy from Industry 3.0, whilst also addressing social issues such as inequality. 

The New S-Curve industries were chosen as the likely new engines of growth based on technologies that Thailand expected will be important for its future. To expedite development, the Act on National Competitive Enhancement for Targeted Industries was introduced in February 2017 to provide incentives aimed at encouraging investments from companies that were new to Thailand or were introducing new technologies such as 3D printing to Thailand’s manufacturing sector. To qualify for these incentives, companies must also partner with an academic institution or a Centre of Excellence in an area to develop human resources. This was to solve the scarcity of skilled labour for the implementation of Thailand 4.0, given that only 50% of secondary school graduates progress to attend a tertiary institution and only 46% of lower secondary leavers are proficient in Mathematics. To upskill the labour force, the government also included specific targets for improvements in education. IT infrastructure is also a major focus area for Thailand as currently 40,000 of 70,000 villages lack access to high-speed internet. On the whole, Thailand’s comprehensive approach to Industry 4.0 tackles each of these challenges to enable the country to transition towards a technologically advanced economy.

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### Thailand 4.0

![Image](image.png)

#### Industries

- **First S-Curve industries:** Automotive, Electronics, Medical Tourism, Agriculture & Biotech and Food for the Future
- **New S-Curve industries:** Robotics, Aviation & Logistics, Biofuels and Biochemicals, Digital and Medical Technology

#### Education

- Increase Human Development Index ranking from 0.72 to 0.80
- Increase tertiary enrolment and proficiency in reading and Maths
- Have five Thai universities be in the World’s Top 100 within 20 years

#### Infrastructure

- High-speed internet provided to 11,250 villages between 2016-2017
- Provision of free Wi-Fi at schools and public spaces
- Creation of a Digital Thailand Infrastructure Fund

#### Incentives

- Benefits of Investment Promotion Act
- Up to 15 years exemption from corporate income tax
- Access to subsidies from a US$300 million fund
- Preferential access to land

### Industry example: Robotics as a focus for Thailand 4.0

- The Robotics industry has prospered in Thailand due to the heavy reliance of the automotive and electronics sector on robotics. The robotics sector is expected to grow significantly in Thailand as a result of the Thailand 4.0 plan and the increasing level of technical expertise across industries. Thailand ranked eighth in the world for its annual robotic consumption in 2014. Thailand imported 3,657 units of robots in 2014 and the number is expected to increase to 7,500 units in 2018. The International Federation of Robotics expected employment in Robotics in Thailand to double from 7,500 in 2016 to 15,000 in 2018.
- In 2015, Swedish-Swiss Robotics Company, ABB opened a Robot Applications Center in Thailand with collaborative dual-arm robot YuMi. The robot, which has applications in the food and beverage, electronics and automotive industries, can expect strong sales in Thailand as a result of the benefits provided to both Thai and foreign companies that leverage robotics. Other companies such as Nachi, Delta, Ureka Design, Daifuku and Celestica also have manufacturing facilities in Thailand.
B. Foster a future-ready manufacturing workforce

With the fifth largest population in the world, Brazil has a wealth of human resources, but there needs to be continued focus on developing further capabilities in areas such as digital skills, engineering, critical thinking and others relevant for improving labour productivity. While employers in Brazil are struggling to find workers with appropriate skills, the country is also facing challenges of unemployment and underemployment. In 2018, 12% of the Brazilian workforce is currently unemployed and an additional 13% are underemployed. The unemployment rate amongst youth (18-24 years) is much higher, currently sitting at 25%. Despite this, 68% of managers in Brazil said that they faced difficulties filling positions – which indicates a mismatch of skills and career aspirations (i.e. part time vs full time work)45. To add, Brazil is also coming to terms with the impact of automation on existing low-skill jobs. Many jobs in the Brazilian manufacturing sector are highly susceptible to automation, with 10.9 million jobs or 69% of the total number of jobs in the sector having the potential to be automated45. Only 22% of jobs in Brazil were considered ‘knowledge intensive’46.

