

Country Profile Singapore

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Präambel:

Wir schreiben im Folgenden in der maskulinen Form, und zwar ausschließlich wegen der einfacheren Lesbarkeit: Wenn beispielsweise von Mitarbeitern die Rede ist, meinen wir selbstredend auch Mitarbeiterinnen.

Empfohlene Zitierweise:

GAUSEMEIER, J.; KLOCKE, F.: Industrie 4.0 – Internationaler Benchmark, Zukunftsoption und Handlungsempfehlungen für die Produktionsforschung. Paderborn, Aachen, 2016

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Summary

The smart regional headquarters hub. Smart technologies and CPS in Singapore focus on smart grid and smart cities technologies. Nevertheless local high-end manufacturing is a key policy focus in Singapore and research on advanced technologies is fostered. Industries such as semi-conductors and logistics drive the industrial use of data analysis technologies, and a strong start-up scene develops data-driven services. No program focusing on exporting solutions specifically for smart manufacturing can be observed. Due to its good infrastructure, legal compliance, political stability and several free trade agreements Singapore became a hub for regional headquarters for the Asian markets for multinational enterprises and investors. The manufacturing sector mainly focuses on high-end technologies in the electronic, chemistry and medicine industry, and is in the need of the latest technologies.

Highlights



Collection and Analysis of Field Data

Strong start-up ecosystem in data-driven technologies, regional headquarters of data-heavy companies and a vision for a smart, data-driven nation – combined with driving industries for using data in manufacturing such as semiconductors.



Internationality

Magnet for international talents due to high living conditions and steering room for industrial and business operations across east Asia due to large concentration of regional headquarters.



Access to Capital

Strong regional banking hub with good access to risk capital, but additionally strong and fast government incentives to pursue high-end manufacturing and industrial R&D.

Map



Industrie 4.0 in Singapore

Drivers/ Challenges	<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p style="text-align: center;">Drivers</p> <ul style="list-style-type: none"> ▪ Governmental incentives to attract high-value manufacturing sites and research and development engagements for high technology products drive development of smart manufacturing. ▪ The high dependency on fossil fuel imports and the high environmental awareness is encouraging sustainable and efficient manufacturing. </div> <div style="width: 48%;"> <p style="text-align: center;">Challenges</p> <ul style="list-style-type: none"> ▪ Requirement to cooperate with neighboring countries for introducing meaningful vertical integration in value chains divided between manufacturing and headquarters functions ▪ Lack of government-backed initiatives to introduce smart technologies to the manufacturing sector </div> </div>
Key Stakeholder	<ul style="list-style-type: none"> ▪ Infocomm Development Authority (IDA) ▪ National Research Foundation (NRF) ▪ Agency for Science, Technology and Research (A*Star) – Research planning agency and umbrella for the national network of application oriented research institutes ▪ Singapore Institute of Manufacturing Technology (SIMTech) – ▶A*Star institute focusing on high value manufacturing technologies and sustainable manufacturing ▪ Singapore Energy Market Authority – Operator of the Intelligent Energy System Smart Grid pilot ▪ Singapore Manufacturing Federation (SMF) – Representative of the interests of Singapore’s manufacturing sector
Key Approaches	<p>Smart Nation Vision Overall political agenda by the ▶IDA to apply Internet of Things and data-driven-technologies into daily life, mobility and industry to promote productivity by connectivity</p> <p>Science, Technology & Enterprise Plan (STEP) Strategic technology plan, outlined by ▶A*Star including targets for high value manufacturing research and »More-than-Moore« integrated circuits with embedded sensors and actuators</p> <p>SMART – Singapore-MIT Alliance for Research and Technology Research enterprise as part of the MIT working on smart city technologies such as low-energy sensors and ICs, smart mobility programs and the ▶Virtual Singapore platform</p> <p>Virtual Singapore 3D model platform of Singapore for knowledge sharing and community collaboration and co-creation to develop smart cities technologies and infrastructure services</p>

Technology (1/2)

