

The Impact of Disruptive Technologies

Chua Fang En
Hwa Chong Institution (College)



Executive Summary

The emergence of new and disruptive technologies is a double-edged sword. The birth of new economic products and sectors (be it artificial intelligence, the sharing economy or the rise of e-commerce), has brought immense convenience and benefits for both consumers and producers, bringing businesses, production and Singapore's productive capacity to new heights. We see the emergence of new products

that highlight immense potential for our future productivity. Yet, these benefits come at a cost. Disruptive technology has interfered with our traditional economic functioning. We see this in the loss of jobs for PMETs and low-skilled workers, as well as the displacement of traditional sectors of our economy. Ultimately, the question remains: do the benefits of disruptive technology outweigh the costs? This essay will attempt an evaluation of the potential harms and benefits of disruptive technology.

The critical issue to consider: we face limitless possibilities, but also endless risks brought by this disruptive technology. To prosper in this new

world means embracing and adapting to changes, how does Singapore then, as a nation with 50 years of miraculous success premised on our high adaptability, deal with harms like the displacement of jobs by disruptive technology while enjoying and maximising the opportunities? Singapore needs to provide sufficient safety nets for those left behind, regulate the growth of disruptive technology and simultaneously promote the utilisation of productive technology. Methods to achieve these will be examined in this essay.

Overall, I propose that while the new age brings change and unpredictability, potential benefits it brings far outweighs the harms, hence as a nation which has continuously and successfully restructured our economy in the past, disruptive technology is a valuable opportunity and propeller for Singapore.

By embracing change, we move towards a new stage of progress and a second economic miracle for Singapore.



The Fourth Industrial Revolution – Disruptive Technology: Bane or Boon?

Today, technological advancements is growing at an unprecedented pace. Private-hire-car drivers disrupt the

taxi industry; robots replace hundreds of blue-collared workers; even start-up companies with minimal experience compared to incumbent firms can triumph when armed with advanced technology. This is the age termed the “Fourth Industrial Revolution”. Disruptive

technology, innovation that creates new markets and products, displace established firms and markets (figure 1). They dismantle, revolutionise and disrupt traditional industries and producers.

E-commerce is the new favourite platform for exchange of goods and services, with

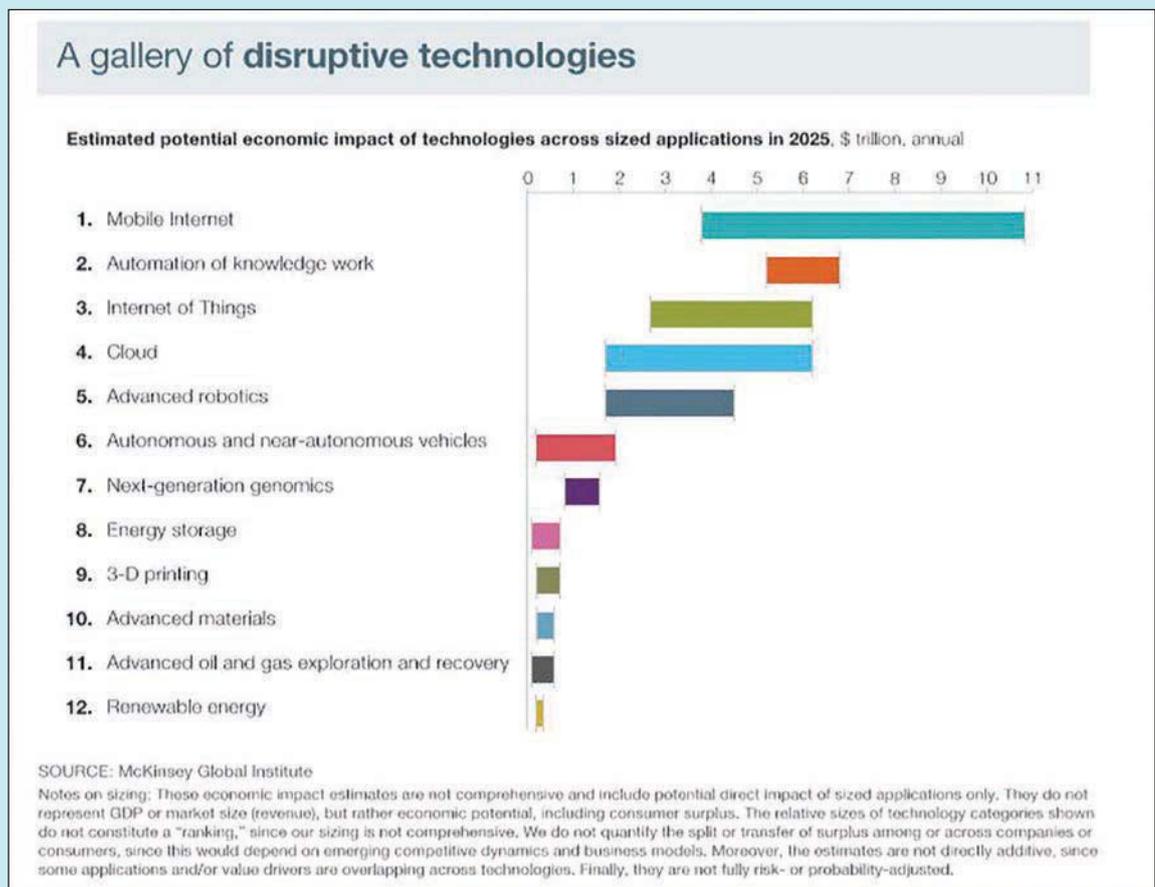


Figure 1: Gallery of Disruptive Technology and its potential economic impact¹

¹ Manyika, James, Michael Chui, Jacques Bughin, Richard Dobbs, Peter Bisson, and Alex Marrs. “Disruptive technologies: Advances that will transform life, business, and the global economy.” McKinsey & Company. May 2013. Accessed February 10, 2017. <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies>.

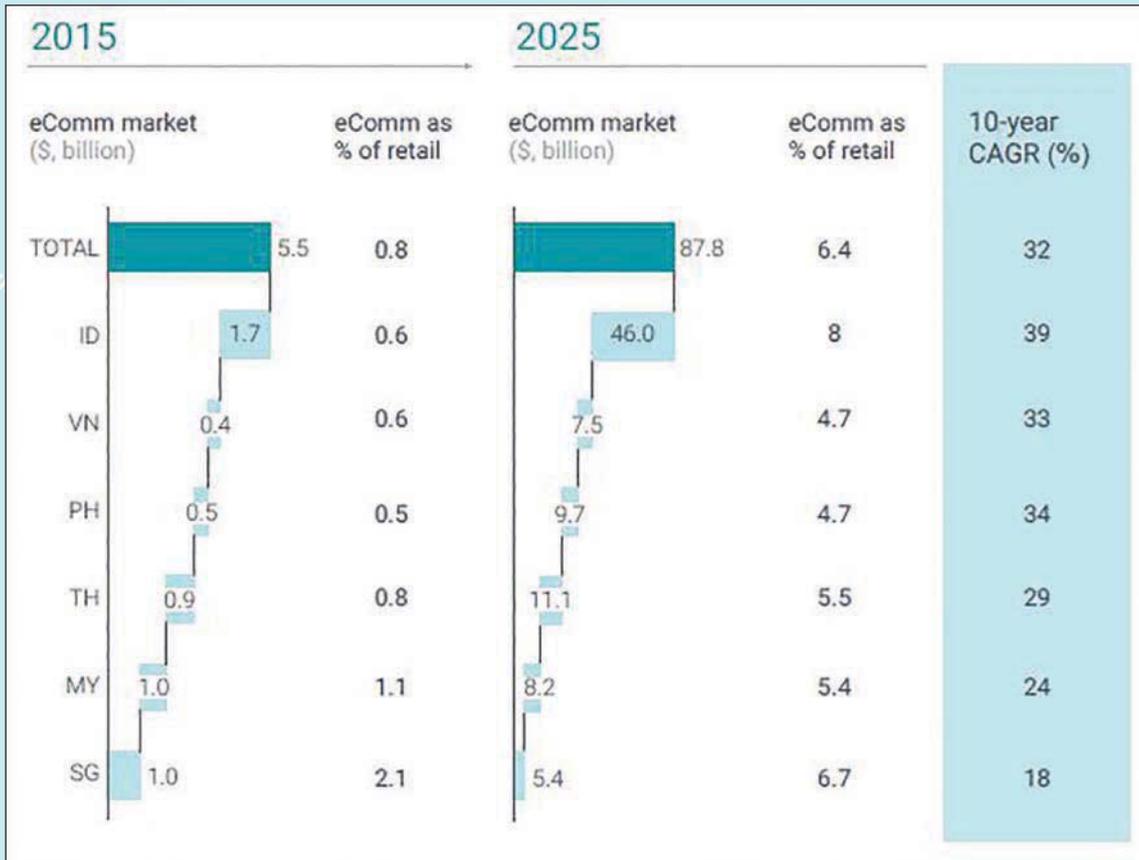


Figure 2: Rise of e-commerce in Singapore illustrated through a growing net worth

