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First report of the Vietnam's
Future Digital Economy Project

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Current profile and trends impacting
Vietnam's economy and digital economy



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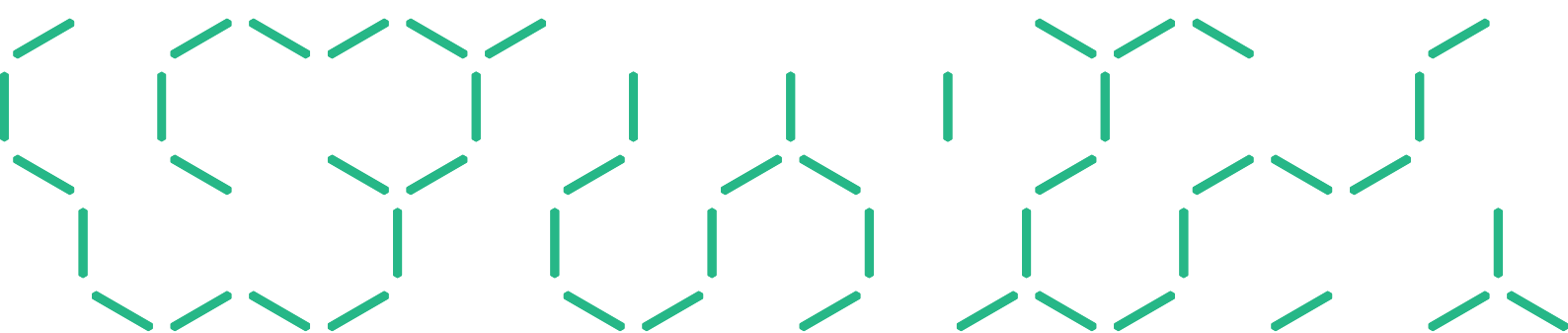
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EXECUTIVE SUMMARY

With youth, innovation and investment, the people of Vietnam have good reason to be optimistic about the future of the economy, and development of the digital economy over the next 20 years. The paths that may be taken for the development and growth of Vietnam through digital transformation are not risk-free, however, and will need to be navigated carefully.

Like many countries around the world at this point in history, the main challenge in the development of the next wave of the digital economy (implementing technologies such as artificial intelligence, advanced automation, digital-biological-physical networks and advanced GPS tracking, cloud-based platforms and blockchain systems) will be to lift labour productivity while maintaining high employment levels, social inclusion and equality; to transition the labour market and government systems along with the systems of wealth generation.

This is the first report in a larger study, *Vietnam's Future Digital Economy*, an innovative joint project between Australia's Data61|CSIRO and Vietnam's Ministry of Science and Technology. It examines the state of Vietnam's economy and digital economy at the beginning of 2018, and the trends that will affect its development over the next 20 years.

The broader study will explore how different rates of digital transformation could create a number of plausible futures for Vietnam's digital economy. The project will also look into the possible impacts of digital technologies on two of Vietnam's more significant industrial sectors: manufacturing and agriculture.

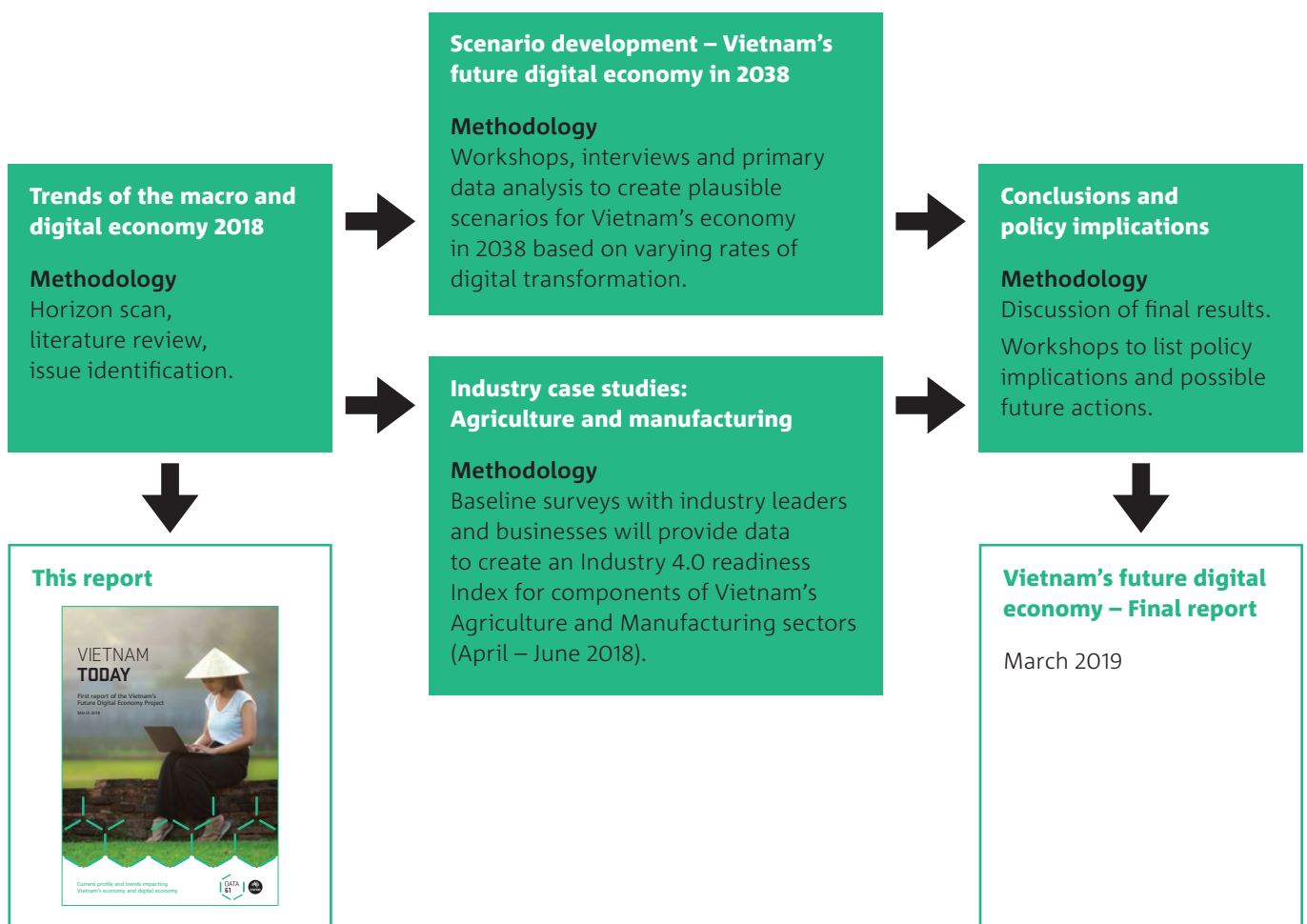


Figure 1 Methodology of the Vietnam's Future Digital Economy Project

Vietnam – a development success story

At 6.4% per annum GDP growth, Vietnam is one of the fastest-growing economies in Asia and the world. Vietnam achieved the World Bank's middle-income status in 2010, and is now the sixth-largest economy in the 10-member ASEAN trading bloc. Vietnam is considered one of the world's development success stories: it was one of the few countries to meet most of the United Nations Millennium Development Goals before 2015.¹

Vietnam's transition from one of the poorest countries in the world to a middle-income country with continually high growth rates resulted from opening up the economy to private enterprise and attracting high levels of foreign direct investment, creating new markets in Vietnam and for Vietnam's exports, modernising industry, maintaining strong government services and building infrastructure. Since Vietnam adopted a path towards a market-based economy in 1986, incomes and employment rates across the country have risen sharply and over 40 million people have been lifted out of poverty.

Vietnam's changing economy

Over the last 30 years, Vietnam's traditional industries and exports – commodities from oil and mining, agriculture, fisheries and aquaculture – have been supplemented with the relatively newer sectors of manufacturing, construction, tourism and business services. Vietnam's top three export sectors are now telecommunications equipment; textiles and garments; and computers, electronics and integrated circuits.² These sectors have grown to provide job opportunities for millions of Vietnamese people, with most of the employment growth in Vietnam's urban districts.³

As new tertiary industries emerge, Vietnam's services sector has increased its relative share of gross domestic product.⁴ The country's economic transformation is continuing under the *Master Plan on Economic Restructuring in 2013-2020*.⁵ This document sets out further divestments in state-owned enterprises (SOEs) and restructuring of banking, foreign direct investment and public investments.



Digital transformation

Digital technologies and online connectivity will be a driving force of growth and transformation of the Vietnamese economy over the coming decades. The IT industry alone is expected to contribute 8-10% of the country's GDP by 2020.⁶ The Vietnam Government is playing an active role in accelerating the development of the digital economy through policies such as the *E-commerce Master Plan*⁷ and the *IT Master Plan*.⁶ These have recently been bolstered by whole-of-government directives on transformation towards Industry 4.0.⁸

The private sector is also investing heavily in digital industries in Vietnam, particularly in manufacturing facilities. In 2010 the world's largest manufacturing plant of Intel computers and processors opened in Ho Chi Minh City. This was followed in 2015 by over US\$11 billion in investment by Samsung in two factories to produce smartphones, digital displays and consumer goods. In late 2017 Seoul Semiconductors announced it would build a facility in North Vietnam. IBM, Siemens, Sony, HP and Toshiba also have a significant presence in offices and facilities in Vietnam. Local company, VNG, which specialises in digital content, entertainment, social networks and e-commerce, was the first Vietnamese company to receive regulatory approval to list on the US-based Nasdaq exchange in 2017, and Australian-based company, Atlassian, grew much of its early value using developers and studios in Vietnam before listing on the Nasdaq for a record US\$6.6 billion.

