

Building a dynamic Singapore: the role of JTC Corporation

SSE1201: BUILDING A DYNAMIC SINGAPORE - ROLE OF ENGINEERS

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Group Project Report

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‘JTC Corporation (JTC) is Singapore’s leading industrial infrastructure specialist spearheading the planning, promotion and development of a dynamic industrial landscape.’

– Centre for Liveable Cities, 2013

Abstract

Singapore has transformed from a Third World to a First World country within a lifetime. This is thanks to the expeditious industrialisation which took place in line with the national objective of economic growth (Centre for Liveable Cities, 2013, p. 1). Jurong Town Corporation (JTC) was formed to undertake the first step of this large-scale process. As a significant part of JTC, engineers have contributed greatly to the creation of industrial infrastructure (Goh, 1977) and will continue to be key assets in the knowledge and innovation economy of the future (Kaushik, 2012, p. 12).

This paper will examine the ways in which JTC, as a key proponent of Singaporean engineering, has met several challenges and demands throughout the post-independence nation-building years (JTC Corporation, 2012). The ‘symbiotic relationship between JTC and EDB’ (Centre for Liveable Cities, 2013, p. 29) will also be explored in order to highlight the positive impact of the link between ‘economic strategy and industrial infrastructure development’ (Centre for Liveable Cities, 2013, p. 1) on national development.

1. Introduction

Singapore gained self-governance from British rule in 1959 and was subsequently faced with various socio-economic concerns, namely high unemployment (Khera, 1971). The Economic Development Board (EDB) was formed in 1961 in order to facilitate the rapid implementation of an industrialisation programme (Tan, 1999, p. 1). However, independence and the resultant separation from Malaysia in 1965 placed Singapore in an even more precarious position with the loss of the common market. There was now a desperate need to ‘absorb the growing population in useful employment’ (Goh, 1972, p. 165) and to end ‘import substitution as a basis of industrial growth’ (Goh, 1973, p. 7).

In 1968, the Industrial Facilities Division was carved out of the fast-growing EDB to form the Jurong Town Corporation (JTC) (Tan, 1999, p. 2). JTC was to ‘develop and manage industrial estates and sites in Singapore and to provide amenities for the people living therein’ (Khera, 1971, p. 77). With the scheme yielding results, the economic objective of job creation through industrialisation soon gave way to the aim of accelerating industrialisation during the skills-intensive phase of the 1970s. Throughout the following years, development continued ‘through the (new) trajectory of export-oriented industrialisation’ (Centre for Liveable Cities, 2013, p. 1).