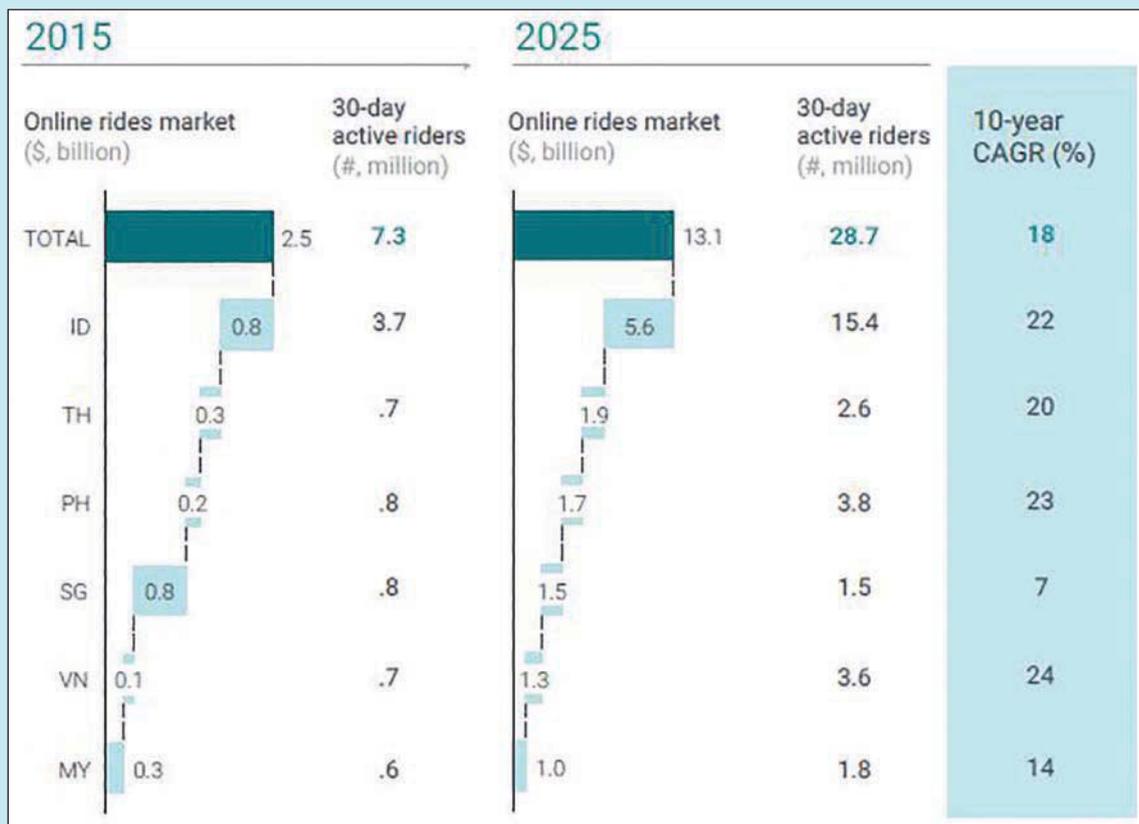


Figure 3: Growth of online rides market illustrated through a growing net worth and active riders

its worth likely to exceed S\$7 billion by 2025² (figure 2). At this rate, it is likely to overtake traditional retail.

Similarly, the sharing economy grows at an unprecedented pace. Uber and Grabcar are formidable competitors for traditional taxi companies, with its net worth estimated to reach S\$13.1 billion by 2025³ (figure 3).

How does this affect Singapore? This essay seeks to analyse the potential costs and benefits of disruptive technology, followed by proposals on how Singapore can cope with disruptive technology. We shall first turn to the costs of disruptive technology.

Trade-Offs in the New Age

Potential Pains of Disruptive Technology

The rise of disruptive technology comes at the decline of traditional production. Before we can fully reap benefits from disruptive technology, we will first feel the impacts of the disruption of jobs and decline of industries, hitting our middle class and those on the lower rungs of the socioeconomic ladder.

First, on the impact on industries.

a) Disruptive technology hits Industries and Businesses

Disruptive technology has revolutionised market structures⁴ (figure 4), creating new markets for consumption and displacing established firms and industries. These new markets have low barriers to entry⁵, drastically increasing competition⁶ in industries (table 1). The high appeal of these new businesses further threaten the incumbent firms.

In the sharing economy alone, through allowing consumers to bypass firms⁹ and traditional rental industries, the idea of collaborative consumption¹⁰ is popularised. Individuals are able to trade with each other directly, making businesses redundant. The

² "Singapore e-commerce market to exceed S\$7b in 2025: Report." Channel NewsAsia. May 24, 2016. Accessed March 20, 2017. <http://www.channelnewsasia.com/news/business/singapore-e->

³ Ibid

⁴ In Singapore particularly, the transport industry remains heavily affected by the rise of the sharing economy in the form of apps such as Uber and Grabcar which replaces traditional taxis with its high convenience. Similarly, tourist agencies are heavily affected with the rise of Airbnb and online booking sites such as Expedia. The rise of Carousell and Shopback has been an obstacle for retail stores.

⁵ Disruptive technology has allowed for firms or individuals with no physical assets to easily enter industries. Online retail has removed problems associated with physical store rental and the sharing economy remains easily accessible for the layman on the street who is seeking extra income.

⁶ Taxi companies still dominate the on-demand transport market in Singapore with close to 30,000 vehicles, but the number of private-hire vehicles that mostly ply for new entrants, such as Uber and GrabCar, has grown rapidly in the past three years to an estimated 10,000. This indicates growing competition for taxi companies that continues to increase at a rapid pace.

⁷ Grossman, Rhys. "The Industries That Are Being Disrupted the Most by Digital." Harvard Business Review. March 21, 2016. Accessed March 21, 2017. <https://hbr.org/2016/03/the-industries-that-are-being-disrupted-the-most-by-digital>.

⁸ Lim Wei Lu, Jaime Pang, Poh Lip Hang, Nimisha Tailor. "E-Commerce in Singapore - How it affects the nature of competition and what it means for competition policy". December 2 2015. Accessed March 12 2017.

⁹ Consumers can now book their own flights and accommodation online through Airbnb rather than through hotel booking agencies. The emergence of sites matching producers with consumers directly, such as Rent Tycoons has diminished the importance of middleman in businesses, in this case, car rental companies.

¹⁰ This includes any form of initiative allowing people to trade with each other directly, such as Airbnb, PandaBed, Rent Tycoons etc. Collaborative consumption refers to when regular consumers collaborate and work with each other to exchange goods and services and enhance satisfaction and welfare.

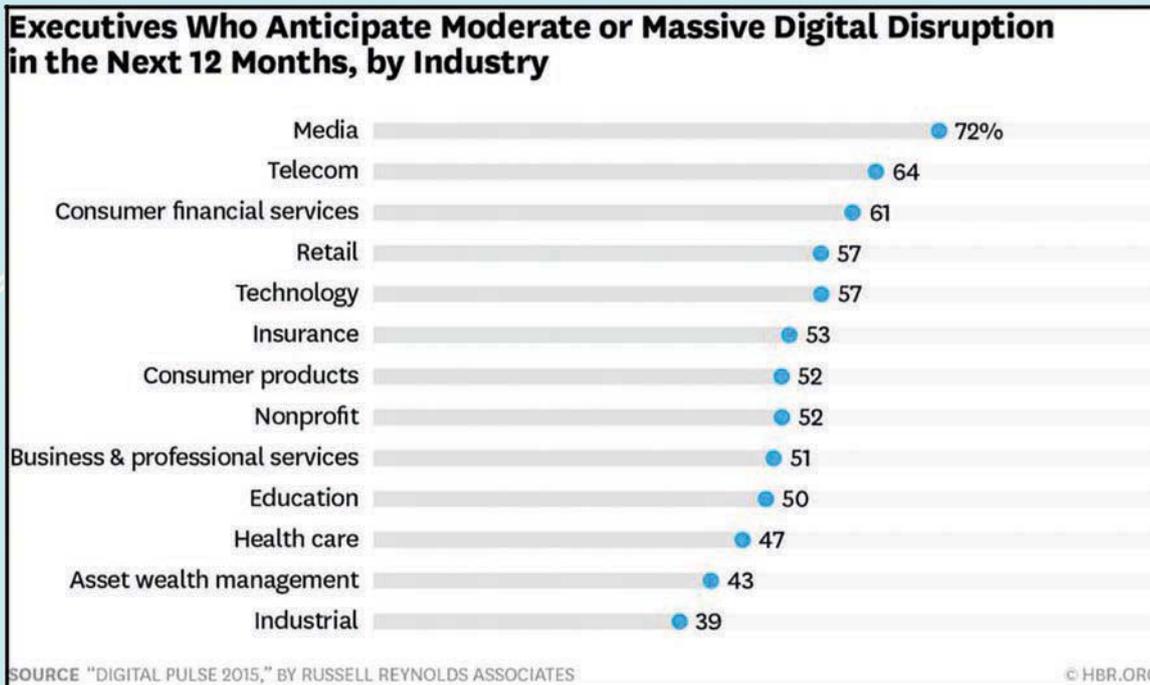


Figure 4: Industries affected by the entry of new businesses with the rise of disruptive technology⁷

Table 1: Entry of new online businesses in Singapore from 2010–2014⁸

Year of Entry	Firm	Industry
2009	Reebonz	Luxury products and services
2010	Qoo10 Clozette Luxola Groupon Deal.com.sg	B2C Marketplace C2C Marketplace Beauty and cosmetics Marketplace for daily deals Marketplace for daily deals
2011	NoQ Store Bellabox VanityTrove	Books Cosmetics/Groceries Beauty
2012	Kwerkee Zalora Carousell Food Panda	Home and lifestyle Fashion marketplace C2C Marketplace Food
2013	Taobao HipVan Omigo	B2C and C2C marketplace Home furnishing, fashion accessories B2C Marketplace
2014	Rakuten Lazada	B2C Marketplace B2C Marketplace

convenience¹¹, novelty¹², lower prices and high efficiency¹³ of this new initiative led to its growing popularity¹⁴, illustrated in the growing worth of this new economic sector, estimated to match traditional sectors by 2025 (figure 5). Users have also doubled to 35,000 in Singapore in 2014¹⁵ and continue to grow rapidly.

What does this mean for Singapore businesses and industries? The popularity of these new initiatives often comes at the expense of traditional industries and businesses losing their consumers to the sharing economy. A shrinking consumer base forces businesses to scale down or even shut down with decreasing revenue.

Putting this into perspective, 73% of traditional financial firms believe that part of their business is at risk of being lost to standalone Fintech companies¹⁷.