The presence of big technology companies has been supplemented in recent years by a thriving tech start-up scene, concentrated in the urban centres of Hanoi, DaNang and Ho Chi Minh City. Young tech entrepreneurs are developing new apps, software, platforms and services for consumers and businesses.⁹

The Vietnamese population has shown a voracious appetite for digital goods and products. There were more than 132 million mobile devices (including 32 million smartphone users) in Vietnam in 2017, and about 50 million Internet users – over half the population.¹⁰

Change can come at a cost to many, however. Digital technologies associated with Industry 4.0, including AI, robotics, automation, drone technologies and big data analytics, may also disrupt existing markets and employment – particularly in agriculture and textiles and goods manufacturing. The composition of Vietnam's industrial base makes the country particularly vulnerable to job losses due to automation over the next two decades.

Understanding the next wave of transformation will be vital for harnessing opportunities and managing risks related to the adoption and use of digital technologies in Vietnam's industries.



Challenges and opportunities

An examination of Vietnam's economy reveals that the country faces a number of challenges and opportunities in the immediate and mid-term future.

Challenges for Vietnam include:

- **Lifting labour productivity and moving Vietnam from a middle-income to high-income country:** Over the last three decades the economy of Vietnam has expanded rapidly on the increased availability of labour inputs, however increases in labour productivity through the implementation of technology have been limited.⁵ For Vietnam to escape the 'middle-income trap', labour productivity must increase sharply over the next decade, and the economy must switch from being based on labour-inputs to being based on knowledge intensive products and services.
- **Digital disruption:** The International Labour Organization reports that around 70% of jobs in Vietnam are at high risk of being replaced through automation over the next two decades. Vietnam was identified as the country most at risk of digital disruption out of the five ASEAN countries examined - Vietnam, the Philippines, Thailand, Indonesia and Cambodia.¹¹
- **Urbanisation and increased internal population migration:** 30% of Vietnam's population live in cities and the United Nations predicts that this will rise to almost 50% by 2040.³ Infrastructure provision is a challenge in fast growing urban areas, as is maintaining air and water quality, waste disposal and sanitation.¹²
- **Climate change and increases in severe weather events:** The International Monetary Fund has placed Vietnam among the world's top five countries most likely to be affected by climate change and extreme weather events.¹³
- **Debt levels:** Public and private debt in Vietnam has been growing over the last five years. Total debt – public and private – was 124% of GDP in 2017, exceeding the ASEAN-5 countries (Thailand, Malaysia, Indonesia, the Philippines and Singapore), other middle-income countries and most other countries at comparable stages of development.¹³
- **Maintaining foreign direct investment:** Foreign direct investment (FDI) is an important driver of growth in Vietnam, accounting for 71.6% of total exports.¹⁴ Vietnam has seen yearly increases in FDI since 2011,¹⁵ but analysts warn that more reform is needed to maintain FDI growth in the longer term.¹⁶
- **Increased inequality:** Vietnam has achieved remarkably inclusive growth over the last 30 years.¹⁷ However, institutions such as the World Bank have expressed increasing concerns about inequality due to divergent educational and life outcomes between urban and rural populations, and between different ethnic groups.¹⁸
- **Skills shortages:** Vietnam faces considerable skills shortages, especially in regard to digital transformation. To meet demand for IT workers, which is increasing by 47% per year, Vietnam will need an estimated one million more workers in the information and communications technology sector by 2020.¹⁹

Opportunities for Vietnam include:

- **Location and geography:** The centre of the global economy is moving from west to east and by 2050 will be located between China and India, which will by then be the world's largest economies.²⁰ Vietnam is well situated to operate across economies and cultures in the heart of Asia's fast-growing nations – being a participant in regional trade routes, and benefiting from growing consumer demand from the region's rising middle classes.
- **A young and educated population:** The median age in Vietnam is only 30.4 years.²¹ A relatively high proportion of the population (70%) is of working age.²² The country provides universal primary education, resulting in high adult literacy (95% of the population), and even higher youth literacy (98% of the population).²³ Youth and education can be considered assets in economic and digital transformation.
- **A growing and entrepreneurial ICT industry:** In 2016 *PC Magazine* described Vietnam as South-East Asia's Silicon Valley.²⁴ Emerging sectors and fast-growing sunrise industries in Vietnam already include finance technology (fintech), telecommunications, electronics and computer manufacturing, and ICT services.
- **Becoming closer to global innovation and venture capital:** Along with a shift in the centre of economic gravity to the east, the world's technological centre is also moving towards the Asia Pacific region. Countries in the region are filing an increasing number of patents – particularly China,²⁵ which is also now second only to the United States in providing venture capital.²⁶
- **A growing Asian middle class:** The global middle class is expanding rapidly. By around 2020, it is projected to make up over 50% of the world's population, up from about 30% in 2010.²⁷ Future middle-class expansion is projected to be heavily concentrated in Asia (88% of the next billion new entrants), especially in China and India.²⁷ This is set to benefit Vietnam's tourism sector, as well as the export of high-value foods and high-technology products.

- **Booming tourism in South-East Asia:** Tourism is one of Vietnam's growing service sectors – contributing 13.9% to GDP in 2015 but predicted to grow to over 15.2% by 2026.²⁸ It is part of a region-wide trend seeing a growth in international visitor numbers. Vietnam has comparative advantages in the tourism market with natural geographic beauty, diverse cultures, and close proximity to China.
- **Leapfrogging technology:** Vietnam has seen rapid development in mobile communication technologies, with 4G networks now covering over 95% of households.¹⁶ Vietnam aims to introduce 5G networks by 2020,¹⁶ which have the potential to enable further digital transformation. The most promising use cases for 5G in Vietnam are connected healthcare, smart cities, autonomous vehicles, industrial Internet of Things and fixed wireless.²⁹

Exploiting the opportunities while navigating the challenges for Vietnam will require careful consideration of the plausible futures that may eventuate from differing levels of digital transformation. The next phase of this project will create scenarios for the next 20 years of Vietnam's development, based on how the next wave of digital technologies are adopted and implemented across Vietnam's industries, with particular focus on the agricultural and manufacturing sectors.





1 VIETNAM – COUNTRY PROFILE AND TRENDS

1.1 Introduction

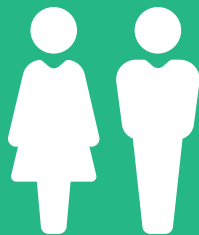
Vietnam has come a long way since reunification of the North and South in 1975. For the following decade, Vietnam was one of the poorest countries in the world – reliant on foreign aid, and with an annual per-capita income of less than US\$300.¹⁷

In 1986 the Doi Moi political reforms gave Vietnam a new direction. The reforms moved the country away from a centralised economy and set it on a path to a liberalised and open market-based economy with high levels of foreign direct investment. The direct impacts

of Doi Moi lifted Vietnam's GDP by 42% by 1998.³⁰ Since the 1990s, Vietnam's reforms have led to remarkable levels of inclusive growth benefiting all sectors of society.¹⁷

In 2011, Vietnam renewed its commitment to market-led development and modernisation through the *2011 – 2020 Socio-Economic Development Strategy*. To achieve further investment and market development, the national government will focus on innovation and promoting skills, improving market institutions and maintaining infrastructure investment.

VIETNAM'S ECONOMY AT A GLANCE



POPULATION DENSITY
308
PEOPLE/KM²

MEDIAN AGE
30.4
YEARS

TOTAL POPULATION
92.7
MILLION

LIFE EXPECTANCY
75.6
YEARS

URBAN POPULATION GROWTH
3%
PER ANNUM



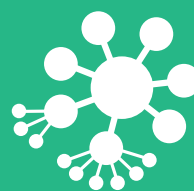
ANNUAL INCOME
2060
US\$ PER CAPITA



GDP
205.3
US\$ BILLION

GDP GROWTH
6.2%
PER ANNUM

TAX REVENUE
19.1%
OF GDP



FOREIGN DIRECT INVESTMENT
12.6
US\$ BILLION

DEVELOPMENT ASSISTANCE
2.9
US\$ BILLION

Source: UN World Population Prospects, World Bank Development Indicators

1.2 Geography

Vietnam is located on the eastern side of the Indochina Peninsula and borders the South China Sea. Vietnam is neighboured by China, Laos, Cambodia and Thailand. The Philippines, Malaysia, and Indonesia are other close neighbours across the South China Sea.