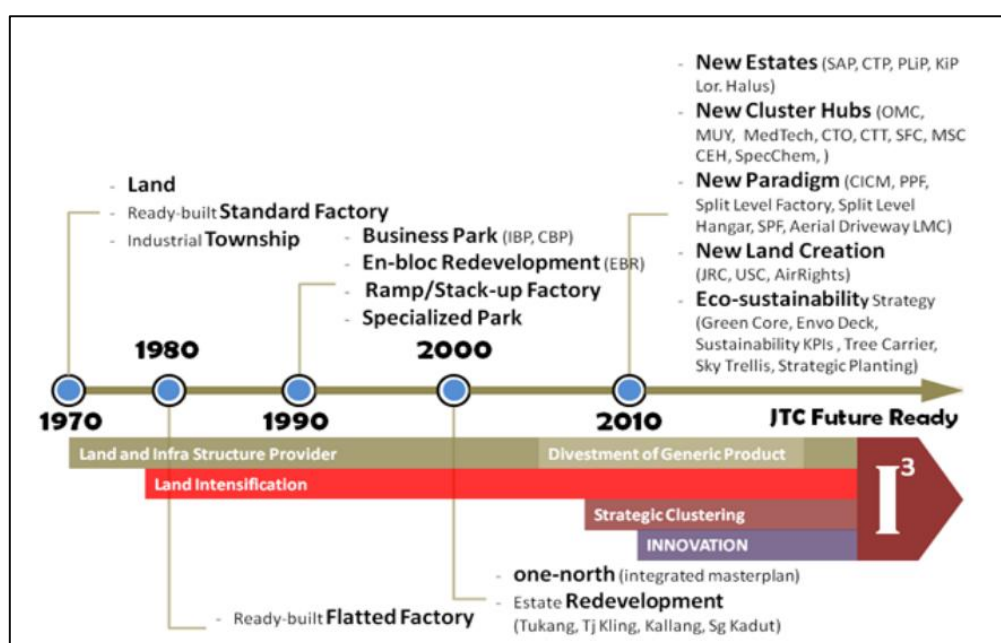


Figure 1: JTC's role and evolution over the years

2. 1960s & 1970s – Labour-Intensive Industrial Development

‘The task was first and foremost economic: how to restructure the low-growth, anemic Singapore economy into a vibrant high-performance one that could be counted on.’

– Chan, C. B. (2002). *Heart Work*.

The Singapore of the 1960s was faced by a series of socio-economic problems such as that of high population growth, unemployment and high labour costs (Khera, 1971, pp. 1-9). Economic growth was hampered by a lack of natural resources, a high degree of dependence on other countries, limited domestic market and the uncertain future of the growth of entrepôt trade. In line with the direction Singapore has begun taking in the 1950s, EDB and JTC took to administrating and facilitating industrialisation. Manufacturing had been identified as a key growth sector and one of the first steps taken was the establishment of Jurong Industrial Estate. This development and the installation of surrounding infrastructure occurred swiftly (JTC Corporation, 2012) and ‘achieved the first objective of solving our unemployment problem’ (Hon, 1973).

Dr Albert Winsemius of the United Nations Survey Mission to Singapore examined Singapore’s potential to industrialise and advised skills enhancement and the increase in supply of engineers (Goh, 1972). The 1970s then saw a ‘switch from quantity to quality’ (Hon, 1973). To maintain and improve standards of living, new industries were built and concerns arose about ‘a congenial living environment’ (Goh, 1973) and the suitable ‘utilization of high quality manpower’ (Goh, 1977). In its capacity as master planner and manager of the industrial estate, JTC tackled these challenges and concerns.

Though it was not an official entity until 1968, the Jurong Town Corporation kick-started Singapore’s industrialisation drive through rapid development of land and construction of low-cost factories. The most notable achievement during this period was the creation of Jurong Industrial Estate and its supporting infrastructure. This will be illustrated in further detail in the following case study.

2.1 Case Study: Jurong Industrial Estate



Figure 2: Jurong Industrial Estate under development - aerial view. (c. 1960s)

In order to form the first ever heavy industrial zone in Singapore, the first step undertaken was land preparation. Low hills around the swamps, jungles and small fishing villages of Jurong were cut and levelled to fill the swamps and hence reclaim the land. According to Tham Tuck Yen, the Chief Engineer of the EDB's Civil Engineering Division (which went to JTC in 1968 under the Industrial Facilities Division) 'whole topography of the place changed' (Reutens, 2000, p. 31).

Following the physical transformation of the swampland, the vast space was made available to investors in the manufacturing industry (Jurong GRC).

To support the estate, JTC also built low-cost workers housing from 1969 onwards and worked to create a convivial living and working environment (JTC Corporation, 2012).

Other supporting infrastructure included social and recreational facilities such as the Jurong Bird Park, Jurong Sports Stadium, Chinese and Japanese Gardens and three golf courses (Reutens, 2000, p. 31). In many ways, the construction of the estate also contributed to community building and culminated in today's 'bustling, self-contained satellite town' (Taman Jurong Constituency).