Talent training is a key issue for Brazil and a number of challenges begin at the lowest levels of public education and progress through to tertiary education. Although the secondary school enrollment rate is 99.7% and tertiary education enrollment rate is 50.6%, the quality of the education system is a cause for concern. Brazil is currently ranked 125th in the world for quality of education with a score of 2.6/7, with the quality of Brazil’s math and science education facing significant challenges ranking 131st in the world in 201647. The current quality and availability of training is unlikely to be able to fill the gaps created by the education system with “Availability of specialized training services” ranking 118th in the world (score of 3.7/7) and “Extent of staff training” ranking 62nd in the world (score of 4.0/7)47. Therefore, building world-class training capabilities and increasing investment in education and teaching resources is a critical requirement for Brazil to foster a future-ready manufacturing workforce.
Develop world-class training capabilities

Business executives have identified an ‘insufficient capacity to innovate’ and an ‘inadequately educated workforce’ as problematic factors for doing business in Brazil. The impact of these challenges will only be exacerbated by Industry 4.0 as the digital innovation models create a need for a new set of skills including creative problem solving, ability to work alongside machines and robots, data analytics and the ability to adapt to digital culture.

To overcome this gap, Brazil needs to leverage existing structures for successful industrial training through The Servico Nacional de Aprendizagem Industrial (SENAI). SENAI is a network of professional training schools established by CNI (Brazilian Confederation of Industry) and SESI (Social Service of Industry) with a mandate to provide professional education to and technological services to promote innovation. SENAI has had a significant impact on its graduates with recent studies finding between a 12% and 30% wage premium for graduates of the training.

Multiple funding models for education and training should also be explored and could include a mix of company funding for a certain number of places for their own employees, sponsorships from other organizations or industry bodies and government subsidies. Practical training could also be carried out at sponsoring companies with classroom sessions conducted by SENAI; and these sponsoring companies could have first access to the newly trained workforce candidates. A concerted effort on attracting unemployed youth, women, indigenous groups and racial minorities (that currently face challenges with significant underemployment) to these programs would also help increase their impact.

The training needs of different groups are likely to necessitate different approaches to training rather than the traditional classroom model. For example, for existing industrial workers looking to transition into new industries and capabilities, online courses can help supplement learning, reduce cost of training delivery and increase the convenience for workers balancing full-time jobs. A combined work-study program would also help low-income workers and youth who may be unable to afford full-time training. Employers would also be able to hire workers that may not have all the necessary skills required upfront but would benefit from parallel training by institutions to fill any gaps.

Finally, programs such as apprenticeships and mentorships can also play an important part in providing support in areas where there are capability gaps. These programs would have one-on-one mentoring and avenues for the sharing of general knowledge, while helping domestic companies access experts in their respective fields, especially in areas such as technology and supply chain management. Such programs can further help companies tackle specific challenges they are facing, by providing targeted resources and bespoke solutions. Where mentorships are in place they should span different levels of seniority within the company so that both leadership and employees have the opportunity to benefit from such initiatives.
Case Study: Germany dual VET

A core strength of the German economic model is that they produce well-trained employees systematically, and in very large numbers, through a dual system for vocational education and training (Dual VET). The Dual VET system is a key pillar of Germany’s remarkable performance as a major industrial power, and is regulated and funded by both the federal government and the German states; and is closely coordinated with German industry. The Vocational Training Act of 1969, which was amended in 2005, introduced this close alliance between the Federal Government, the federal states (the ‘Länder’) and companies with a view to providing young people with training in nationally recognized occupations which is then documented accordingly by means of a certificate issued by a competent body, i.e. a chamber of industry and commerce or a chamber of crafts and trades.

Germany’s system consists of a 3 year program with a split between classroom instruction in trade-school courses and on-the-job training at participating companies under the supervision of skilled mentors. The main characteristic of the dual system is the collaboration between mainly small and medium sized companies, on the one hand, and publicly funded vocational schools, on the other. Trainees in the dual system typically spend part of each week at a vocational school and the other part at a company, or they may spend longer periods at each place before alternating. The students therefore emerge from their apprenticeships knowing their trade, and knowing how to get a job done in a real work environment. Some 52 percent of young Germans graduate from Dual VET apprenticeships and post their graduation they are often offered long-term employment at the company where they did their apprenticeship.