Vietnam has been part of a broader rise in the economic influence of the South-East Asian region – including the rapid-growth nations of China, Laos, the Philippines and Cambodia, as well as further-developed nations such as Singapore, Thailand and South Korea. Over the last 20 years the region as a whole has witnessed a sharp increase in trade associated with transport, travel, business services and income from the sale of intellectual property.³¹

Vietnam is a member of the 10 country ASEAN (Association of South East Asian Nations) trading bloc. Over the last decade ASEAN's economic growth rate has outpaced global averages, and it is predicted to become the world's fourth-largest economy by 2030. Real per-capita incomes in developing economies of the region have doubled on average since the early 1990s, and the number of people living in poverty more than halved between 1990 and 2009.

Vietnam covers 33,123 square kilometres, of which 34% (11,530 square kilometres) is under agricultural production, and 45% (14,923 square kilometres) is forested; 15% of land in Vietnam (5,287 square kilometres) is protected forest or park land.³²



Vietnam’s coastline stretches 3,260 kilometres, connecting two rich and fertile river deltas – the Mekong in the south and the Red River in the north – and runs beside mountainous regions in the far north (the Annamite Range) and the centre (Central Highlands). Vietnam also lays claim to the Paracel Islands and parts of the Spratly Islands in the South China Sea.³²

Most of Vietnam has a humid subtropical climate, but the climate varies considerably between north and south, and between the low-lying coastal areas and the mountainous regions.

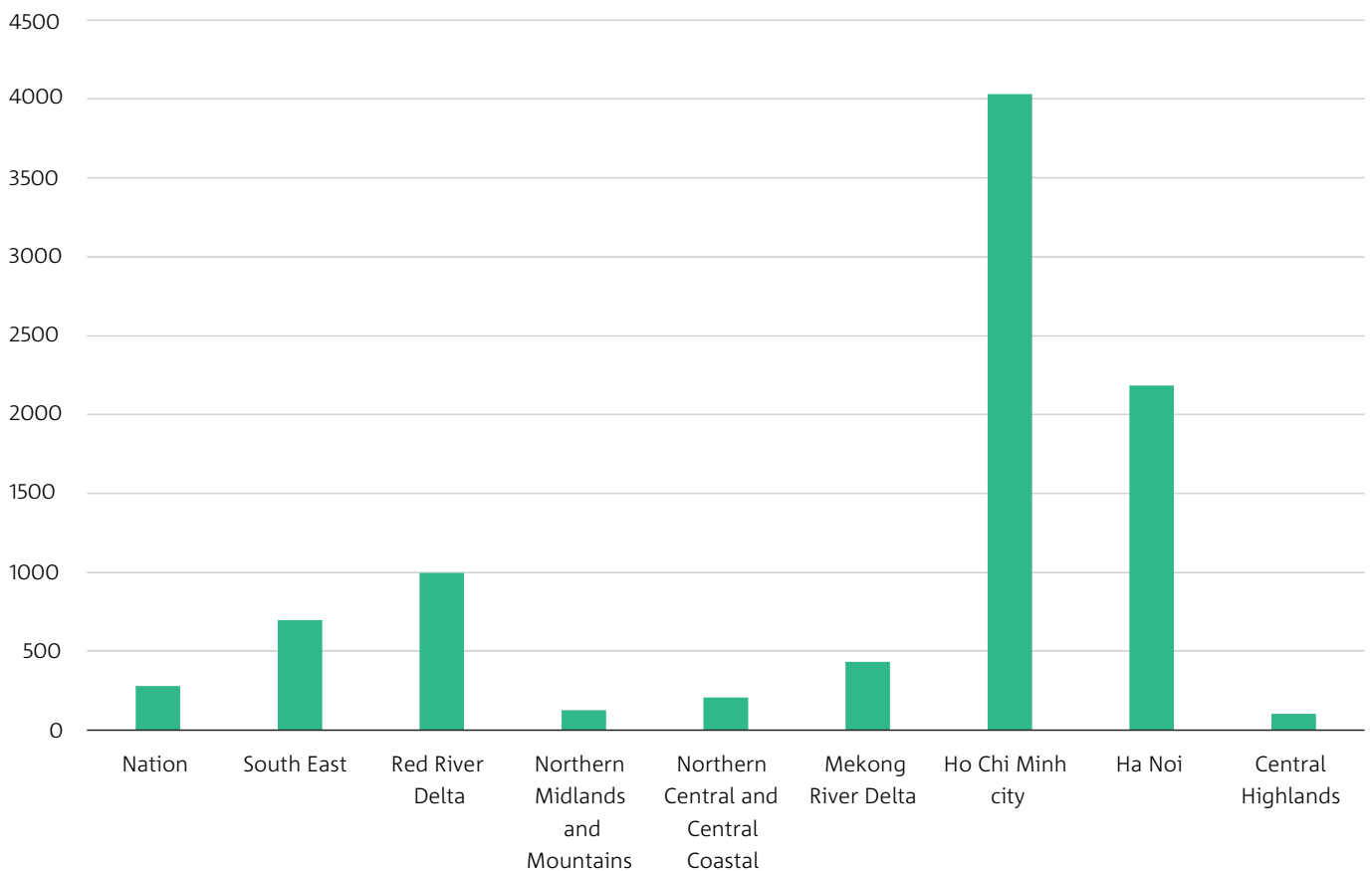


Figure 2 Vietnam’s population density (person/km²) by region

Source: General Statistics Office, Vietnam³⁴

1.3 Demographic profile and trends

MOVING TO THE CITIES

Vietnam has a population of 92.7 million,³³ with the highest densities around the cities of Ho Chi Minh City in the south (8.3 million) and Hanoi in the north (7.33 million).³⁴ Rich river deltas have led to high population densities also in rural areas – particularly in the Mekong River Delta in the south and the Red River Delta in the north. Vietnam’s overall population density is above average at 308 people per square kilometre.^{21,35}

In 2016, 30.3% of the population lived in an urban area, and this is increasing at an average of 3% per year.^{3,36} Urbanisation in Vietnam is likely to continue as service-based jobs centred in urban areas grow, and commodity-producing jobs found in rural areas decline. The United Nations predicts that close to half the population of Vietnam will live in cities by 2040.³ That will mean more than 20 million more people will need to be accommodated in urban areas within the next 22 years.

Local population densities in Vietnam will change as people migrate away from the Mekong Delta (currently experiencing an out-migration rate of 5.7%) and rural northern areas (between 3% and 3.3%).³⁷ The regions seeing the sharpest population growth and net migration are Ho Chi Minh City (1.8% population growth, 6.6% net migration) and the neighbouring South East province (1.8% population growth, 8.4% net migration).^{34,38}

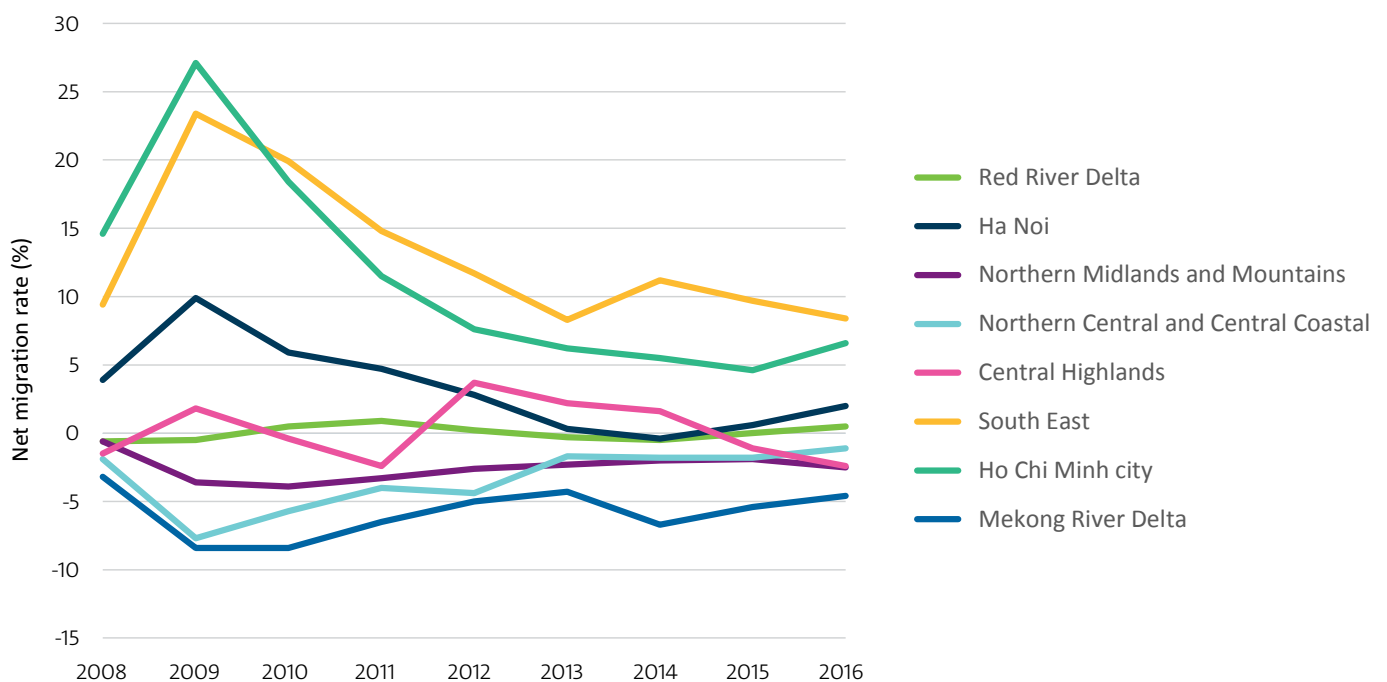


Figure 3 Net migration rate (%) by region

Source: General Statistics Office, Vietnam³⁷

MIGRATION: THE TREND IS FLAT

The country’s overall net migration rate is nearly zero.³⁷ This indicates an approximately equal level of imported and exported labour. Around 5.9 million people officially entered and exited Vietnam in 2016, most of working age (20-40 years).³⁹