Challenges and How JTC Overcame Them

The whole scheme of industrialising Jurong was seen as immensely ambitious and was widely referred to as Dr Goh's folly. 'The estate was to have not just factories and a port, but also housing, social and recreational amenities for the residents – no small task even for highly experienced engineers' (Reutens, 2000, p. 31). However, as will be seen throughout Singaporean history, industrial infrastructure implementation was successfully carried out under carefully constructed economic plans. JTC financed the infrastructure under an EDB loan (which has been long repaid) and was able to acquire the required land under the 1967 Land Acquisition Act. JTC bought land cheaply and charged industries low land premiums so that they could spend on capital equipment instead (Centre for Liveable Cities, 2013, p. 7).

Developing the first industrial township also meant having to build ahead of time to be ready for prospective investors. EDB attracted foreign investment and JTC worked to make the land usable (prepared land) and to build 'factories, public utilities, roads, drains, sewers, housing and amenities'. Planning and skilled execution on the part of EDB and JTC allowed Jurong to be a self-contained township. Speed and efficiency, as well as the 'quick start-up and plug-and-play industrial environment delivered by JTC was important in providing a competitive edge' (Centre for Liveable Cities, 2013, p. 10).

2.2 Role of Engineers in JTC

The Civil Engineering department of EDB's Industrial Facilities Division became JTC. From a mere 3 engineers, the department had grown to 100 staff including 40 engineers by 1968. One of the pioneers was Chief Engineer Tham Tuck Yen who oversaw land preparation and generic standard factory construction (Reutens, 2000). Engineers of the time executed the infrastructure development required for industrialisation and the resultant invigoration of the Singaporean economy.

3. 1980s - Shift from Labour to Technological Intensive Industries

In the 1980s, Singapore saw a shift in focus from labour intensive to technological intensive and value-added industries (JTC Corporation, 2008). As these industries require a large amount of capital, the government's strategy was to improve the design and quality of the industrial infrastructure in order to attract investors. As Singapore's industrial and estate developer, JTC set up a 10-year Master Plan to facilitate this shift.

3.1 The Master Plan

One of the main challenges Singapore faced was land scarcity. In order to overcome this, JTC made use of land optimisation and intensification through their new generation of "8" series factories, as well as ramp-up and stack-up factories.



Figure 3: JTC's Flatted Factories

In conjunction with Singapore's "Clean and Green" image, JTC decentralised industrial estates to reduce congestion, which in turn, eliminated other negative externalities such as air and noise pollution. Decentralisation, alongside with improving amenities and commercial services enabled people to live nearer to their workplace, reducing transport distance. This also encouraged more people to join the workforce, especially women.

To encourage research and development, JTC planned and opened Singapore's first science park, Science Park I (which will be elaborated in case study 3.2). The Master Plan also included projects such as the first petrochemical plant on Pulau Ayer Merbau which produced 300,000 tonnes of ethylene and 160,000 tonnes of propylene yearly.

3.2 Case Study: Singapore Science Park

The Singapore Science Park is located within close proximity of world class research institutes and tertiary education institutes. This spatial proximity enabled close interaction between these different institutes and facilitated many joint research projects.

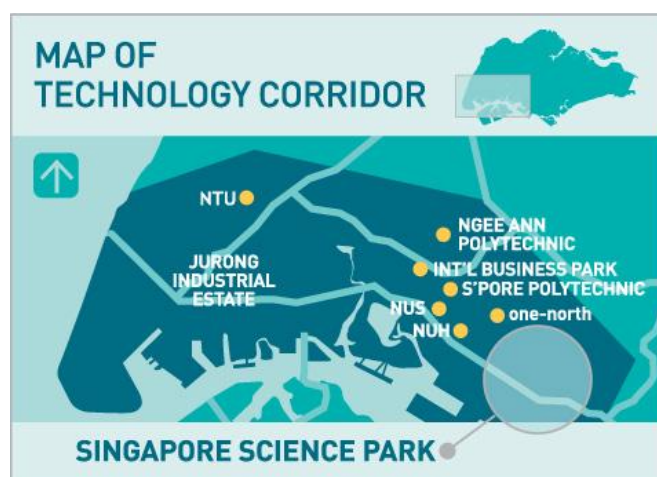


Figure 4: Map of Singapore Science Park

Within the park, small firms were consolidated together and occupied the Faraday and Fleming blocks whereas bigger firms leased land for their own buildings. These firms focused on R&D activities in the areas of biotechnology and biomedical sciences, information technology and computing, and petrochemicals, chemicals and chemical engineering.