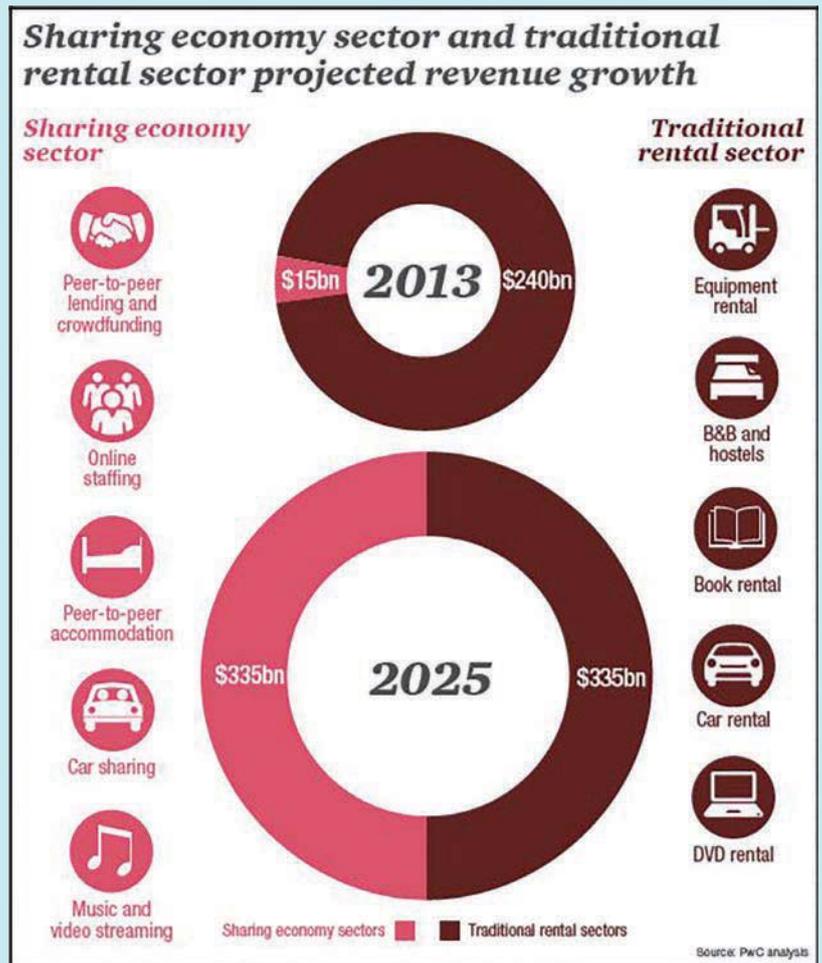


Figure 5: Illustration of growing worth of sharing economy and the displacement of traditional rental sectors¹⁶

¹¹ It takes as little as 30 seconds to put up a listing on the app and the app's messaging system allows for communication between buyer and seller without external applications or emails, asking for more details of the goods or settling transaction details. Users can opt for delivery with their goods delivered right to their doorstep, rather than having to access a physical store.

¹² Airbnb provides a novel experience of living like a local, with houses spread out all over the country and filled with local cultural influences, hence bringing a brand new experience to tourists. The high number of detailed reviews by other tourists also give greater and more accurate insight to consumers, making Airbnb not just convenient, but also highly reliable.

¹³ Flexible pricing used by Uber and Grabcar increases the availability of vehicles during peak hours and offer simpler fare structures, as compared to complicated surcharge systems by taxi companies, thus appealing consumers.

¹⁴ In less than two years, 2,000 owners have signed up for Rent Tycoon, a site directly matching users with individuals wanting to rent out their cars. Airbnb also witnesses increasing popularity and consumer base.

¹⁵ "Singapore's sharing economy is on the rise." TODAYonline. August 11, 2014. Accessed March 27, 2017. <http://www.todayonline.com/business/singapores-sharing-economy-rise>.

¹⁶ "PwC Says Traditional Rental Sectors are in BIG Trouble!" Accessed March 30, 2017. <http://www.phlatbed.com/blogs/?p=136>.

¹⁷ Ang, Audrey. "Disruption in Singapore: Is your industry next?" E27. August 24, 2016. Accessed March 30, 2017. <https://e27.co/disruption-singapore-industry-next-20160824/>.

Transcab¹⁸ could be losing S\$3 million a month to Uber and Grabcar. Traditional retail is increasingly threatened by the popularity of e-commerce (figure 6) (figure 7).

Increasing unpredictability from the rapidly evolving technology scene can further erode competitive advantages overnight. Even when businesses evolve, innovations can be disrupted as well²¹, making adaptation difficult.

With competitors armed with strong technology, traditional industries and businesses approach sunset.

b) Disruptive technology hits Workers and Employment

When businesses are hit, workers are sacrificed. MOM's recent report²² showed that 9510 workers were retrenched,



Figure 6: Infographic depicting rise of e-commerce and increasing consumer taste and preference towards convenient online shopping¹⁹

Retail Sales Index¹

	Total		Total (excluding motor vehicles)	
	Month-on-Month ²	Year-on-Year	Month-on-Month ²	Year-on-Year
	↑ 1.7%	↓ 3.2%	↓ 1.1%	↓ 9.6%
% Change in Retail Sales				
	Month-on-Month ²	Year-on-Year		
Department Stores	↓ 1.8	↓ 10.5		
Supermarkets	↑ 2.7	↓ 7.1		
Mini-marts & Convenience Stores	↓ 3.2	↑ 0.8		
Food & Beverages	↑ 0.9	↓ 34.7		
Motor Vehicles	↑ 15.0	↑ 51.3		
Petrol Service Stations	↓ 7.4	↓ 7.6		
Medical Goods & Toiletries	↑ 2.7	↑ 4.1		
Wearing Apparel & Footwear	↑ 5.2	↓ 12.7		
Furniture & Household Equipment	↓ 5.9	↓ 13.5		
Recreational Goods	↓ 3.1	↓ 4.8		
Watches & Jewellery	↓ 1.2	↓ 12.4		
Telecommunications Apparatus & Computers	↑ 4.6	↓ 16.6		
Optical Goods & Books	↓ 5.7	↓ 5.9		

Figure 7: Table indicating a fall in revenue in most retail sales in 2016²⁰

¹⁸ This is the second largest taxi operator in Singapore. A recent Straits Times article had reported that about 800 Trans-Cab taxis were left idling in a yard at Sungei Kadut, instead of plying the roads, a sign of the problems taxi operators face in the new age.

¹⁹ Poh, Joanne. "Why retail shopping in Singapore is in real trouble." AsiaOne. April 14, 2017. Accessed April 30, 2017. <http://news.asiaone.com/news/business/why-retail-shopping-singapore-real-trouble>.

²⁰ Williams, Ann. "Singapore retail sales disappoint with 3.2% drop in February." The Straits Times. April 15, 2016. Accessed April 10, 2017. <http://www.straitstimes.com/business/economy/singapore-retail-sales-fall-32-in-february>.

²¹ For instance, driverless cars can disrupt Uber. Prime Minister Lee Hsien Loong in the National Day Rally Speech mentioned this phenomenon, where he highlighted the constant changing economic environment and the problems this has posed for businesses. "Everywhere where there's Uber and Grab - or in China, Didi Kuaidi and in other cities, different names - they are disrupting the taxi industry," he said. "Disrupting, but commuters are benefiting: Better service, more responsive, faster - but taxi companies and drivers find their business affected. I think we all know that we cannot stop progress. Even Uber and Grab are going to be disrupted!"

²² The overall unemployment rate rose from 1.9 per cent in March to 2.1 per cent in June. Among citizens, unemployment rose from 2.6 per cent to 3.1 per cent and rose from 2.7 per cent to 3 per cent among residents. Economists and Members of Parliament explained that several factors were at play, including predominantly older workers displaced by disruptive technology who are reluctant to accept jobs that pay lower wages, or who are not equipped with the skills to cope with new technology. MOM's report on the job situation in the third quarter also showed a drop in the total number of people employed, and the number of layoffs for the first nine months of this year rose to the highest since the 2009 global financial crisis. Jobseekers continued to outnumber the vacancies available for the second quarter in a row, figures showed. (Source: Today and MOM)

the highest since 2009²³. In Singapore's manufacturing industry alone, 22,400 fewer workers were employed in 2016²⁴.

The rise of automation – one of the key components of disruptive technology – has replaced jobs of low-skilled labourers²⁵, as witnessed in America (figure 8) and potentially in Singapore. Retrenchment is especially harmful as these labourers earn low incomes and lack skills for better jobs, thus are trapped in unemployment.

Even for those employed, the decreasing demand for their labour stagnates their income, while high-skilled income rises, increasing income inequality²⁶.

The rest are not spared. For self-employed individuals, such as taxi drivers, the entry of strong competitors²⁷ decreases their customers and income²⁸. Having to operate at higher costs, with new businesses bypassing rental fees and operational costs²⁹, further reduces their revenue. AI³⁰ can also replace lawyers, accountants and doctors³¹,

threatening traditionally stable professions.

However, the worst effects are on the PMETs³² (figure 9) belonging to the middle-class. The scaling down of businesses in sunset industries³³ and entry of disruptive technology³⁴ decreases demand for their labour, causing retrenchment. While high-tech sunrise industries³⁵ create jobs, they require skills most PMETs lack. Hence, those retrenched fail to obtain jobs or are forced to take up poorer jobs³⁶, increasing structural unemployment.

²³ "Unemployment in Singapore rises, more workers made redundant in Q2." Channel NewsAsia. September 15, 2016. Accessed April 10, 2017. <http://www.channelnewsasia.com/news/business/unemployment-in-singapore-rises-more-workers-made-redundant-in/3128434.html>.

²⁴ Chuan, Toh Yong. "Local workers, note where the job compass is pointing." The Straits Times. January 29, 2016. Accessed April 10, 2017. <http://www.straitstimes.com/singapore/manpower/local-workers-note-where-the-job-compass-is-pointing>.

²⁵ Printing prototypes for Ford now takes under a week and only a few thousand dollars with barely any labour required, as compared to the past where workers are needed to manually produce prototypes. 3D printing can reduce production processes to 3-4 steps. Automation simplifies production and replaces the processes traditionally labour-intensive, hence, reduces demand for labour.

²⁶ With the entry of disruptive technology, individuals with skills equipped to fill the gaps of researchers, innovators are priced, driving up the demand for their labour. For these individuals, they may witness rising or at least high income. However, for low-skilled labour, the decrease in demand for their labour, due to decreasing demand in the industry and automaton, is likely to further stagnate or worse, decrease their income. The rise of disruptive technology is hence, likely to further increase Singapore's income inequality.

²⁷ Uber, Grabcar or any other private-hire transport services

²⁸ Several taxi drivers working for the traditional operators to said that their earnings have dropped by at least 20 per cent since the apps came onto the scene. Comfort maxi cab driver Mr Henry Tay, 45, who has been driving a taxi for eight years, noted that the customer typically pay lower fares for taking Uber or GrabCar. (Source: Channel News Asia)

²⁹ Uber and Grab operate with lesser restrictions, as they work on a network of independent contractors. For instance, uber drivers need to send their cars for service regularly and pay significantly lower rental of around \$50 a day, instead of the approximate \$150 taxi drivers pay.

³⁰ Artificial Intelligence

³¹ AI can review and create contracts, identify potential fraud and other legal misconducts or do legal research for lawyers. For accountants, AI takes over sifting and sorting of data and other mathematical calculations. Similarly for doctors, rapid growth in medical technology can replace certain jobs of doctors in the future.