The top destinations for working migrants were Taiwan/China, Japan, South Korea, Malaysia, and Saudi Arabia.³⁹ Migration to Taiwan reportedly more than doubled between 2012 and 2016, from 30,533 to 68,244. While men and women were equally represented in overall migration data, females accounted for only 36.4% of Vietnamese labourers abroad.³⁹ Over 74% of the labourers abroad came from the Red River Delta, northern central, or central coastal regions of Vietnam.³⁹

YOUNG BUT AGING RAPIDLY

Vietnam has a comparatively young population but the population growth rate is falling and the population is aging rapidly.^{21,40} UNESCO has identified Vietnam as one of the world’s fastest-aging societies.⁴¹ In 2017 the median age in Vietnam was 30.4 years; in 2050 it is projected to be 42.1 years.²¹ As the proportion of the population over 65 years increases, the proportion of working-age people in the population will decrease, and costs associated with age and health care will grow. By 2050, life expectancy is projected to be 82.1 years, up from 75.6 years in 2018.²¹

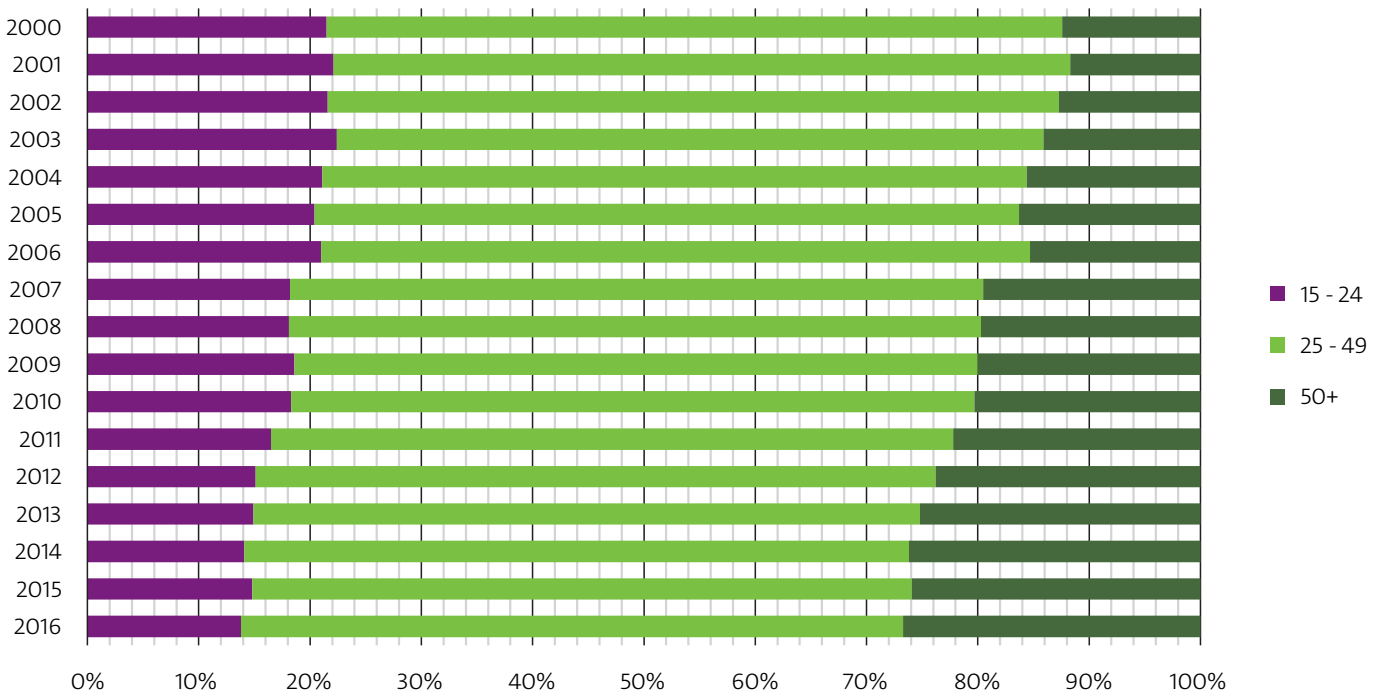


Figure 4 Percentage of labour force in different age groups, 2000-2016

Source: General Statistics Office, Vietnam⁴²

IMPROVING LEVELS OF GENERAL EDUCATION, STILL LOW LEVELS OF SKILLED WORKERS

Large investments in primary schooling and education over the last two decades have resulted in Vietnamese people completing a mean of 8.5 years in schooling, and they are highly literate as a result (95% literacy rate).^{23,43} Over 90% attend lower secondary school, but this drops to 75% in upper secondary.^{41,44,45} Those at most risk of dropping out at upper secondary are male, rural, and lower-income students.⁴⁴ Less than half the lowest-quintile income students attend.⁴⁴

Only 20.6% of the labour force have achieved post-secondary education (8.9% from vocational training, 2.7% from university, and 9% from graduate school or above).⁴⁶ Outside of the education system, over 50% of urban firms in Vietnam report offering (mostly internal) vocational training.⁴⁷

Vietnam has seen rapid growth in the number of VET institutions, improved literacy rates, improved teacher-student ratios, and higher student enrolments due to reforms such as the Higher Education Reform Agenda (2005-2020).^{44,48}

1.4 Economic trends

ASTONISHING GROWTH

The most prominent feature of Vietnam's economy over the last 30 years has been its astonishing economic growth. China is the only Asian economy that has, on average, grown faster since 1990.⁴⁹ The average growth rate was 6.86% in the 2000-2015 period.⁴

In 2017, GDP grew by 6.81% to 5,007 trillion VND (US\$234.69 billion).^{50,51} Total investment in 2017 equalled 33.3% of GDP, a 12.1% increase from 2016.⁵⁰ This was higher than expected, bolstered by stronger than predicted domestic demand.

INCREASING PROSPERITY AND MIDDLE CLASSES

Although Vietnam is growing more prosperous, the country lags behind a number of other Asia Pacific countries in terms of wealth per capita. So while Vietnam came close to the world's highest average annual growth in GDP per capita (5.3%) between 1990 and 2016,⁵⁵ Vietnam's annual GDP per capita remains comparatively low at US\$6,434.90 PPP (2016).^{56,57}

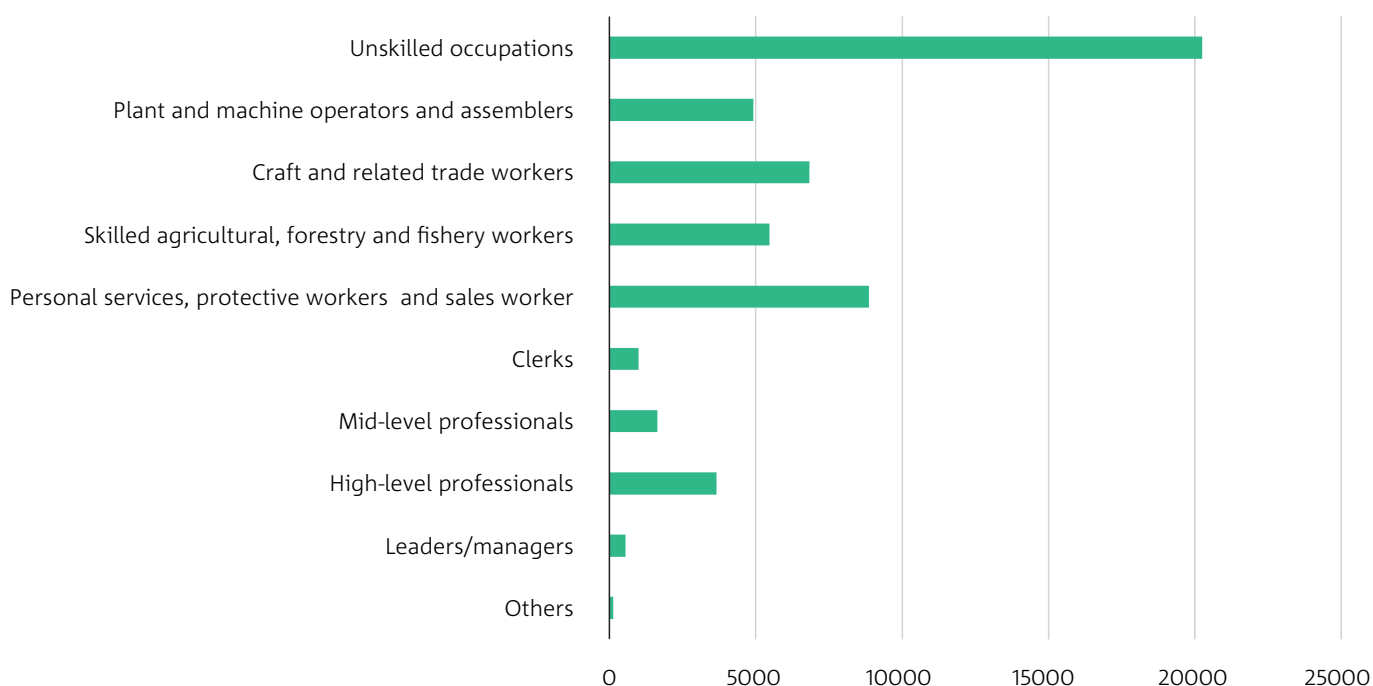


Figure 5 Number of employed Vietnamese people by occupation, 2016

Source: General Statistics Office, Vietnam³⁸

Vietnam's middle classes have been the beneficiaries of this rapid economic growth, becoming a much larger proportion of the population. In 2015, roughly 10% of the Vietnamese population formed part of the global middle class.⁴¹