Challenges and How JTC Overcame Them

As Singapore Science Park was the first of its kind in the country, it faced various challenges. Firstly, conceptualising from scratch was not easy. Hence, JTC formed a team which visited similar facilities around the world to learn from them. These places include the Silicon Valley, Cambridge Science Park, Stanford Research Park and science parks in Korea and Taiwan (ASCENT, 2012).

Secondly, it was difficult to attract tenants as Singapore's reputation in R&D was not yet established. To overcome this, JTC offered attractive rental rates with the aid of a \$60 million grant from the government (ASCENT, 2012). Also, JTC handed over the planning, promotion and administration works of the park to EDB upon the park's opening as EDB had

excellent facilities and international connections that were good for attracting tenants. The administration of the park was later given to the Science Council to be collaborated with JTC and EDB. The Science Council administered a government tax incentive and grant scheme which encouraged firms to set up in the park.

Lastly, as firms were mostly operating independently, there was little accountability for the amount of R&D involved. Therefore an admissions committee made up of representatives from the JTC, EDB and other R&D organisations was set up to regulate and ensure that firms mainly engaged in R&D activities (Chua, 2012). The quality of research staff and work was also strictly monitored.

Success of Science Park

The mid-1980s recession showed that firms which had invested in R&D were more resilient during the downturn compared to labour-intensive ones, as those labour-intensive firms faced strong competition from neighbouring countries (i.e China and India) with cheaper labour (The National Research Foundation, 2015).

The success of Science Park I led to the expansion of Science Parks II and III as well as other R&D hubs such as one-north.

3.3 Role of Engineers in JTC

Engineers played a vital role during this time period by offering their expertise in planning, constructing, and management of these industrial estates. From the Master Plan, it is evident that engineers helped to solve complex problems and benefited Singapore on a whole. For instance, Singapore Science Park was the brainchild of then JTC Chairman, Mr Tang I-Fang (Menkhoff, T. ,2010), who was a mechanical engineer.

After the development of Science Park in tandem with the industrial shift in the economy, engineers started to take on a different role by being more involved in more R&D. This will be further elaborated in the subsequent chapters of this paper.

4. 1990s – A Business Outlook

In the 1990s, Singapore's industries are becoming increasingly technologically intensive but a new perspective of the importance of customer service is starting to emerge. Singapore became aware that pure reliance on the manufacturing industries is not a sustainable method. They recognised the need to address the services sector hence incorporating it to their existing manufacturing methods. This policy was created in effort to achieve a holistic operation and to remain competitive. During this period of time, JTC came up with a master plan of diverting their approach to encompass a more business-oriented outlook on their industrial estates. Some key policies will be discussed below.

4.1 Key policies

Recognising the significance of customer service in Singapore, JTC has released a few fundamental policies that will guide future industrial estate towards ensuring a positive service-oriented environment.

Initially a simple Customer Service Group was first established in 1996. This group was set up in aim to develop infrastructures to help their tenants and customers answer any queries or resolve any issues related to lease and property management. (JTC, 2008) 4 zone offices are also set up island-wide for customers' convenience and accessibility.

To keep up with the evolving needs of customers, JTC released another Customer Service 21 policy in 1998 with the theme of "going the extra mile for customers". At this time, JTC Summit was also constructed and a customer service centre was situated in their headquarters. (JTC, 2008) These ongoing efforts have shown that JTC views customer service as an important aspect in strengthening their business capacity.