³² Professionals, Managers, Executives, Technicians

³³ These industries are typically the industries that employ the most PMETs, such as the traditional banking industry that has been increasingly threatened by Fintech.

³⁴ Artificial Intelligence can increasingly replace of jobs of PMETs, making them redundant. In the finance industry, the rise of AI can completely replace the job of a professional, completing all logistics and documentation at a high speed.

³⁵ Examples include Medtech, Fintech, Robotics etc

³⁶ Only a rough 40 per cents of PMETs are fortunate enough to get back into a job that is similar in grade and salary while 60 per cent have to reinvent themselves or do something totally different.

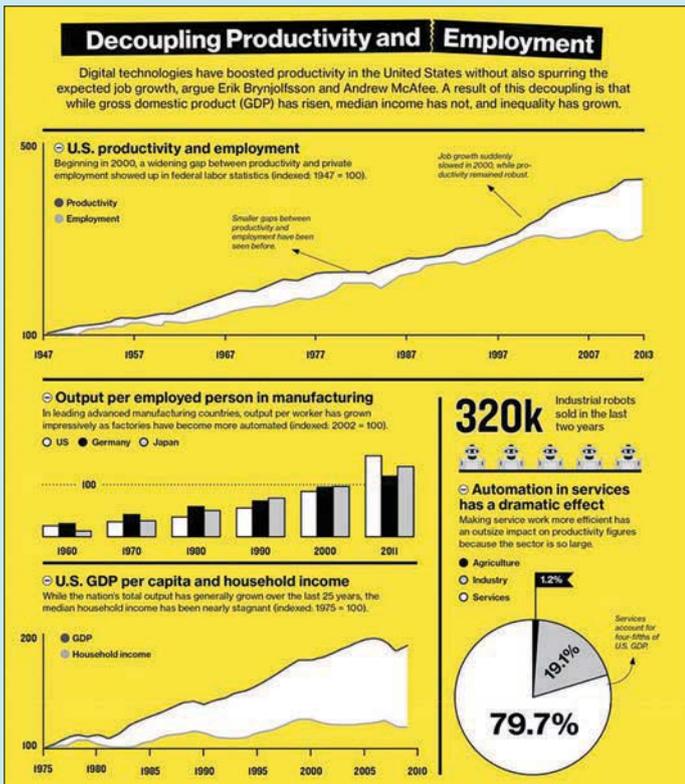


Figure 8: Trends of unemployment caused by automation in US

Even when employed, real income grows slowly³⁷, given decreasing demand. These harms can potentially lead to the “hollowing out”^{38,39} of our middle-class, with worrying consequences⁴⁰.

Ultimately, technology disrupts careers and leaves many vulnerable to unemployment.

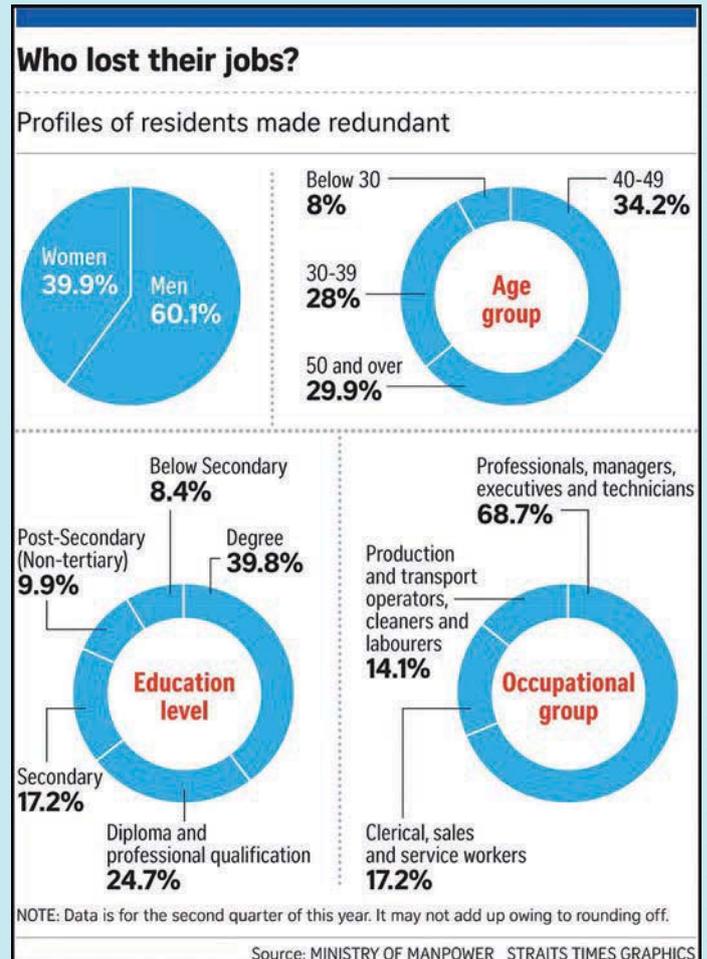


Figure 9: Infographic depicting job loss for Singaporeans because of technology, particularly hitting labourers and PMETs

³⁷ Middle-class citizens saw the slowest rise in their monthly real incomes, compared with households at the top and bottom, going by the latest official figures. Wages for households in the middle 60 per cent of income earners here rose an average of less than 5 per cent last year from 2013, after adjusting for inflation, compared to a 5.9 per cent average gain in real wages for the bottom 20 per cent of households, and a 6.2 per cent average rise in incomes for the top 20 per cent, according to the Department of Statistics' latest annual Key Household Income Trends survey. (Source: Straits Times)

³⁸ This refers to a phenomenon where the middle class increasingly see their incomes being squeezed by the loss of jobs and shrinking sectors, yet their income is not low enough to qualify for a huge portion of state benefits while they bear the brunt in any increase in taxes or cost of living. This is a common phenomenon in OECD economies, and with the rise of disruptive technology, will be a growing concern for Singapore, as middle-class citizens employed as PMETs witness job loss.

³⁹ Liang, Lim Yan. "Middle-income families feeling salary squeeze." The Straits Times. February 22, 2015. Accessed March 01, 2017. <http://www.straitstimes.com/singapore/middle-income-families-feeling-salary-squeeze>.

⁴⁰ See Appendix A

Opportunities in the New Age

Potential Gains of Disruptive Technology

“We in Singapore believe in hard work. We believe that we must adjust ourselves to changing situations. We believe in seizing economic opportunities and not let them go past us. Finally, we believe in self-reliance..... These are human qualities that have helped to transform an island-swamp into a thriving metropolis. They are the traditional virtues of Singaporeans and so long

as we retain these virtues, we can face the future with confidence”

Dr Goh Keng Swee

However, short-term losses are not entirely harmful. As Dr Goh says, as long as Singapore seizes opportunities and remains resilient, endless opportunities lie in the future.

a) New age, new jobs, new industries

While disruptive technology shuts down industries, it similarly opens new industries, as history has shown⁴¹. New industries create new jobs and

with retraining, technology makes every job a better job, every career a better career⁴².

Locally, the emergence of Fintech⁴³, Medtech⁴⁴ and Artificial Intelligence⁴⁵ generated many jobs in knowledge-based sectors⁴⁶. While traditional jobs were lost, about 15,000^{47 48} knowledge-based and technology jobs were created.

While these jobs require new skills, they provide higher wages⁴⁹ and more room for skills upgrading⁵⁰. Jobs displaced are often “muscle jobs⁵¹” low-skilled and inefficient. This has been witnessed in America

⁴¹ Motor industry developed only when old inefficient sectors of transport industry were shut down.

⁴² This is quoted from Mr Lim Swee Say’s speech on the impacts of disruptive technology in Singapore.

⁴³ Financial technology (Fintech) refers to an industry composed of companies that use new technology and innovation with available resources in order to compete in the marketplace of traditional financial institutions and intermediaries in the delivery of financial services, such as digital payment methods. MAS intends to move towards building a Smart Financial Centre.

⁴⁴ Medical technology (Medtech) refers to development in technology in the medical sector, such as the development of high technology medical equipment, surgery processes, stem cells research and other medical related R&D that disrupts current existing medical processes. This includes Immunotherapies, Liquid Biopsy etc. Specific to Singapore, 30 global medical technology companies, as well as local start-ups, now carry out R&D in areas such as technology and product development locally. In 2015, Singapore’s medical technology sector contributed about S\$10 billion in output and about 16,000 jobs across manufacturing, R&D and HQ functions. The sector continues to grow rapidly, employing more people with higher productivity. (Source: EDB)

⁴⁵ Artificial Intelligence is one of the main forms of disruptive technology, directly taking over manufacturing and production by storm, threatening the jobs of low-skilled labour. The global robotics industry is projected to grow from US\$20 billion today to US\$80 billion by 2025, on the back of deployment of such advanced robotics in industrial applications, and the potential for deployment in services sectors, creating new jobs in the robotics sector. (Source: EDB)

⁴⁶ Singapore’s medical technology manufacturing sector employs more than 12,000 workers in high-value and complex roles, and this number is set to grow with more than 20,000 science and engineering graduates entering the workforce from Singapore’s tertiary institutions each year. Similarly, there are more than 1,000 professionals employed in the new space industry, and this is expected to grow by 300 professionals over the next five years. Similarly, the growth in tourism related industries create new jobs that require simple skills retraining for Singaporeans. (Source: EDB)

⁴⁷ Hui, Calvin. “More tech professionals needed in Singapore: IDA.” Channel NewsAsia. December 30, 2015. Accessed April 01, 2017. <http://www.channelnewsasia.com/news/singapore/more-tech-professionals/2387798.html>.

⁴⁸ A new industry transformation map to develop Singapore into the leading food and nutrition hub in Asia was launched and it aims to create about 2,000 new jobs for professionals, managers, executives and technicians (PMETs) for the sector from now till 2020. These jobs lie in new additions to the sector, such as Food Innovation Cluster which aim to encourage the development and commercialisation of new products and the establishment of shared R&D and production facilities. (Source: Channels New Asia)

⁴⁹ In Singapore, while unemployment increased, the median income rose from \$3,566 in 2014 to \$3,798 in 2015, a 7 per cent increase in real terms. Ministry of Trade and Industry says “ If Singapore succeeds in restructuring its manufacturing sector, both companies and workers will benefit” (Source: MOM, MTI)

⁵⁰ Jobs created are focused on creating a knowledge-based economy, which hence means jobs created are higher skilled, white collar jobs with higher pay, given the higher requirements placed on workers in a knowledge-based economy. There is more room for skills improvement as such jobs often do not have a limit to productivity nor do they degenerate with age, as opposed to muscle jobs (limit on physical strength, speed etc).