Income inequality is moderately low, at a 35% GINI coefficient.⁵⁸ Over the last three decades Vietnam has been successful in improving the prosperity of the poorest, dramatically reducing the number of people living in poverty or extreme poverty: the poverty rate decreased from 15.5% in 2006 to just 5.8% in 2016.⁴³ There has also been growth in the rich and 'super rich' over the last two decades: in 2017 it was estimated that over 200 individuals in Vietnam were worth US\$30 million or more.⁵⁹

Institutions such as the World Bank have raised concerns about increasing inequality, however, due to divergent educational and life outcomes between urban and rural populations, and between different ethnic groups.¹⁸

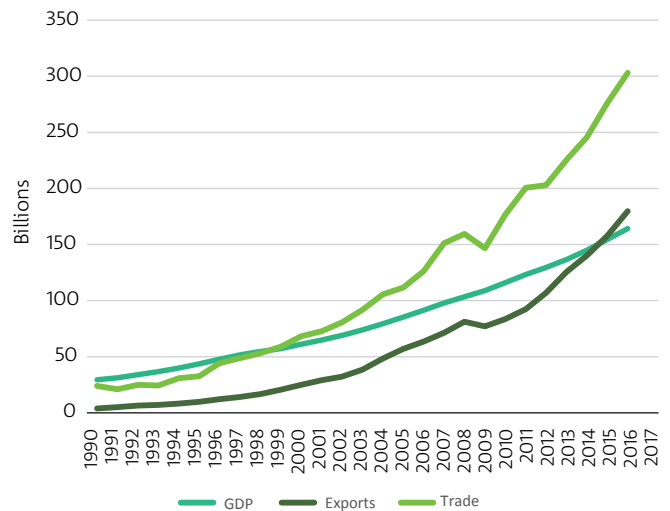


Figure 6 Vietnam GDP, exports and trade (constant 2010 US\$)
Source: World Bank⁵²⁻⁵⁴

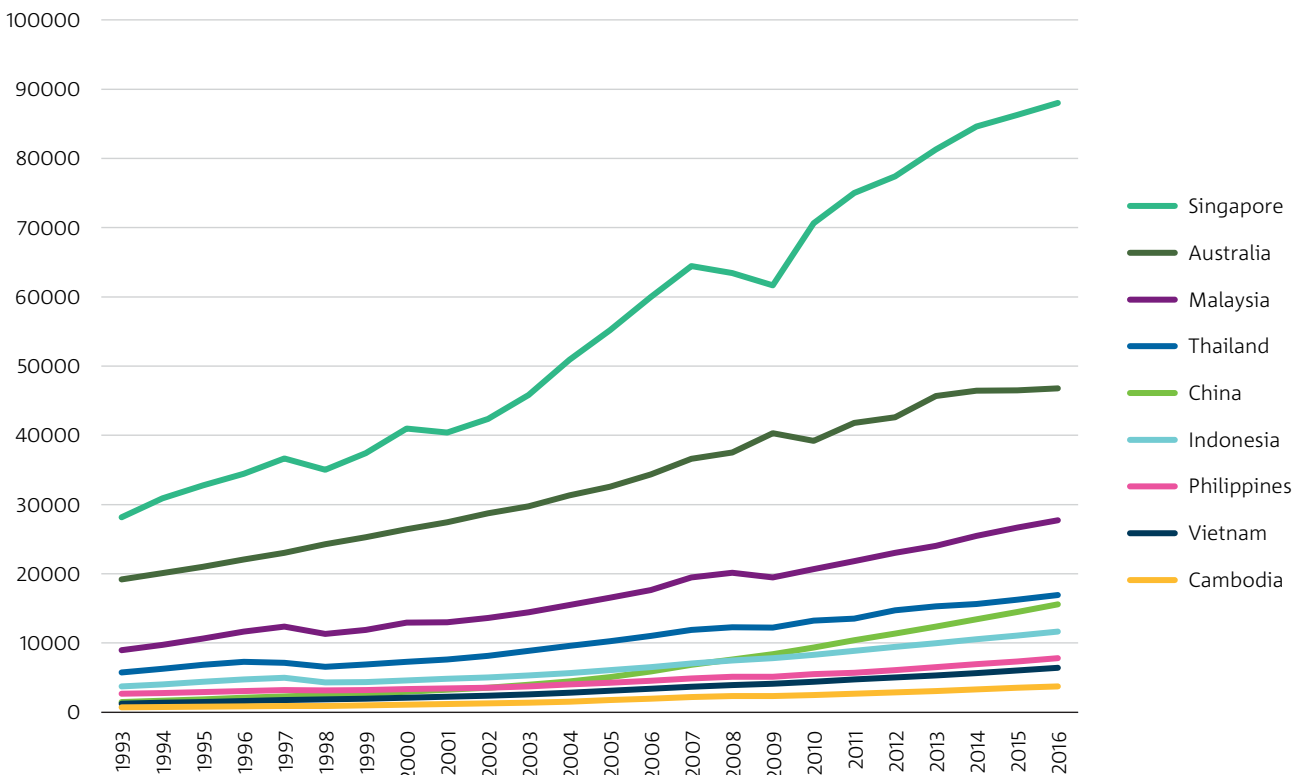


Figure 7 GDP per capita at PPP current international \$, 1993-2016
Source: World Bank⁵⁶

CURRENCY DECREASING AGAINST THE US\$, AND INFLATION VOLATILE

The Vietnamese Dong (VND), the currency of Vietnam, has depreciated by approximately 30% against the US dollar over the last ten years. This period has seen wild fluctuations in inflation (measured by the consumer price index), with two spikes – above 20% in 2008, and just over 18% in 2011. Annual inflation was 3.53% in 2017.⁵⁰ Inflation has decreased significantly since 2011, however, and the State Bank of Vietnam (SBV) and government officials have stated publically that they will use monetary policy to keep inflation below 4% over the coming years.^{60,61}

PRODUCTIVITY IS RISING, BUT FROM A LOW BASE

Vietnam has the highest labour productivity growth of the ASEAN countries.⁵⁰ Since 2011, labour productivity has grown on average by 4.7% per year, with a 6% rise in 2017 to 93.2 million VND (~US\$4159) per worker.⁵⁰ However, its overall productivity is lower than that of other countries in the region. Estimates suggest that Vietnam will need to increase productivity by 50% in the next 10 years to maintain its rapid growth.⁶³

The Vietnamese labour force is composed of 54.9 million people aged over 15.⁶⁴ The labour force participation rate is 76.2%.⁶⁴ Participation rates differ for males and females

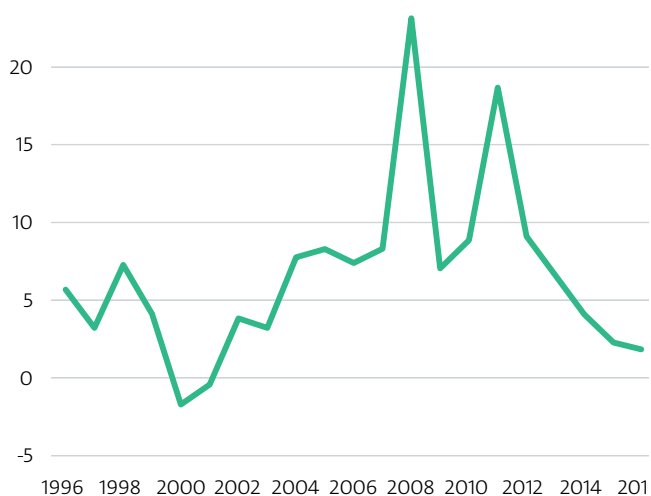


Figure 8 Vietnam inflation, consumer prices (annual %), 1996-2016

Source: World Bank⁶²

(81.1% vs. 71.5%), as well as for urban and rural regions (70% vs. 79.5%).⁶⁴ The overall labour force is mostly rural (67.8%), and 49.9% are aged between 15 and 39.⁶⁴

The unemployment rate is 2.02%, equalling over 1.1 million people.⁶⁴ Unemployed youth (aged 15 to 24) make up 55.1% of this figure.⁶⁴ Unemployment is also higher in rural areas than urban centres. Additionally, over 800,000 people are underemployed.⁶⁴ Of this population, 84.1% are rural workers and only 17.7% are youths.⁶⁴

PUBLIC DEBT LEVELS RISING

In 2017, total government revenue was estimated to be 1104 trillion VND.⁵⁰ This was less than government expenditure, estimated to be 1219.5 trillion VND.⁵⁰ The International Monetary Fund estimate that central government gross debt grew to 63.6% of GDP in 2017, compared with 48.1% in 2010.⁵¹

1.5 Trade and investment

FDI AND THE PRIVATE SECTOR CONTINUE TO BE DRIVING FORCES OF GROWTH

The private sector in Vietnam contributed more than 43% of total GDP in 2016, compared to 28.9% from state-owned enterprises (SOEs) and 18% from foreign direct investment (FDI) firms. However, it engaged more than 85% of total labour force, particularly through agricultural enterprises.