To diversify their current industrial hubs which are mostly manufacturing and technologically inclined, JTC planned for the construction of two new business parks to provide a location for commercial businesses like banks, and multinational companies to undergo knowledge intensive and high technology research as Singapore prepares for the upcoming of knowledge based industry in 2000s. The two business parks that will be discussed is the International and Changi Business Park.

4.2 Case Study: International and Changi Business Park

The International Business Park (IBP) was constructed in 1992 and followed by Changi Business Park (CBP) in 1997. JTC's main consideration, when coming up with the business park plans, was to diversify its industrial estates. Now, industrial and commercial corporations share these integrated hubs and work together to have higher efficiency, bigger economies of scale, and enhanced competitiveness.



Figure 5: International Business Park

Key Features and Challenges

In the 1990s, JTC recognised the need to address the pressing issue of land constraints in Singapore. Being a small country, it was difficult for JTC to mindlessly expand and construct new industrial estates. JTC had to source for a more effective strategy to manage available land space and construct the most efficient industrial estate so that for every land they use up, they will reap the highest possible yield. (Kaushik, 2012)

The idea of integrated business and industrial spaces was first conceptualised in the 1990s. Concentrating companies of the same industry within the same area will help them reap higher economies of scale and allows strong collaboration. Stack-up factories were also evolved from flatted factories in the past. However, accessibility for stack-up factories are not compromised as ramps are built to access all levels for loading/unloading. (Kaushik, 2012) This is in aim to improve the plot ratios of the integrated hubs. Stack-up factories can achieve a plot ratio of 2.05 which is much higher than a 0.8 in the previous low-rise factories. (Kaushik, 2012) Both International and Changi Business Parks aimed to achieve a plot ratio as high as 2.5 and the minimum requirement is at 1.0.

Besides a high plot ratio feature, both business parks are in close proximity to various amenities. (JTC, 2014) Both parks are located near MRT stations which provides the workers easy access to the place. CBP is also located near Changi Airport and Expo. The strategic location does not happen by chance but is fully planned by JTC. This allows convenience when transporting manufacturing raw materials and end products. Both parks are also located near research institutes like, NUS and NTU. With these convenience, land use is greatly optimised and will ensure high productivity of companies.

In the face of an uprising sustainability challenge, JTC has made efforts to incorporate green features in its business parks. IBP and CBP have 22% and 10% greenery space respectively. Centralised District Cooling Systems are also installed to reduce energy consumption and also help tenants cut down on their costs. (JTC, 2014)

Success

JTC has attracted many tenants from many different types of industries to relocate themselves at their business parks. Banks are seeing the benefits of a highly integrated office and also the perk of having to pay a 30% cheaper rent than compared to central business districts. (The Straits Times, 2014) Tenants like DBS, Standard Chartered and Credit Suisse who were previously located in many places in Singapore are now centralising their operations in CBP. A DBS spokesman mentioned that having operations under one-roof will “facilitate faster decision-making and greater teamwork” which will help them to “respond faster to customers’ needs”. (The Straits Times, 2014)

4.3 Customer service efforts beyond 1990s

JTC is continually doing research on enhancing their customer service operations. More highly efficient methods are adopted beyond the 1990s like the introduction of the Krypton internet portal in 2002. Krypton was designed for customers to have easy access to carry out transactions in their own homes. Processing time for these applications and transactions is also greatly reduced from a previous 5 days to only under 5 minutes. (Abecha, 2002)

In 2004, eCREAM (Customer, Real Estate and Marketing System) was established. eCREAM is an integrated platform with about 52 processes to deals with customer-related services. This cuts down processing time and ensure that JTC can reach out to its customers

effectively. It was reported that the benefits generated is about \$3.8 million in manpower savings per year. (Challenge, 2004)

4.4 Roles of Engineers

Engineers played a variety of roles in the period of 1990s. The most notable group of engineers in this period was the IT engineers who created breakthrough soft-wares that momentarily improved the customer service situation. The eCREAM services was awarded the National Infocomm Award and MIS Innovation Award. (JTC, 2004)

Other engineering roles include, civil, mechanical, electrical which dealt mostly with the construction of stack-up factories and land reclamation projects in Jurong Island.