Overall, the German Dual Vet program has resulted in a 7.0% youth unemployment rate, the lowest in Europe. Responsibility for the VET program is shared between the government, employers and trade unions ensuring that training programs are standardized, current with regard to new technologies and responsive to new challenges such as the impact of IoT on manufacturing.

Case Study: Finland VET

The Finnish vocational education and training (VET) system has strong synergies with the German VET system and is designed for both young people without upper secondary qualifications but also for adults who are already in the workforce.

The program can be completed via school-based VET or as a competency based qualification. It is predominantly offered as “on-the-job” learning or as an apprenticeship training program. VET also qualifies Finnish students to be eligible for applied science universities.

The Finnish Ministry of Education and Culture prepares and supervises the VET program in the country.

Omnia, an education provider licensed under the Ministry of Education, is one of the main providers of VET in Finland where they provide other educational offerings such as professional career training, apprenticeship training and corporate training. Nationally Omnia cooperates with cities, chambers of commerce, organizations and entrepreneurs as well as trade unions within education and training. Omnia has well-established links with the labour market allowing it to act in an agile manner to meet the changing needs of and remain relevant to the Finnish employment market.

Conclusion

Brazil's emergence in the past year from a lengthy recession has been helped by an increasing robustness of exports, a recovery in private consumption and foreign investment, and surprisingly lower inflation.

Brazil now needs to stabilise its economy and look beyond the short term for sustained growth.

As the largest economy in the region, Brazil also has the most developed and most integrated manufacturing sector and this provides a solid base for adopting Industry 4.0 methods.

When companies adopt Industry 4.0 they work digitally, harnessing the benefits of Big Data, analytics, artificial intelligence and cloud technology. The result is a responsive operation with absolute control over demand, inventory and production processes. Industry 4.0 can provide Brazilian manufacturing companies with benefits ranging from improved efficiency and agility to lower costs and higher revenues. It will also encourage deeper integration into the more digital global economy and supply chains.

Successful Industry 4.0 implementation needs a capable, well-trained and future-ready workforce to support it. Industry 4.0 will decrease the number of routine jobs but will increase jobs requiring flexible responses, critical thinking and problem solving mind sets.

Brazil should foster a culture of continuous learning and implement programs that remedy deficiencies in the skills that will be both in demand by employers and deemed strategic to Brazil's manufacturing competitiveness.

The establishment of more technical schools and centres of excellence across the country that drive innovative behaviours will also be an important value-add to the manufacturing sector.

The increased innovation from 4.0 and the dynamism that it bring to the workforce will benefit not only the manufacturing industry in Brazil but, in the long term, the broader economic and social fabric of the country will also benefit.

“Brazil’s SMEs and large industrial companies – in mining, livestock, steel, aerospace, automotive, and others – need to be innovative and grab the opportunity offered by Industry 4.0. They need to take a longer-term view and invest, and should expect to be rewarded with enhanced operational and financial performance. Brazil’s economic revival depends on the ability to attract strategic investments partly on the basis of its national investments in innovation, digital transformation, and IoT.”

Anil Khurana
GMIS Organising Committee
PwC Partner, US & ME, and Advisor
Authors

Dr. Anil Khurana
Committee Member, Global Manufacturing & Industrialisation Summit, Partner, Strategy & Innovation, PwC Middle East and US, ME lead – Consumer & Industrial Products & Services
T: +971 50 883 6369
E: anil.khurana@pwc.com

Mohammad Shaban
Director of Strategy
Global Manufacturing & Industrialisation Summit (GMIS)
T: +971 55 900 8363
E: mohammed@gmisummit.com

David Wijeratne
Partner, Growth Markets Centre Leader, PwC
T: +65 6236 5278
E: david.wijeratne@sg.pwc.com

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