The Vietnam government has fully or partially privatised thousands of SOEs since the beginning of the economic liberalisation program in 1986. Since that time, Vietnam has restructured 5950 SOEs, equitising 4460 of them. A further 240, with a capital value of over US\$4.7 billion, are scheduled to be privatised by 2020.⁶⁵

Although FDI is a small component of total GDP, it plays a critical role in attracting capital and expertise to value-added industries in Vietnam. In the last three decades, Vietnam disbursed US\$154.5 billion (about 50% of total FDI-registered capital), accounting for approximately 20% of total investment in Vietnam industry.⁶⁶ The mining and quarrying sectors have traditionally been the main beneficiaries of FDI, but their share has gradually decreased as investment flowing to manufacturing and processing industries has increased.

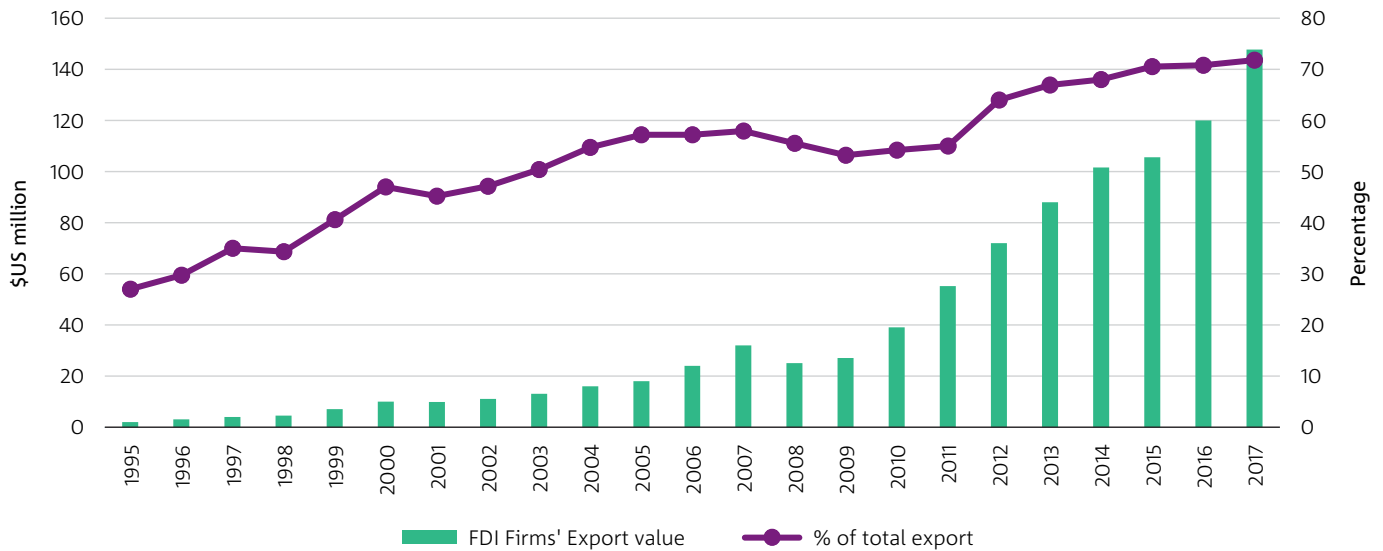


Figure 9 Foreign-invested firms' export value and proportion of total exports, 1995-2017

Source: World Bank, Vietnam Customs ^{67,68}

The attraction of FDI to Vietnam improves the country's overall reputation as a destination for industrial investment and capital: Vietnam is attractive to international investors as an emerging market, and always ranks highly on international investment tables.⁶⁹ The attraction of FDI is also closely linked to increased exports: 70% of total exported goods were generated from FDI firms in 2017.⁶⁶

TRADING UP – THE INCREASING VALUE OF VIETNAM'S EXPORTS

Vietnam has become the 26th-largest exporter of merchandise in the world.⁶⁸ In 2017 merchandise exports reached a record US\$425 billion in value, an increase of 21% on 2016.^{2,70}

Exports create many jobs within Vietnam – both directly and indirectly – as seen in the increase in labour valued-added contained in Vietnam's exports after 1995.

Vietnam has benefited from increasing wages in China, as many manufacturing jobs can now be done more cost-effectively in Vietnam. This is likely to change as wages in Vietnam also rise and the country loses its comparative advantage based on labour costs alone.



Figure 10 Increasing labour value added of export products in Vietnam, 1995-2011

Source: World Integrated Trade Solution⁷¹

TRADING PARTNERS

In 2017 Vietnam had more than 200 trade partners. Its top four export markets were Korea, China, the United States and Japan, together accounting for more than 60% of Vietnam's total exports.⁶⁷

TRADE AGREEMENTS

Vietnam is an effective member of 11 free trade agreements and is in negotiation for another four.* Vietnam signed a bilateral trade agreement with the United States in 2000 and became the 150th member of the WTO in 2007. Vietnam will also be a signatory to the Trans Pacific Partnership Agreement (TPP). Although the TPP suffered a major setback when the US withdrew in 2016, it is likely to be signed by the 11 remaining members – Japan, Mexico, Canada, Australia, New Zealand, Vietnam, Peru, Chile, Malaysia, Singapore and Brunei – and, when fully implemented, it will control approximately 20% of global trade.

INDUSTRY PROFILE

Vietnam's rapid growth over the last two decades has been accompanied by a shift in its industrial composition. Agricultural production has been contributing steadily less as a proportion of GDP, decreasing its share from 38% in 1986 to 16% in 2016, while industry and construction grew from 28% to 32% over the same period. The service sector is, however, the largest contributor to national output, accounting for more than 40% of total GDP.⁵⁰ Vietnam aims to improve the combined contribution of industry and services to 85% of total GDP by 2020.⁷²

Part of the industrial shift being seen in Vietnam is the growth of manufacturing in high-technology goods such as smartphones, computers, electronic and telecommunications equipment and white goods. Telephone and broadcasting equipment now make up the largest category of exports.

Despite the decline of agricultural exports as a proportion of all exports, the agriculture sector is still the largest employer in Vietnam.

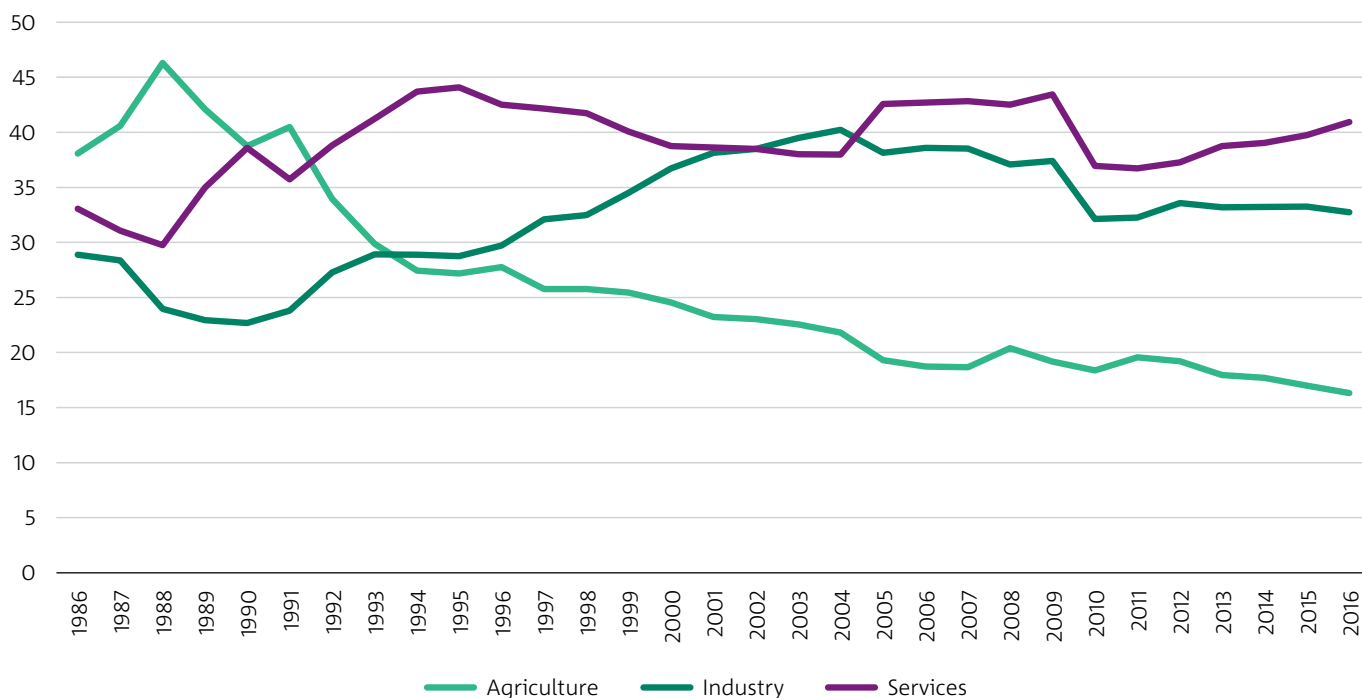


Figure 11 Value added to Vietnam GDP (%) by economic sector

Source: General Statistics Office⁴

* The four FTAs under negotiation include the Regional Comprehensive Economic Partnership (RCEP, ASEAN-Hong Kong, Vietnam-Israel, Vietnam-EFTA)