⁵¹ This refers to jobs that are largely repetitive, labour intensive and low skilled, such as factory production. These are also the jobs most affected by automation and other disruptive technology.

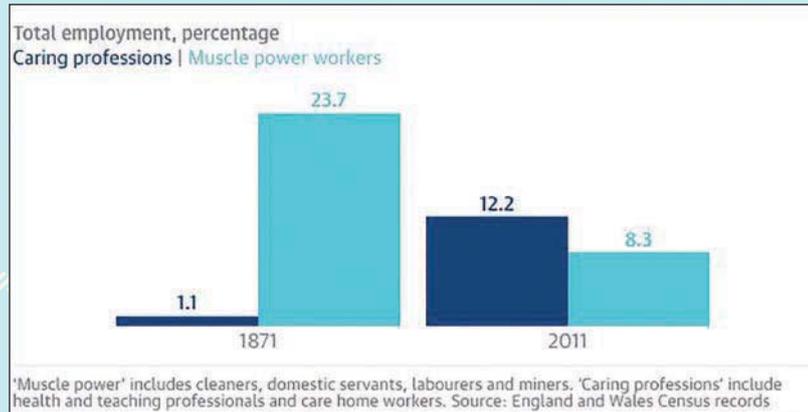


Figure 10: Decline in muscle labourers in US due to technology; jobs transferred to new sectors⁵²

(figure 10) and will likely occur in Singapore, technology makes jobs *better jobs*.

Industry wise, disruptive technology has popularised start-ups and knowledge-based industries. Technology squeezes out inefficient old industries and usher in better ones. The transformation of BLK71⁵³ from an old unproductive industrial estate facing demolition, to a thriving technology cluster with more efficient products⁵⁴ (figure 11) illustrates this. These industries are highly productive and provide valuable opportunities for workers.



Figure 11: BLK71 at a glance, showing the sheer number of start-ups, venture capitalists and events

Furthermore, the rise of the gig economy has lowered barriers to entry⁵⁵ for jobs, providing rising (figure 12) income⁵⁶ for more Singaporeans, thus cushioning the impacts of unemployment.

Therefore, technology also makes careers better careers.



Figure 12: Uber drivers witness a rising income per hour from \$18.87/h in 2014 to \$26.08 in 2016.

⁵² Allen, Katie. "Technology has created more jobs than it has destroyed, says 140 years of data." The Guardian. August 18, 2015. Accessed March 01, 2017. <https://www.theguardian.com/business/2015/aug/17/technology-created-more-jobs-than-destroyed-140-years-data-census>.

⁵³ BLK71 in Ayer Rajah was one of the oldest industrial estates in Singapore and by 2010, was slated for demolition for re-development. In 2011, it was turned into a technology start-up, pulling together scattered startups to one common location for increased synergy and economies of scale. It currently continues to grow at an unprecedented pace and has the potential to be the *Silicon Valley* of Singapore.

⁵⁴ T.Ware was produced by a start-up in BLK71, which develops a wearable technology that provides deep pressure to calm autistic children.

⁵⁵ Any individual can become a "producer" by selling their goods and services. This is compare to the past where people needed an established firm to trade goods and earn an income. This gives low-income entrepreneurs, who would otherwise be priced out of the market through costly occupational licenses the opportunity to flourish in a market.

⁵⁶ Airbnb says hosts in San Francisco who rent out their homes do so for an average of 58 nights a year, making \$9,300. Car owners who rent their vehicles to others using RelayRides make an average of \$250 a month; some make more than \$1,000. Uber drivers similarly see a rising income, seen in figure 11.

b) Better manufacturing, better products

Secondly, technology allows for production of previously unconceivable products, increasing quality, convenience and variety of goods for consumers. Internet of Things⁵⁷, Uber⁵⁸ and Rotimatics⁵⁹, which simplifies and quickens the whole process of roti making, illustrate this. Furthermore, production using advanced technology increases productivity at lower costs⁶⁰ (figure 13), which culminates in lower consumer prices.

Better products are also important for the public sector. Drones allow for safer and more efficient fire-fighting⁶¹. Robots can operate on patients

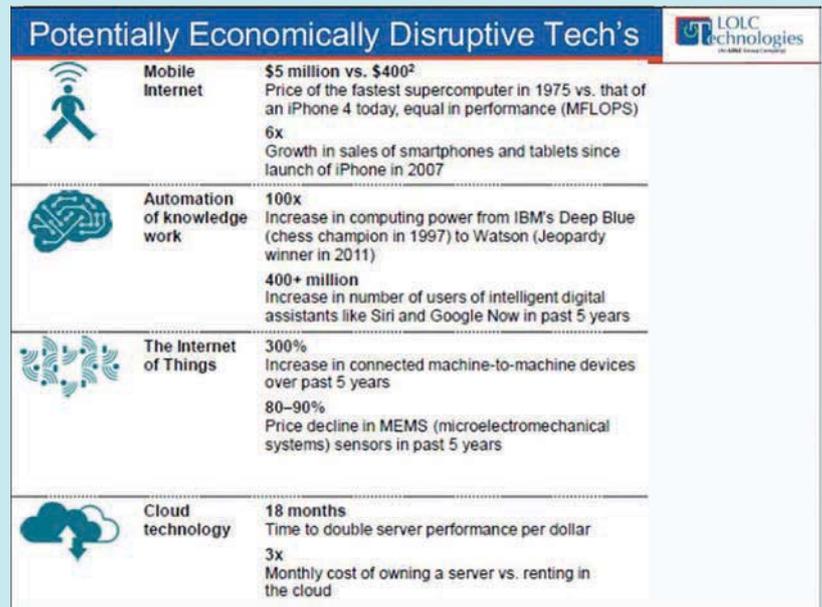


Figure 13: Disruptive technology can reduce costs of production, while increasing efficiency in production (Source: LOLC Technologies)

less invasively, lowering risks (figure 14). 3D printing aids the disabled⁶² and space exploration⁶³.

Hence, the entry of technology produces new innovative products, increasing Singapore's standard of living.

⁵⁷ Internet of Things (IoT) refers to the new concept of connecting all devices to the internet. The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.

⁵⁸ Uber operates with dynamic pricing, allowing for a far greater supply of drivers available to cater to consumer demands and less complicated pricing allowing for a simple consumer experience. The ability to track exact location of drivers, contact the driver and other mechanisms not present in taxis further enhances the consumer experience.

⁵⁹ Artificial intelligence produced in BLK71, the machine can make up to 20 cooked roti in under 30 minutes, using only whole wheat flour, oil and water. Users can also the thickness of the roti, roast level, amount of oil and number of roti required, simply pressing a button to start the process. Nearly 8500 were sold out in a few days after its launch. The machine can even be wifi operated. This serves as a success story of BLK71 and was specially mentioned by PM Lee in the National Day Rally. (Source: Straits Times, Rotimatics Website)

⁶⁰ A survey conducted among 3000 SMEs found that businesses who relied more on cloud solutions, a new technology, saw higher revenue growth, lower costs and more than twice as much profits as those who used fewer cloud services. Another example is seen in China. Self-charging robots used in China delivery services can sort up to 200,000 packages a day, and are self-charging, making them operational 24/7. The company estimates its robotic sorting system saves around 70% of the costs a human-based sorting line would require.

⁶¹ Singapore Civil Defence Force has announced the development of drone technology, to be employed in fire-fighting. The use of drones, or unmanned aerial vehicles (UAVs), is being developed for use in major operations. They will complement other unmanned and electric vehicles. Together with other new technology, fire can be detected extremely quickly and fought in safer, faster methods. (Source: The New Paper)

⁶² 3D printing brings art to life for the blind, allowing for the blind to "feel" famous art pieces. 3D printing can also print science models to educate blind students in disability schools, allowing them to learn objects they are unable to see visually.

⁶³ Home-grown start-up Gilmour Space Technologies successfully launched a self-made rocket in Australia in 2016, being the first in the world to use 3D printed fuel from combining two materials, which drastically decreases the cost of space exploration and rocket launches. (Source: Spring Singapore)

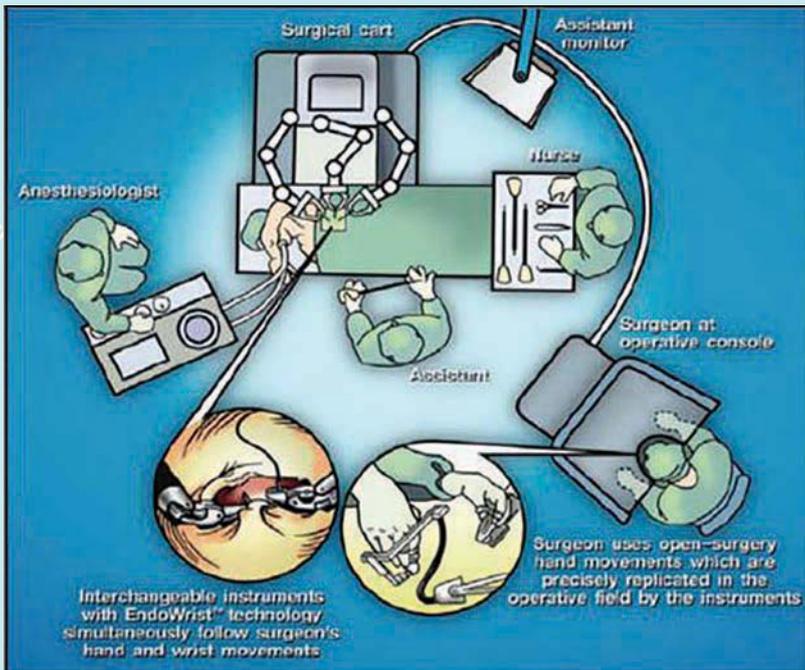


Figure 14: Robot-assisted laparoscopic surgery (Da Vinci robotic surgery), a minimally invasive surgical technique for complex urological surgery used in Singapore⁶⁴

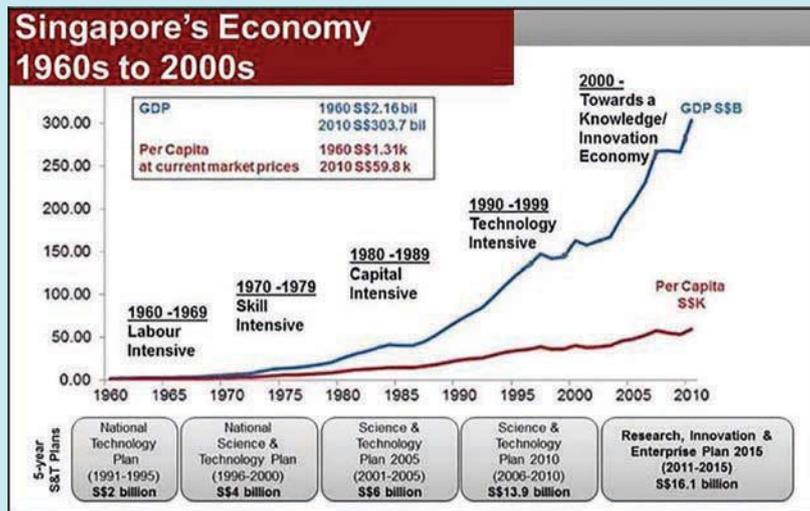


Figure 15: Restructuring of Singapore's economy from a labour intensive one to an innovative one to adapt to the world's changing demands

c) A better economy: A more competitive Singapore

“Madam, technology is the main driving force of future growth, globally. We can either use it to our advantage or allow our competitors to use it to our disadvantage. The choice is clear.”