5. Transition into the 2000s: Knowledge-Based Industry

Entering the 21st century, most companies are moving towards a more knowledge based industry – industries that are relatively intensive in their inputs of technology and human capital (Organization for Economic Cooperation and Development, 1999). A company's success are no longer based on the traditional evaluating tools such as property sizes. They are now mostly measured based on the skills and knowledge possessed by company's human capital, which leads to the creation of innovation. Acknowledging the importance of knowledge, companies are all transiting to a knowledge-based industry to avoid losing its competitiveness in the global market. This applies to JTC as well as JTC saw the need to adapt to the trend for highly skilled labour to produce high value added goods and services.

5.1 Key features of a knowledge-based industry

According to The Work Foundation, a knowledge-based industry could be identified through several key features such as the application of specialised skills and thinking, exchange of complex information and high cognitive skills (Brinkley, 2006). This is heavily dependent on human capital and the quality of the skills possessed. It is difficult to precisely measure the quality of human capital but it is often linked and compared to paper qualifications or creativity. To prepare Singaporeans for the knowledge-based industry, Singapore has been increasing its investments for higher education (Singapore Budget, 2010). JTC releases annual reports to their investments, and according to their 2012/2013 report, it could be seen that JTC upgrades the skills of their current employees and that shows how JTC is adapting to the need of higher skilled labour force (Jurong Town Council, 2013). An exemplary example would be that of the Jurong Rock Caverns (JRC) where it could be seen how JTC used expertise knowledge as part of their human capital asset to propel them in this knowledge-based era.

5.2 Case study: Jurong Rock Caverns

With the growth of Singapore's petrochemical industry, there was an increase in demand for land space for storage and expansion. To meet the rising consumer needs, it spurred JTC to look for new innovative storage means. This led to the construction of South-east Asia's first underground oil storage facility in Jurong Island, Jurong Rock Caverns (JRC).

The caverns store liquid hydrocarbons such as crude oil, condensate, naphtha and gas oil, which are required as feed by petrochemical companies residing in Jurong Island (The Straits Times, 2014). The caverns also free up approximately 60 hectares of land which are to be used for the petrochemical industry. This makes Singapore's petrochemical hub more competitive in the global market. Also, storing chemicals underground would be safer than on ground land. If there were to be any leakage, it could be easily contained (Jurong Town Council, 2013).



Figure 6: Jurong Rock Caverns

Role of Engineers in Jurong Rock Caverns case study

The building of JRC involves many engineering properties and would require engineers to play their role in ensuring that JRC could be built successfully. There were a lot of technicalities involved as there were many factors regarding sea pressure, design and stability to be taken into account so as to build a successful underground storage facility. At that point in time, Singapore has yet to explore construction farther deeper than the current MRT stations. There was a need for a new innovation (Chia, 2014).

Due to the Singapore's climate, weathering was a factor that needed to be taken into account as it could lead to potential hazards such as the collapse of JRC. This would be fatal and could cause deaths. Studies of the rock structures and the mechanical properties of the rocks

were needed to ensure that JRC could be built under safe conditions in the long run. Engineers played their part and conducted a series of tests known as the point-load strength index test to find the optimum depth to build the cavern. Through rigorous testings, it was studied that the stability of the cavern would be structural rather than stress-dependent - which means that as long as the structure of the cavern is built ideally, the cavern would not collapse even if it is exposed to weathering and other natural factors.