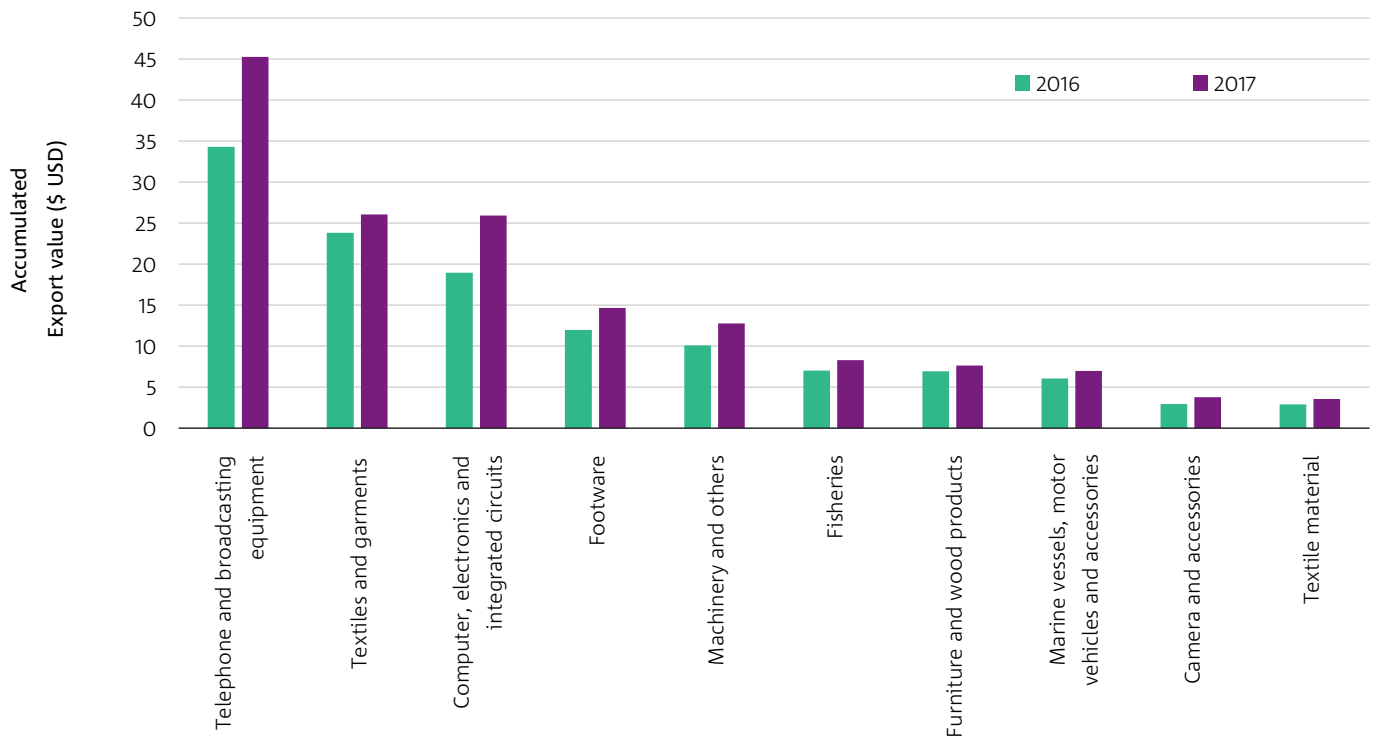


Figure 12 Top exports by sector (accumulated export value US\$), 2016-2017

Source: Vietnam Customs⁷³

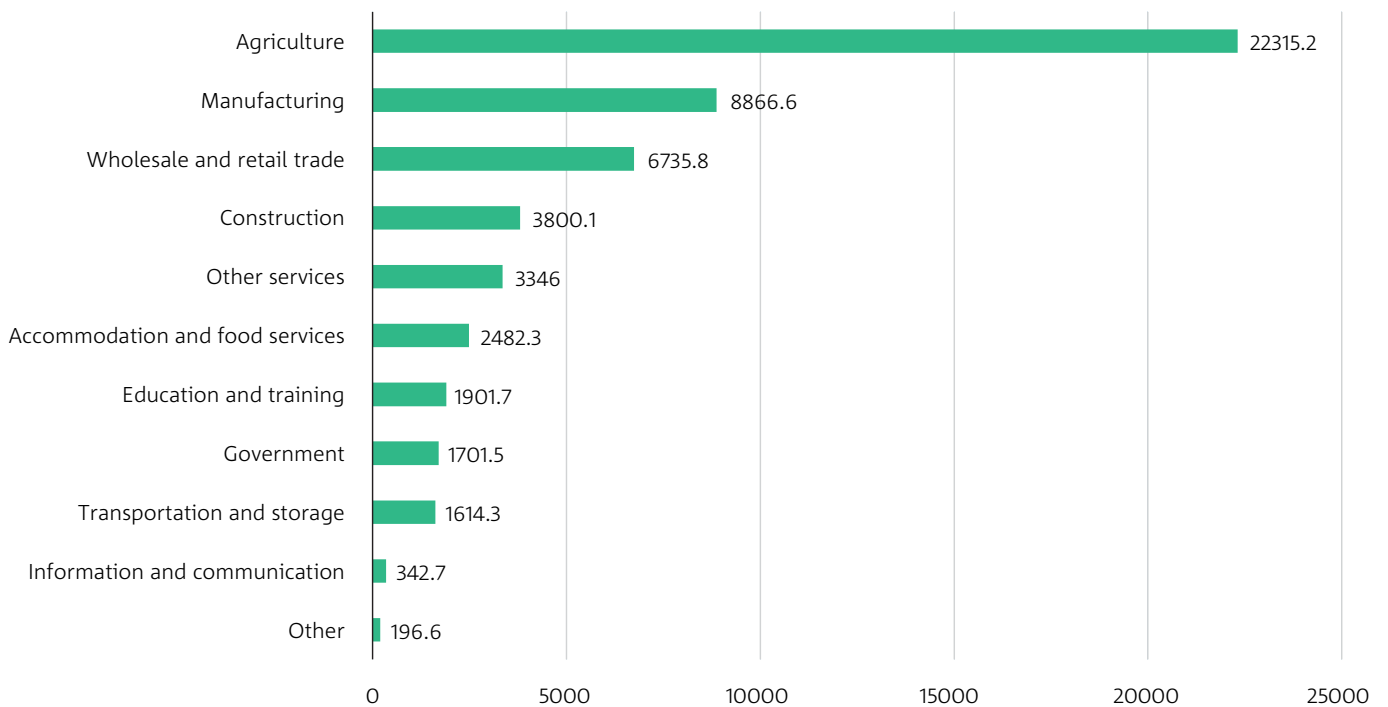


Figure 13 Employment of labour force (aged 15+) by sector (1000 persons), 2016

Source: General Statistics Office, Vietnam⁷⁴

INTERNATIONAL INTEGRATION: INTERNATIONALISING RAPIDLY

Vietnam shows strong commitment to international integration and cooperation. In 2017 it hosted the Asia-Pacific Economic Cooperation meetings, and is currently working towards the ASEAN Community Vision 2025, a roadmap for unity and improved well-being in the region.^{75,76} In addition, Vietnam has formed strategic partnerships with countries including the United Kingdom,⁷⁷ India,⁷⁸ Australia,⁷⁹ Japan,⁸⁰ Malaysia⁸¹ and the Philippines.⁸²

OFFICIAL DEVELOPMENT ASSISTANCE: FROM AID RECIPIENT TO AID PARTNER

Over the last three decades, official development assistance (ODA) contributed to Vietnam's success in lowering poverty and improving infrastructure.⁸³ Once Vietnam reached middle-income country status, however, its status changed from being an aid recipient to an aid partner.⁸³ ODA peaked in 2011 at US\$6904 million,⁸³ decreasing to US\$2759 million in 2015.⁸³ ODA will continue to decrease in the next five years.⁸³ ODA loans from the World Bank and Asian Development Bank will soon shift to higher interest rates and less favourable terms.⁸³ Borrowing will be more expensive and loans will be held more accountable in terms of investment effectiveness.



ENERGY: DEMAND INCREASING RAPIDLY AND OUTSTRIPPING SUPPLY

Access to electricity in Vietnam has vastly improved in recent decades, reaching 98.8% of the population in 2016.⁸⁴ Vietnam recently transitioned from being an energy exporter to an energy importer as growing demand is not being met by internal supply. Demand will continue to increase as the country's industrial capacity grows and develops further.