Mr Lim Swee Say

On a macro level, seizing technology can increase Singapore's competitiveness. Increasing isolationism⁶⁵ in the world has led to world trade weakening⁶⁶, negatively affecting trade-dependent Singapore⁶⁷. Rising technology expertise in other countries and Singapore's lack of natural resources has made retaining comparative advantages⁶⁸ in niche sectors harder. To solve this, learning from our past successful changes (figure 15), it is time to shift towards value-creation.

⁶⁴ “Da Vinci Robotic Laparoscopic Surgery - minimally invasive surgery for urology procedure.” Accessed March 01, 2017. <https://www.singhealth.com.sg/PatientCare/ConditionsAndTreatments/Pages/Minimally-Invasive-Surgery-Urology-robotic-surgery.aspx>.

⁶⁵ Countries are slowly turning isolationist and protectionist. This is evident in US and its backing out from the TPP and in China, which is increasingly more cautious of trade partnerships. The impact of Brexit and wave of populism across Europe can also have significant impacts on turning European countries more isolationist than ever.

⁶⁶ Chinese industry is becoming less increasingly reliant on imported components for its exports. The cancellation of Trans-Pacific Partnership further enforces the weakening demand for Singapore commodity exports.

⁶⁷ Singapore is the most trade-dependent and Singapore's external trade is three times the size of its GDP.

⁶⁸ In the highly globalised world, comparative advantages can get lost quickly, since countries constantly employ new technology to produce goods at a lower opportunity costs. This is worsened as Singapore's lack of resources and a cheap labour force means we can never produce commodities at as low prices as other countries such as China. Furthermore, the flow of capital and investments into emerging economies have led to rapid existing technology and skills transfer into other countries and Singapore can no longer depend on producing our current value-adding exports to develop economically.

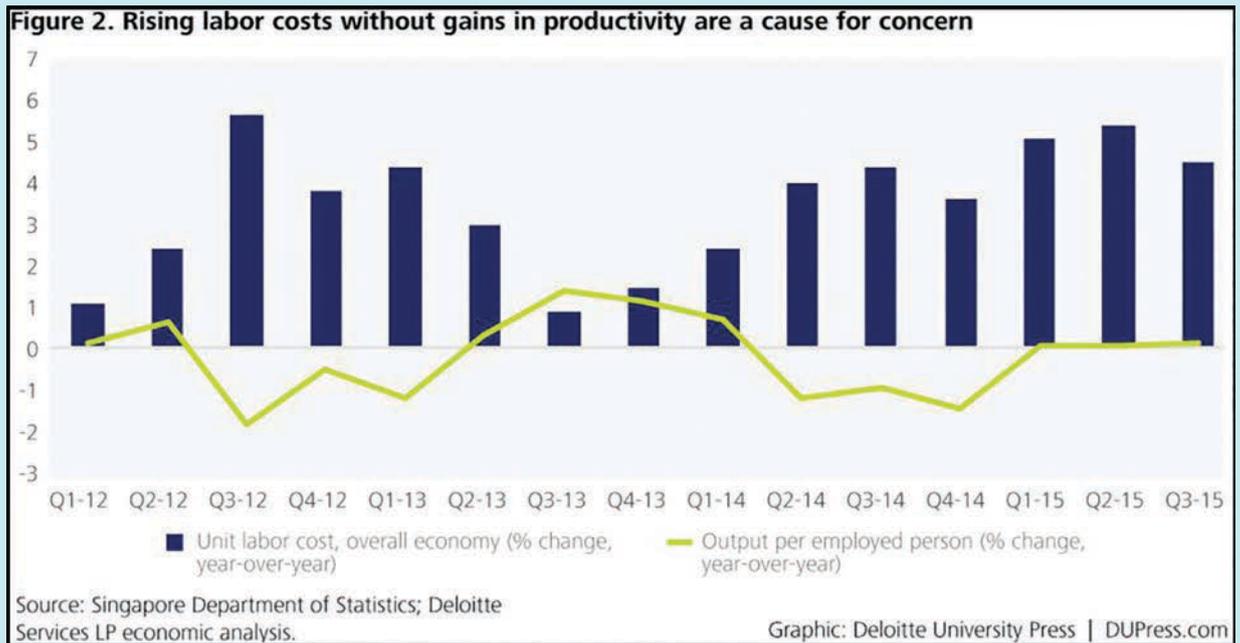


Figure 16: Rising labour costs without gains in productivity seen in recent years in Singapore

Should we seize and develop new technologies, we can revolutionise our exports and increase competitiveness by becoming an innovation-led value-creating⁶⁹ economy.

Value-creation means we create new ideas and products using technology. Innovations like Rotomatics, advanced

medical equipment and self-driving cars⁷⁰ grants us a first-mover's advantage⁷¹ in new industries. With successful movement to value-creation, we can lead in producing unique goods and services, increasing export competitiveness.

Furthermore, a knowledgeable workforce well-

equipped⁷² with new technology attracts MNEs⁷³ and emerging companies to Singapore, providing valuable jobs and skills transfer opportunities. Moreover, advanced technology resolves the problem of rising labour cost and stagnant productivity (figure 16) as technology creates

⁶⁹ We have been a value-adding economy for the past years, by producing goods part of the supply chain. Value-creating economy means rather than focusing on producing goods in the value chain, Singapore needs to move towards innovation, new ideas and piloting new products unseen in the global world using new technology. This makes having a high-skilled workforce necessary. If successful, it can make our exports extremely competitive and turn Singapore into a technological hub.

⁷⁰ Singapore launched the world's first self-driving taxi, collaboration between nuTonomy and Grab.

⁷¹ *First mover's advantage* refers to when Singapore becomes the first entrant in value-creating technological goods, thus granting Singapore a competitive advantage and a monopoly-like status as a leader in value-creation.

⁷² This is already slowly observed. 126,000 Singaporeans picked up new skills in 2016 as a result of the S\$500 credit provided by the SkillsFuture. The high employment in Medtech and Fintech industries, especially in MNEs subsidiaries also illustrate the growing skills and attractiveness of our workforce.

⁷³ As of now, more than 30 of the world's leading biomedical sciences companies (including GlaxoSmithKline, Novartis and Takeda) are leveraging Singapore as a key home base to drive innovation, growing the nation's biotechnology and pharmaceutical industry by more than 30% in 2011. (Source: EDB)

efficient production methods, increasing productivity⁷⁴ and lowering unit labour cost⁷⁵, further attracting firms.

Ultimately, the rise of disruptive technology is inevitable. As Mr Lim says, it is either we use it or we lose it to competitors and the choice is clear for Singapore.

Dealing with the New Age

The Four Keys to Success with Technology for Singapore

“In the end, the location of the new economy is not in the technology... it is in the human mind.”

Alan M. Webber

While potential impacts can be discussed, ultimately, our future

does not lie fully in technology, but in how Singapore copes with it. I propose that four keys⁷⁶ unlock the door to success and a better Singapore.

1. Better Protection
2. Better Workforce
3. Better Economy, Better Jobs
4. Better Laws

a) Better Protection

The first key: protecting the vulnerable.

Existing wage credits schemes⁷⁷ can be enhanced to prevent high retrenchment of workers. The government can co-pay a percentage of wages if the company continues employing these workers⁷⁸ and train⁷⁹ them with skills to handle automation. To

complement this, existing workfare income supplement⁸⁰ schemes can be expanded⁸¹. For the retrenched, unemployment help and retraining should be provided. Singapore has thrived with minimal unemployment welfare due to consistently low unemployment⁸². However, structural unemployment is likely to peak with economic restructuring, hence short-term pensions should be considered. These benefits can be conditional on workers actively seeking jobs or undergoing skills upgrading. Through collaboration with companies, workers can be employed while on-job training will be provided for workers to adapt, protecting the retrenched.

⁷⁴ Automation increases speed and ease of production, thus, when complemented with workers, it allows for higher productivity per worker, while decreasing cost of production.

⁷⁵ Disruptive technology maximizes our productive capacity, as it can bring new, more efficient production methods. This prevents Singapore from being caught in a development bottleneck while allowing for Unit Labour Cost to decrease with the increase in quality of our workforce.

⁷⁶ This analogy is adapted from Mr Lim Swee Say's speech, where he states "This will not be easy, because to open a door to a future of good jobs and better careers for all our people, we must have four keys in hand.". The four keys refer to better job creation, more adaptable workforce, inclusiveness and a fair, progressive workplace.

⁷⁷ As of now, over the period of 2016 to 2017, the Government will co-fund 20% (instead of 40%) of wage increases given to Singaporean employees earning a gross monthly wage of \$4,000 and below.

⁷⁸ A maximum retrenchment count can be enforced. Should companies retrench beyond a fixed number of workers, wage credits and subsidies will not be offered.

⁷⁹ Beyond the need to meet government requirements, a natural incentive is provided for firms to enhance skills training to maximise the value of workers especially given that they are forced to continue employing them to receive government subsidies.

⁸⁰ WIS is paid out in cash and CPF up to 4 times a year for employees earning lower income. Self-employed persons are paid annually to complement their existing income for low income individuals.