Engineers also play an important role in the budget proposal of building JRC. Even though one might not expect engineers to be involved in financial issues, engineers were crucial in the cost-benefit analysis of building the cavern. Engineers used the Q-system to measure the rock mass qualities of the rocks where they planned to build the cavern. Numerical values were assigned from 0.001 to 1000 for the quality of the rocks. This method requires expertise in geological engineering and data analysis as it evaluates the amount and type of materials are to be used. Stress and friction factors are also included in the calculations. Potential sites for building JRC was then evaluated to find the best spot. (Zhao, J., Liu, Q., Lee, K.W., Choa, V., Teh, C.I., 1999).

Engineers did not stop at building JRC, they proceed further and developed multiple usage of the space created. As Singapore faces land constraints, it is important that land is optimally used. Other than being a storage area for petrochemical feed, JRC also doubles up as a nuclear shelter as well as recreational centres such as swimming pools. Engineers also look into the potential usage of JRC in the water cycle of Singapore. Underground pipes could be built such as to accommodate the collection, storage, and treatment of water. This would value add Singapore's water industry and contribute to the self-sustainability of Singapore in water supply (Zhao, J., Liu, Q., Lee, K.W., Choa, V., Teh, C.I., 1999).

5.3 Challenges of a knowledge-based industry

With the construction of high technological innovations, there is an increase need for security for these innovations. For intellectual properties concerning research and development, there ought to be suitable and strict intellectual security protecting the companies. This is especially important for structures such as One-North, Business Park and CleanTech Park, as these places are heavily involved in research and development as well as test bedding for various industries. Currently, Singapore are able to obtain high investments in these areas due

to the strict laws protecting intellectual property. In the future, Singapore will have to ensure that intellectual property laws will be able to keep up with the advancement in technology so that she still retains her competitiveness in this area.

Furthermore, physical structures would have to be protected against potential terrorist attacks. Singapore's economy will be affected by any disturbance to any of the knowledge-based industry buildings as Singapore relies heavily on this area. This is also the main reason as to why these places are at high risks of potential attacks from terrorists. The Singapore government would have to ensure that it is always prepared for any potential attacks and make sure that recovery should be fast and to keep damage to the minimum.

6. Evaluation and Future Prospects

Through the usage of various master plans and projects as examples, this paper has examined the role of JTC in building industrial infrastructure to aid economic growth. This has been done in order to observe the planning and execution strategies of JTC, as well as to detect manufacturing industry and R&D trends. By noting these trends, it is then possible to predict or suggest the direction JTC will take in future to tackle the imminent challenges.

6.1 Upcoming Trends

In recent years, globalisation that involves government agency mergers or collaboration to strive towards a common goal has been observed. An example of this is the joint effort by JTC and Surbana in building the new capital city of Andhra Pradesh state in India. (Channel News Asia, 2015) The main advantage of mergers is that these big corporations can have higher economies of scale and increased manpower. This will be especially useful for JTC since they are aiming to branch themselves out and become a reputable global company. It is hence likely that in future, JTC will collaborate with more government agencies or home-grown companies in order to achieve the greater goal of helping neighbouring countries and simultaneously growing its international operations.

An exciting and possible future prospect our group has identified is that JTC can adopt a new business outlook. Currently, the global business environment is now witnessing the emergence, growth and success of companies that stress on environmental sustainability, ethics and compassion (Confino & Muminova, 2011). Thus far, investment has been the core mission of technology development but ethics and emotion have not yet been a forefront consideration in government or JTC planning. In the recent years, an increasing number of consumers make purchasing decisions based on ethics and emotions. Asia Pacific regions, like Singapore, are spotting this trend and have 64% of the public willing to fork out extra cash for goods and services from sustainable companies (Nielsen, 2014). JTC can take a step towards incorporating ethical core values in their projects and encourage local research institutes or home-grown companies to take on this approach. Incentives may be offered to companies which take on these ideals in their day to day operations. In addition, JTC can use them as “model” companies by leasing them a space in existing tech corridors such as the industrial parks, one-north or JTC Launchpad. These model companies may then lead by

example and foster an ethical and sustainable business environment that the industry as a whole may profit from.