 <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Overview</p>	<p>Singapore reached its economic power starting with the manufacturing industry. In the last decades, the low-cost manufacturing moved to the neighboring countries. The manufacturing industry focused more heavily on high-technology based products such as electronics, medical equipment or aircraft components. The digital strategy of Singapore encourages research and development on knowledge-based technologies such as cloud computing. Both ICT and manufacturing sector have a good technology basis</p>
 <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Security</p>	<p>Singapore has a cyber-security master plan developed by the Infocomm Development Authority. R&D projects for security especially for cyber-physical systems are done in cooperation between several universities and the ministry of defense. In addition, the ASEAN states are cooperating together to boost the cyber security in the region with help by Singapore. 50% of the south-east Asian data are located in Singapore. To defend its position as a data hub, Singapore is extending its efforts for cyber security. Singapore is attracting international companies to bring advanced cyber security capabilities in the country. In terms of price sensitivity, security is more a hygiene factor than a price factor. With approaches for smart city technologies gathering large amounts of personal data, privacy is recognized as an important challenge by the authorities; however privacy is seen as less of a public concern.</p>
 <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Standards, Migration and Interoperability</p>	<p>The Singapore Manufacturing Federation is responsible for standard development in the industry, and aims for the development of standards for maximizing manufacturing productivity. Singaporean enterprises prefer to adopt international standards and have only a small amount of national standards. Singaporean committees are active in international standardization boards to represent Singaporean interests. Application and implementation of international standards can be seen in the logistics sector, such as at the Singapore port. The current factory infrastructure in Singapore is in good condition, and in addition, there is limited space for new greenfield factory developments. Thus, upgradeability and downward compatibility are seen as essential for the introduction of new production paradigms.</p>
 <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Sustainability</p>	<p>Singapore is an early adaptor of environmental efforts in Asia. Water and energy are very limited and have to be imported mainly. Therefore, the use of energy-efficiency and water recovery technologies is promoted by the government. The state imposes tough regulations on carbon dioxide emission for vehicles, based on EU regulation. A state-of-the-art public transportation system exists, and the population is environmentally conscious. Singapore offers training for managers from the manufacturing sector to improve sustainability in their operations. Waste management in Singapore is very sophisticated. Construction activities consider ecological aspects of urban planning. Know-how for green technologies and concepts is sourced from abroad, but Singapore has pilot projects on using smart technologies to save energy in a smart grid.</p>

Technology (2/2)



User friendliness

With a strong start-up scene, Singapore has strong research in user friendly application of technology. Research conducted in the field of user friendliness is mostly oriented to providing products or services to **end customers**, with one focus being **easy access to city infrastructure such as public transport services**, or innovative guiding systems. Nevertheless, efficient ergonomic systems and methods to increase human productivity are also recognized as important by the government and enterprises. Increasing work efficiency using **innovative ▶ HMI-related technologies**, e.g. semantic technologies, **▶ augmented reality** or **▶ assistance systems** is a development focus. The **paradigm for worker-machine interaction** is more focused on **reducing training need** than on enabling wider decision scopes.



Collection and Analysis of Field Data

The **ICT industry in Singapore is very dynamic**. **Data analysis start-ups** focusing on recent trends such as **▶ cloud-computing** and **▶ big data** have emerged from Singapore. Companies dealing with large amount of data such as Google or IBM locate their Asia regional headquarters in Singapore due to the strong potentials of IT-innovation. Using data analytics in factories or enterprise processes is also researched, with a focus on **▶ sensors** used in manufacturing and automation. However, domestic sensor competence is not on par with market leaders and **imports of sensor products are inevitable**. **Real-time data analysis from sensors is still new** to the manufacturing industry. The semiconductor industry is seen to be a pioneer regarding data integration and analytics. Due to the concentration of regional headquarters in Singapore, enterprise data from different sites tends to run together in Singapore. Singapore has long focused on data-driven **e-Government**, with the eGov2015 plan focusing on co-creation between government services and private companies. In addition, **data-heavy pilots in smart grid or smart cities technologies** exist in Singapore, building a high domestic competence level in advanced data analytics. The **▶ Smart Nation vision** plans to **set up a platform collecting and providing access to data collected nation-wide from a mesh of sensors**, with test-beds operating.