⁸¹ A possible extension is to give more frequent payouts to self-employed persons, as many self-employed individuals, such as those in retail, taxi drivers etc are heavily hit by the rise of the sharing economy and e-commerce. Hence, measures must be adapted accordingly to provide for them.

⁸² Singapore's unemployment rate averages around 2%, as a result of consistent growth rates.

b) Better Workforce

Second key: Better Workforce.

Skills upgrading is necessary to maximise our labour force potential. MOM's existing Adapt and Grow⁸³ initiative and SkillsFuture (figure 17) can be expanded. Focus should be on promoting technological skills and familiarising Singaporeans with new technologies (ie. Internet of Things, Artificial Intelligence). Programmes should be revised constantly, ensuring that skills remain relevant as technologies develop.

Enhancing existing incentives to participating companies for these programmes can increase participation. To incentivise workers, wage credits conditional on skills upgrading can be increased. These enhance the adaptability of our workforce, minimising structural unemployment.

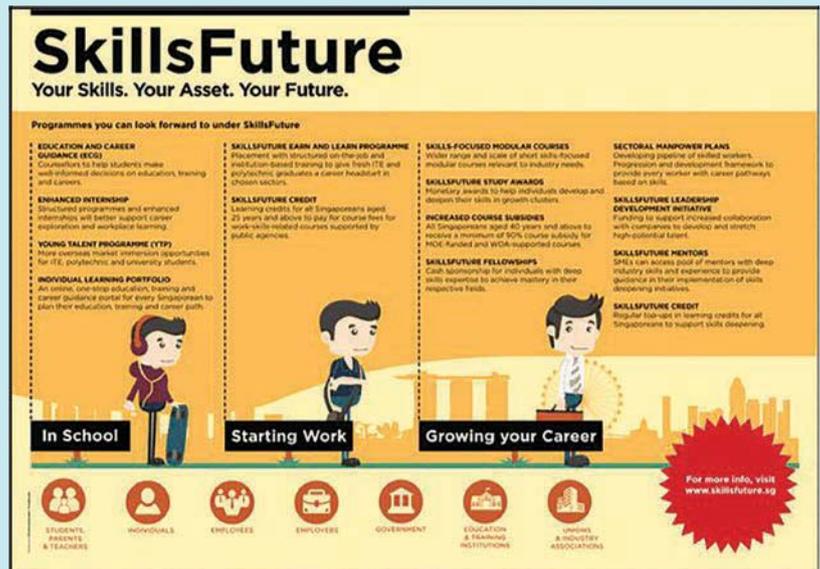


Figure 17: SkillsFuture programme aimed at helping Singaporeans acquire skills relevant to demands in the economy

c) Better Economy, Better Jobs

Third key: Successful restructuring to a value-creating economy that encourages innovation and risk-taking, creating better jobs for all.

Firstly, start-ups and new initiatives should be encouraged. Seed funds can

be provided to start-ups with potential while SMEs can be subsidised for investments in new technology. Competitions and events should be held to discover innovative ideas, where winners are awarded grants or attachments to well-established technological companies to develop their initiatives⁸⁴. More technological zones⁸⁵ should be created to concentrate start-ups, reaping economies of scale and cultivating synergy. The government can assist and encourage SMEs engaging in joint ventures with advanced MNEs⁸⁶. Through collaboration, SMEs gain access to mentors, networks and resources, which enable them

⁸³ Includes three schemes: Career Support Programme (CSP) introduced in October 2015, Professional Conversion Programme (PCP) and P-Max. CSP encourages employers to hire mature long-term unemployed Singapore Citizen PMETs into mid-level PMET jobs. PCP help PMET job seekers re-skill themselves to take on new jobs in different sectors or different job scopes. Individuals are employed by companies and go through a period of structured training, to acquire the skills required for the new job. Under P-Max, SMEs will benefit from a one-time \$5,000 grant if they successfully implement the recommended HR processes and retain PMETs hired under the programme for at least six months. (Source: MOM)

⁸⁴ Rotimatics was a product of the Start-Up@Singapore Business Plan Competition, where the founders won the top prize of \$40,000 in 2009, giving them the opportunity to start working on their idea.

⁸⁵ Similar to BLK71

⁸⁶ Relevant Ministries can act as the connection between SMEs and MNEs, giving small firms access to mentors, networks and financing within MNEs. Joint projects between the government, SMEs and well-experienced MNEs can also be piloted, giving small firms an opportunity to learn from bigger companies.

to scale-up, internationalise and engage new technology.

Furthering this, increased training in STEM industries should start early. More innovation should be encouraged in schools via innovation programmes, competitions, attachments and disruptive technology⁸⁷ modules to encourage interest in students. Internships to start-up companies in emerging industries can be encouraged for students to gain first-hand experience.

Together, these bring Singapore closer to value-creation and generate better jobs.

d) Better Laws

Lastly, embracing technology does not mean they are left without control. Technology such as drones and self-driving cars should be

subject to regularly revised legal regulations⁸⁸ to prevent unwanted externalities⁸⁹, such as creating no-drone-areas and clear penalties for accidents involving self-driving cars.

Possible dangers arising from lack of accountability in the gig economy should also be mitigated to prevent fraud or scams, such as through stringent limits on purchase and background checks. This can be complemented with mandatory licensing for e-commerce and the shared economy.

Protection of workers should be enforced too. Proper labour regulations must be strictly enforced for new industries⁹⁰, through mandating firms, like Uber, to provide insurance, CPF and additional labour rights⁹¹.

With better laws, we master technology.

Conclusion: Masters of the New Age

Even after proposing possible keys to success, the rapid technological developments mean we can never *know* what to expect. While we can estimate potential costs and benefits of disruptive technology, the overall impact is still yet to be seen.

The loss of jobs for workers and the sunset for traditional industries is likely in the short-run. However, we must not lose sight of the potential benefits these changes can bring to Singapore. In the long-run, a successful transformation of our economy into a value-creating one may bring a second economic miracle. We may see better jobs, better products and better lives. How do we strike a balance?

⁸⁷ Additional modules on new technology can be done in courses include engineering, technology, biomedical science, finance courses and any other discipline relevant to emerging industries. This is done through including new technology in teaching, such as operation of drones, 3D printers and surgery robots etc, or by educating students on the impact and potential of disruptive technology.

⁸⁸ This can include the creation of no-drone areas, the banning of drones for spying and other illegal uses. Self-driving cars should also be regulated, laws concerning liability and penalties must be set clearly for unexpected situations such as car accidents, illegal driving etc. Legal regulations need to be constantly updated as technology develops at an extremely rapid pace, thus new technologies have to be regulated fast and loopholes in the regulations need to be filled fast. Possible methods to do this can be via setting up a committee with members from both the Law and technology sector, specially to revise regulations for new technologies, so as to ensure flexibility and adaptability of regulation.

⁸⁹ Possible dangers can be illegal actions by users of new technology, such as scamming cases through new financial transaction methods, the use of drones to spy, self-driving cars being a danger on the road et cetera. Ambiguous areas also need to be dealt with, such as the concerns of privacy with the use of drones, the areas where drones can be used without it being considered an intrusion to a shared community, level of taxes for automation, exploitation and unsustainable use of shared resources in the gig economy (ie. Tragedy of the Commons) et cetera.

⁹⁰ This includes Uber drivers, e-commerce workers and other relevant new industries that are currently not covered heavily as official workers under traditional labour laws.

⁹¹ Protections such as company provided health insurance, work hours regulations and existing wage schemes can be expanded to cover workers in these new economic sectors. Grab has already led in the industry in providing CPF boost for GrabCar drivers under the GrabCar Medisave Programme as of March 2017.

Ultimately, our future never lies in technology. It lies in Singapore's adaptability and resilience, in constantly evolving our labour force and ensuring our workers' skills remain relevant. It lies in courage, risk-taking and determination.

Technology can disrupt our economy, but not our success. By embracing the possibilities and moving ahead, we shape the uncertain future into miracles.

We master technology, we master fate.

References

Allen, Katie. "Technology has created more jobs than it has destroyed, says 140 years of data." *The Guardian*. August 18, 2015. Accessed March 01, 2017. <https://www.theguardian.com/business/2015/aug/17/technology-created-more-jobs-than-destroyed-140-years-data-census>.

Ang, Audrey. "Disruption in Singapore: Is your industry next?" *E27*. August 24, 2016. Accessed March 30, 2017. <https://e27.co/disruption-singapore-industry-next-20160824/>.

Auyong, Hawyee. "Coping with technological disruption in the taxi industry." *TODAYonline*. May 2, 2016. Accessed March 21, 2017. <http://www.todayonline.com/singapore/coping-technological-disruption-taxi-industry>.

Chuan, Toh Yong. "Local workers, note where the job compass is pointing." *The Straits Times*. January 29, 2016. Accessed April 10, 2017. <http://www.straitstimes.com/singapore/manpower/local-workers-note-where-the-job-compass-is-pointing>.

Cunico, Kane, and Sarah Yang. "Eight years of stubbornness to give birth to their roti-maker." *Channel NewsAsia*. October 26, 2016. Accessed May 01, 2017. <http://www.channelnewsasia.com/news/singapore/eight-years-of-stubbornness-to-give-birth-to-their-roti-maker/3236100.html>.

Dawson, Freddie. "How Disruptive Is 3D Printing Really?" *Forbes*. September 31, 2014. Accessed April 01, 2017. <https://www.forbes.com/sites/freddieawson/2014/09/30/how-disruptive-is-3d-printing-really/#1913c3694e44>.

Grossman, Rhys. "The Industries That Are Being Disrupted the Most by Digital." *Harvard Business Review*. March 21, 2016. Accessed March 13, 2017. <https://hbr.org/2016/03/the-industries-that-are-being-disrupted-the-most-by-digital>.

Hollinger, Peggy. "A hollowing middle class." *OECD Observer*. Accessed May 01, 2017. http://oecdobserver.org/news/fullstory.php/aid/3660/A_hollowing_middle_class.html.

Hui, Calvin. "More tech professionals needed in Singapore: IDA." *Channel NewsAsia*. December 30, 2015. Accessed April 01, 2017. <http://www.channelnewsasia.com/news/singapore/more-tech-professionals/2387798.html>.

Liang, Lim Yan. "Middle-income families feeling salary squeeze." *The Straits Times*. February 22, 2015. Accessed March 01, 2017. <http://www.straitstimes.com/singapore/middle-income-families-feeling-salary-squeeze>.