Another direction now being taken by JTC and much of the research landscape in Singapore is encouraging technopreneurship. It is evident that R&D has been taking place extensively and that innovation is the next anticipated step. However, this leap has not yet been made to a large extent. The success of the research undertaken is largely due to the platform offered by the government and JTC. Thus it is possible to say that in order for a saleable product to emerge from this investment, there needs to be a platform offered to new technology companies. In other words, a very specific business environment needs to be created such that the innovation step is taken. Using local and foreign expertise, JTC may create a physical or online environment where a product of research can be put onto the market.

Along with thinking in new directions, the growth of the industry-driven R&D and innovation environment will exacerbate existing challenges of space constraint and sustainable development. Just as Singapore has done in the past, these vulnerabilities and disadvantages will have to be turned into core competencies and assets.

6.2 Future challenges and potential solutions

The future prospect of globalising under joint efforts also poses certain risks. Though a decision to undertake an infrastructure project abroad may be taken either altruistically or with diplomatic inclinations, the resulting project may not always yield the desired results. For example, the China-Singapore Suzhou Industrial Park, which JTC worked on in the late 1990s, was not a success and actually incurred losses before the Chinese government took over control. The failure of an attempt to recreate Singaporean industrial parks brings to bear the important question of whether the Singapore model of development can truly be exported. Differences in economic conditions, business environments, foreign policies and government attitudes to the project (in terms of providing adequate promotion) were cited as reasons for the failure (Han, 2008). However, this project had certain strengths and lessons have since been learned from it. To prevent future projects from facing similar difficulties, JTC may seek not only to strong project management, but also better understanding of the conditions in foreign countries. More advanced research about varying business cultures, ethics and foreign socio-political and economic conditions may be carried out and presented to the involved JTC employees for smoother project execution. Though the engineering and business

involved may be technically similar between Singapore and another country, the way interpersonal interactions are carried out play a significant role in the success of a project.

Hence, the question now would be whether JTC should plan for an industrial park overseas. Our group believes that it should be done as it will solve our land constraints issues in Singapore. Given the nature of industrial parks, it is undeniable that land would be needed. It would be a valuable tool for JTC to create even more innovative industrial solutions and achieve much more than what they are capable of doing currently. Working with and observing other industries overseas can help increase economies of scale and bring about convenience for JTC's clients.

Other areas of innovation undertaken by JTC are the development of specialised land and new innovative space solutions in order to support the growth of new industries (JTC Corporation, 2012). Alongside this and in line with government ecological aims, is the goal of sustainable development. As seen by the entirely new kind of infrastructure in the one-north development in Singapore, JTC is taking a direction towards building eco-friendly smart buildings which are highly energy-efficient. The integration of environmentally sustainable designs which reduce energy consumption in cooling and lighting in the buildings along with seamless wireless connectivity has been the first step towards creating a smart, eco-friendly and self-contained township. A future potential solution that JTC could undertake to tackle the issues of energy constraints is to adopt the idea of decentralised energy supply. This idea will help industrial parks cut down costs on energy consumption as these energy can be reused and recycled through a close loop cycle and it in turn improves the existing environmental situation. One possible feature is the construction of swales for efficient storm-water management so that industrial parks can have a self-sustaining decentralised water system for toilet-flushing and irrigation. In short, new expertise has to be fostered and JTC, with its history as a land and industry developer and its expertise in engineering and as an industrial company, will have to develop new and lucrative solutions.

Given the Singaporean government's "Smart Nation vision" and the current global scenario with regard to climate change and changing lifestyles, a smart city is widely considered to ultimately be the future of modern city living. With one-north and upcoming developments as a test-bed for the futuristic "work-live-play-learn" environment, JTC is likely to be the regional pioneer in building smart cities and smart nations.

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