Material and Information Flow

Due to its location and world-class port Singapore is one of the **global top performers in logistics** and the **logistics hub** of the south-east Asian region. Other relevant organizational systems such as **public transport, air transport or logistics management are also considered world-class**. **ICT industries** focusing on data analysis and information flow are rapidly growing. However, **spill-over of logistics and ICT innovation to manufacturing can only be seen in selected fields**. Compared to the overall high innovation level of the ICT sector, **the focus on connectivity in manufacturing is still low**. The companies delivering **automation solutions are relatively small distributors**. The **use of industrial robots is widespread** in Singapore. Singapore has accumulated a considerable amount of knowledge in **▶ Interlogistics** through semi-conductor and electronics industries. **Logistic tracking and real-time locating methods** using connectivity are currently **starting to be deployed in the manufacturing sector**.

People

 <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Overview</p>	<p>Singapore has a very highly educated local workforce, although a gap between the education level of younger and older people is still very noticeable. Singapore is also able to attract people with high education from abroad, due to a very high living standard and the use of English as the prevalent business language. The dependency on foreign low-skilled workers, mostly from other Asian countries, is seen as negative by the local population. Automation and smart manufacturing are seen as drivers to reduce this dependency.</p>
 <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Training and Qualification</p>	<p>Through its education system and world-class universities, Singapore is able to educate high skilled people needed by its economy. Although technical studies are regarded positively among young people, technical graduates often decide to pursue non-technical careers due to the lack of career progression opportunities and low wages. Thus is Singapore lacking of young engineers. To boost technical studies and engineering as a career, government incentives exist. Nevertheless, Singapore has a rich pool of human resources skilled in manufacturing engineering, as well as in the ICT sector. For training skilled workers, apprenticeship programs e.g. for precision and manufacturing engineers exist. SMEs have difficulties to compete with large enterprises for talented people. Life-long qualification measures for employees are promoted by the government, even for low wages workers</p>
 <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Importance of » Production«</p>	<p>In terms of GDP manufacturing has lost importance to the Singaporean economy. Singapore's economic boom started with heavy-duty manufacturing, and while the government aims to keep and extend high-value-add manufacturing, retention of low-skill manufacturing dependent on migrant workers is not seen as a priority, but rather keeping the coordinating and headquarters functions for operations in neighboring countries. Singapore is focused on developing a regional manufacturing supply chain, where companies can position their manufacturing sites outside of Singapore in low-cost manufacturing countries and conduct the engineering and design in Singapore, which is incentivized by the state. The adoption of high technologies and automation in the manufacturing industry is promoted by the government and valued among the society. Technologies to improve productivity such as industrial robotics, additive manufacturing and intelligent automation are key targets highlighted in Singapore. Working in manufacturing is not considered to be attractive. In general, engineering is seen as less attractive than business functions and especially finance positions. As a consequence, manufacturing companies have difficulties to attract local graduates.</p>
 <p style="writing-mode: vertical-rl; transform: rotate(180deg);">» Pioneering Spirit«</p>	<p>In local companies' culture, traditional Asian values such as lower failure tolerance and collectivism are still in focus. Strict rules and importance of authority are respected. Employee loyalty is assessed below the global average, mostly due to the heavy use of temporary migrant workers. The mindset of the employees is positive and the work force is considered very motivated and productive in international comparison. Furthermore, due to the different backgrounds of the employees, the companies have deep insights and understandings of other countries. Singapore has a rather risk-averse culture. Nevertheless, Singapore has a very good business environment for entrepreneurs and start-ups. The unproblematic process to open a business encourages pioneering spirit for both foreign and national businessmen.</p>