Lim, Christopher, and Tamara Nair. "Commentary: How 3D printing could disrupt Asia's manufacturing economies." *Channel NewsAsia*. January 11, 2017. Accessed May 01, 2017. <http://www.channelnewsasia.com/news/asiapacific/commentary-how-3d-printing-could-disrupt-asia-s-manufacturing/3429894.html>.

Lim, Lydia. "Making disruption work for humans." *The Straits Times*. August 6, 2016. Accessed March 06, 2017. <http://www.straitstimes.com/opinion/making-disruption-work-for-humans>.

Lim, Patrick John. "How financial technology will impact Singapore in 2016." *Channel NewsAsia*. December 28, 2015. Accessed May 01, 2017. <http://www.channelnewsasia.com/news/business/singapore/how-financial-technology/2382374.html>.

Lim Wei Lu, Jaime Pang, Poh Lip Hang, Nimisha Tailor. "E-Commerce in Singapore - How it affects the nature of competition and what it means for competition policy". December 2 2015. Accessed March 12 2017.

Mangan, Dan. "Lawyers could be the next profession to be replaced by computers." *CNBC*. February 17, 2017. Accessed April 01, 2017. <http://www.cnbc.com/2017/02/17/lawyers-could-be-replaced-by-artificial-intelligence.html>.

Manyika, James, Michael Chui, Jacques Bughin, Richard Dobbs, Peter Bisson, and Alex Marrs. "Disruptive technologies: Advances that will transform life, business, and the global economy." *McKinsey & Company*. May 2013. Accessed February 10, 2017. <http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/disruptive-technologies>.

Menkhoff, Thomas, Siew Ning Kan, and Eugene Tan. "Drones, AI and getting undergrads ready for great disruption." *The Straits Times*. February 22, 2017. Accessed May 01, 2017. <http://www.straitstimes.com/opinion/drones-ai-and-getting-undergrads-ready-for-great-disruption?xtor=CS3-17>.

Menon, Ravi. "An Economic History of Singapore: 1965-2065" - Keynote Address by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Singapore Economic Review Conference 2015 on 5 August 2015." November 26, 2016. Accessed March 30, 2017. <http://www.singaporeeconomicreview.com>.

www.mas.gov.sg/News-and-Publications/Speeches-and-Monetary-Policy-Statements/Speeches/2015/An-Economic-History-of-Singapore.aspx.

Morgan, Jacob. "A Simple Explanation Of 'The Internet Of Things'" *Forbes*. May 13, 2014. Accessed February 21, 2017. <https://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#486926981d09>.

Poh, Joanne. "Why retail shopping in Singapore is in real trouble." *AsiaOne*. April 14, 2017. Accessed April 30, 2017. <http://news.asiaone.com/news/business/why-retail-shopping-singapore-real-trouble>.

Sim, Royston. "Singapore can do much more when it comes to adopting new technology: PM Lee." *The Straits Times*. February 26, 2017. Accessed March 01, 2017. <http://www.straitstimes.com/singapore/singapore-can-do-much-more-when-it-comes-to-adopting-new-technology-pm-lee>.

Sng, Gabrielle. "This born-in-Singapore robot could soon be your receptionist." *Channel NewsAsia*. June 22, 2016. Accessed March 01, 2017. <http://www.channelnewsasia.com/news/singapore/this-born-in-singapore/2894522.html>.

Soon, Sze Meng. "Preparing Singapore in a disruptive world." *The Straits Times*. August 22, 2016. Accessed March 01, 2017. <http://www.straitstimes.com/opinion/preparing-spore-in-a-disruptive-world>

Sun, David. "SCDF to fight fires from the sky." *The New Paper*. April 18, 2015. Accessed March 28, 2017. <http://www.np.sg/news/singapore/scdf-fight-fires-sky>.

Williams, Ann. "Singapore retail sales disappoint with 3.2% drop in February." *The Straits Times*. April 15, 2016. Accessed April 10, 2017. <http://www.straitstimes.com/business/economy/singapore-retail-sales-fall-32-in-february>

Whang, Rennie. "Rotimatic's hot success story." *The Straits Times*. August 22, 2016. Accessed May 01, 2017. <http://www.straitstimes.com/business/companies-markets/rotimatics-hot-success-story>.

Yong, Melvin. "Companies need to innovate to disrupt tech disruption." *The Business Times*. September 10, 2015. Accessed March 21, 2017. <http://www.business-times.com.sg/companies-markets/companies-need-to-innovate-to-disrupt-tech-disruption>.

"Da Vinci Robotic Laparoscopic Surgery - minimally invasive surgery for urology procedure." Accessed March 01, 2017. <https://www.singhealth.com.sg/PatientCare/ConditionsAndTreatments/Pages/Minimally-Invasive-Surgery-Urology-robotic-surgery.aspx>.

"Emerging Businesses." Singapore Economic Development Board. Accessed March 01, 2017. <https://www.edb.gov.sg/content/edb/en/industries/emerging-businesses/emerging-businesses.html>.

"Factsheet on 'Adapt and Grow' Initiative." Ministry of Manpower. Accessed April 22, 2017.

"Industries - Medical Technology." Singapore Economic Development Board. Accessed March 01, 2017. <https://www.edb.gov.sg/content/edb/en/industries/industries/medtech.html>.

"Industries - Pharmaceuticals and Biotechnology." Singapore Economic Development Board. Accessed April 12, 2017. <https://www.edb.gov.sg/content/edb/en/industries/industries/pharmabiotech.html>.

"PwC Says Traditional Rental Sectors are in BIG Trouble!" Accessed March 30, 2017. <http://www.phlatbed.com/blogs/?p=136>.

"Singapore e-commerce market to exceed S\$7b in 2025: Report." *Channel NewsAsia*. May 24, 2016. Accessed March 20, 2017. <http://www.channelnewsasia.com/news/business/singapore-e-commerce/2811118.html>.

"Singapore's sharing economy is on the rise." *TODAYonline*. August 11, 2014. Accessed March 27, 2017. <http://www.todayonline.com/business/singapores-sharing-economy-rise>.

"The rise of the sharing economy." *The Economist*. March 09, 2013. Accessed May 01, 2017. <http://www.economist.com/news/leaders/21573104-internet-everything-hire-rise-sharing-economy>

"Unemployment in Singapore rises, more workers made redundant in Q2." *Channel NewsAsia*. September 15, 2016. Accessed April 10, 2017. <http://www.channelnewsasia.com/news/business/unemployment-in-singapore-rises-more-workers-made-redundant-in/3128434.html>.

"Unemployment with Artificial Intelligence and Automation." *Investments Lab*. Accessed March 01, 2017. <https://investmentstab.blogspot.sg/2017/01/unemployment-with-artificial.html>

"2,000 PMET jobs to be created with new food manufacturing sector roadmap." *Channel NewsAsia*. November 18, 2016. Accessed May 01, 2017. <http://www.channelnewsasia.com/news/business/2-000-pmet-jobs-to-be-created-with-new-food-manufacturing-sector/3299570.html>.

"3 disruptive tech trends every SME should know." *StarHub*. October 27, 2016. Accessed March 01, 2017. <http://www.starhub.com/business/resources/blog/3-disruptive-tech-trends-every-sme-should-know.html>.

"3D printing taking off in emerging 'space' in Singapore." August 3, 2016. Accessed May 01, 2017. <https://www.spring.gov.sg/NewsEvents/ITN/Pages/3D-printing-taking-off-in-emerging-space-in-Singapore-20160803.aspx>.

Appendix A: “Hollowing Out” the Middle-Class

With the retrenchment of PMETs due to technology, many individuals in the middle-class lose their income and are left unemployed. This, coupled with the rising living costs, has slowly diminished the sense of security typically associated with being middle class. The middle class are left vulnerable in such situations; they are not living below poverty line, thus mostly do not qualify for social benefits, yet they are not sufficiently rich enough to sustain high standards of living when hit with a sudden economic shock (such as retrenchment). The “hollowing out” of the middle class thus, occurs as economic developments leave out the middle-class and squeeze their income. Opportunities, income and jobs for the middle-class slowly disappear in such societies. This has been an increasing trend in developed countries, such as Japan, leading to the creation of a “M-shaped” society, with a squeezed middle income and polarisation of income. In Singapore, this can also mean a further increasing

A huge part of our narrative of success is hinged on the increasing affluence and hard work of the middle-class. Hence, the hollowing out of our middle class will be particularly pernicious, since it will have particularly significant effects on economic outlook, social mobility and social stability, ideals that form the basis of our society.

Gini Coefficient from 0.458 in 2016, indicating worsened income inequality in Singapore. These effects harm our society and economy, as the middle-class is typically seen as the key to maintaining the stability and balance of a society, acting as the “back-bone” of a society.

Economically, the middle class plays a huge role in consumption in an economy. Low-income households have limited ability to consume and save little. High-income households save a lot but consume little, relative to

their incomes. Middle-income households provide an important balance in consumption and savings, thus key to our economic development. Singapore particularly has a large middle class, who plays a huge part in investments and consumption.

Socially, William Esterly, a US Economist, states that middle class income often affects other indicators, such as life expectancy, infant mortality and education. In Singapore, the middle-class aspirations typically consist of good

education, proper housing and job security. The hope that these aspirations bring play a huge part in motivating people to work hard and contribute to the economy, and drives high investment in public goods and infrastructure.

More importantly, in Singapore, middle class aspirations have long been inherent in our economic culture and the motivation to work hard. A huge part of our narrative of success is hinged on the increasing affluence and hard work of the middle-class.

Hence, the hollowing out of our middle class will be particularly pernicious, since it will have particularly significant effects on economic outlook, social mobility and social stability, ideals that form the basis of our society. A more negative outlook on social mobility can lead to fewer aspirations among Singaporeans to improve their positions, leading to the disappearance of values of diligence and resilience. This lack of confidence also affects sense of belonging to Singapore and can potentially lead to a

weakened national identity, further affecting our social stability.

Therefore, in light of an increasingly squeezed middle class, measures must be implemented to create security for the middle class and prevent the “hollowing out” of our middle class in Singapore.

Reference

Abandines, Argee. “Who wants to be middle-class? Why Singapore has lost its drive for better.” January 3, 2017. Accessed March 20, 2017. <https://www.aseantoday.com/2017/01/who-wants-to-be-middle-class-why-singapore-has-lost-its-drive-for-better/>