Organization

 Overview	<p>The legislation system in Singapore is seen to be business friendly. Foreign companies have trust in the Singaporean legal system, which is why many R&D facilities are located there. IP-protection and measures against product piracy are considered very effective. Singapore generally has good conditions for occupational safety and health. The Ministry of Manpower strives for an injury-free working environment called »Vision Zero« to reduce occupational hazards, which is however based on cultural aspects and less on safety-ensuring technology.</p>
 Business Model	<p>► Business model innovation is highly encouraged and since 2014 companies which have successfully undergone ► <i>business model</i> transformation are awarded with the ► business model innovation prize by the Singapore manufacturing federation. In addition, many global enterprises consider Singapore to be an attractive testing ground to apply new ► <i>business models</i>, especially in case of entering the Asian market. New business models are swiftly implemented and driven by international trends. The service sector in Singapore is well-developed and the rapidly growing interdependence between the manufacturing and service sector is supported by the state.</p>
 Corporate Culture and Flexibility	<p>While local companies have a more hierarchal organization, MNC presences adopt to more flexible organization paradigms. Flexibility in blue-collar functions is not common, especially since a large amount of blue-collar workers commute from Malaysia, or are foreign workers. Singapore has very good innovation capabilities. The country is very sensitive to market trends due to high concentration of international companies and experts. The Singaporean mentality is bound to adhering to regulations. Companies have high uncertainty avoidance and a risk adverse culture. Nevertheless, Singaporean corporations are generating good innovators.</p>
 Internationality	<p>The diversity in Singapore is the driving force behind the Singaporean economy. The mix of Asian and Western culture is seen to enable the companies to be more flexible and knowledgeable in doing business with different customers and partners. Mostly, English and Mandarin are the corporate languages. Global talents consider Singapore as an attractive workplace. The population strives to reduce the dependency on migrant blue-collar workers. The close proximity to the countries with low-cost labor has supplied the Singaporean labor market and enabled the set-up of cheap production dependencies for Singapore-based companies. The good reputation of the business environment, state support and IP-protection prompted global companies to invest in Singapore. Singapore offers attractive tax regulations and easy entry options for foreign companies wishing to establish a presence. Especially the use of regional headquarters for Asia operations in Singapore is common. Strong integration into the ASEAN region allows for manufacturing operations in Malaysia, Indonesia or Thailand to be steered from Singapore.</p>

Business Environment



Overview

Singapore pursues an **application-oriented technology strategy** with **heavy focus on R&D**. The **most important goal** of the implementation of smart manufacturing technologies is the **optimization of productivity**. International companies see Singapore mainly as a **location for high-technology manufacturing**. Despite the availability of cheap labor from neighboring countries, **state-of-the-art factories with large-scale-automation systems exist**. The government grants **tax incentives for companies** operating in key industries including advanced manufacturing. **Automation and the ICT industry particularly incentivized by the state**.



Political Will and Restrictions

The Singaporean government wants to continue the ongoing **transformation of the classic labor-intensive manufacturing sector into a knowledge-based high-technology manufacturing**. Singaporean is **well-known for attracting successful companies** by providing the necessary business environment for the manufacturing sector. The state provides a **business-friendly regulatory environment**. **Political strategies take the manufacturing sector into consideration** and the goal is to **upgrade and expand** the sector. The **high degree of transparency and stability** contributes to Singapore's economic performance. Singapore **does not have a specific program to boost Industrie 4.0 or smart manufacturing**. Productivity improvements in general are aims of manufacturing policy. The **government operates with mid- to long-term vision and offers strong stability and swift implementation**.



Access to Capital

The Industry is benefiting from Singapore's function as an international finance platform and **banking hub**. In general, the chemistry, ICT and electronic industries receive the largest share of investments. **Risk capital for start-ups is available**, and the **business-friendly environment and legislation attracts investors**. **Technology development investment** is fostered by **very development-friendly policies on piloting technology**. For **strategic technology development**, government incentives such as **tax cuts and grants exist**. The **distribution of research funds** to research institutes is very much aligned to the needs of industry in the government-set strategic foci, and is considered to be **fast and efficient**.



Access to Selling and Procurement Markets

Singapore has an **influential position in ASEAN**, and a strong international trading position. The **geographical and economical closeness to the potential customers** in the region are beneficial for the manufacturing sector. Neighboring countries with cheap wages offer the possibility for offshoring low-value manufacturing within its scope of influence. Especially with the recent shift of the low-cost manufacturing from the mainland China to the south-east Asian countries, has Singapore an **easy access to procurement markets**. Singapore as an international cluster has a **high export orientation**. **Local clusters** focusing e.g. on smart grid technologies, biotech and the ICT sector are **focused on innovation**.