The Ministry of Industry and Trade Energy forecasts energy demand will increase by up to 72% by 2025, from 54 to between 89 and 93.3 million tonnes of oil equivalent.⁸⁵ *The National Power Development Master Plan (2011-2020)* is being implemented to help meet this growing demand, including through the generation of more renewable energy.⁸⁶ More private investment will need to be attracted into the energy sector, as the state's major energy enterprises currently lack the finance to increase capacity from existing infrastructure.¹⁶

In the short term, energy imports are likely to increase as readily accessible oil, gas, and coal resources diminish and the potential of hydropower in Vietnam is fully realised.¹⁶

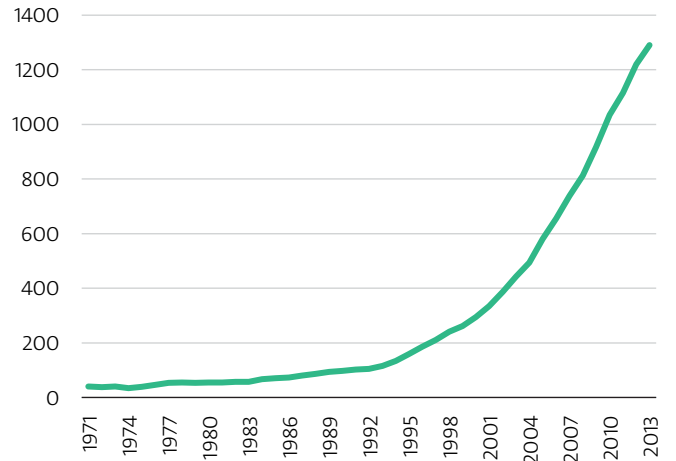


Figure 14 Vietnam power consumption (kWh per capita), 1971-2014

Source: World Bank⁸⁷

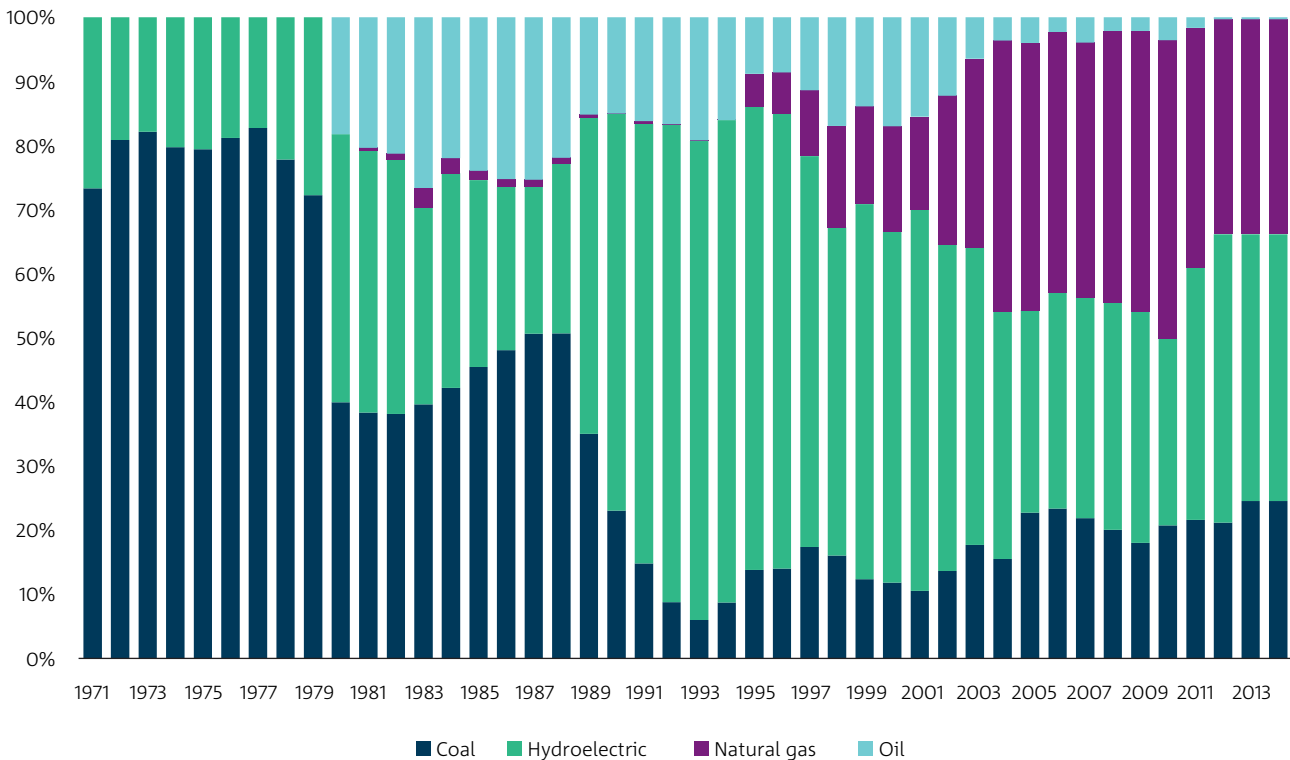


Figure 15 Sources of Vietnam electricity production (% of total), 1971-2014

Source: World Bank⁸⁸⁻⁹¹

TRANSPORT INFRASTRUCTURE: INCREASING INTERNATIONAL LINKS, NORTH-SOUTH CONNECTIONS AND URBAN LIVEABILITY

Vietnam's long coastline provides a comparative advantage in trade. The South China Sea is the world's second-busiest shipping lane, carrying 25% of global shipping traffic.¹⁶ To service this sea lane, Vietnam has 14 main and 100 smaller sea ports.¹⁶

Maritime trade was boosted in 2011 with the opening of the Tan Cang-Cai Mep International Terminal (TCIT), the first sea port in Vietnam to be able to accommodate and unload larger ships – up to 15,000 TEUs (twenty-foot equivalent units).¹⁶ Previously, most cargo shipped to the United States or Europe was first trans-shipped to Singapore, Hong Kong, Malaysia or Taiwan.¹⁶ The TCIT has reportedly reduced transit times to the United States and Europe by four days.¹⁶

The *Transport Strategy 2020* aims to further develop road, railway and aviation infrastructure to better support the country's growth. Goals for 2020 under this strategy include:

- increasing road connections between North and South Vietnam, as well as to surrounding countries;
- building 2300-2700 km of highways;¹⁶ and
- increasing the number of global aviation routes.¹⁶

A feasibility study is underway for a high-speed railway between Hanoi and Ho Chi Minh City.¹⁶ These two fast-growing cities are also building much-needed underground rail (metro) systems to improve congestion and increase urban efficiency and liveability.

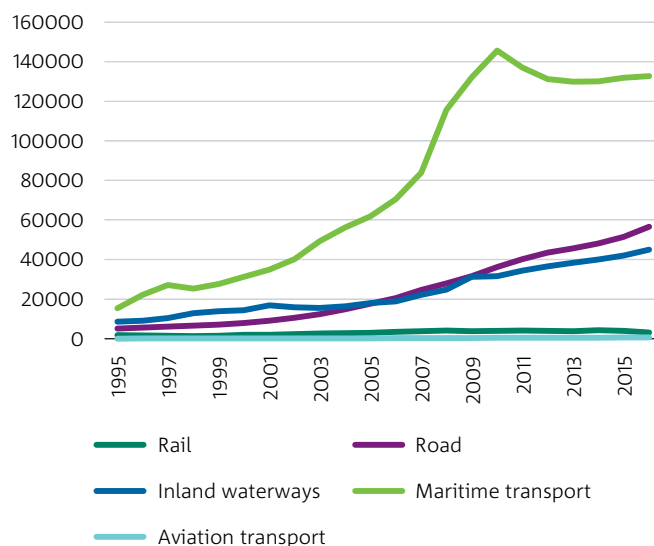


Figure 16 Volume of freight traffic (million tonne-km) by type of transport, 1995-2016

Source: GSO⁹²

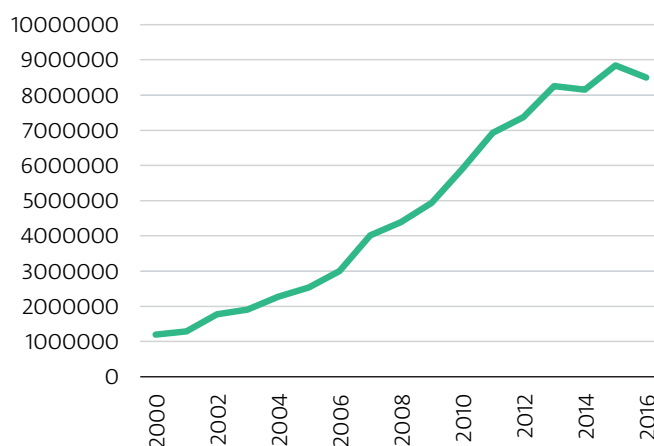


Figure 17 Vietnam container port traffic (TEU: twenty-foot equivalent units), 2000-2016

Source: World Bank⁹³





2 VIETNAM'S DIGITAL ECONOMY

2.1 Introduction

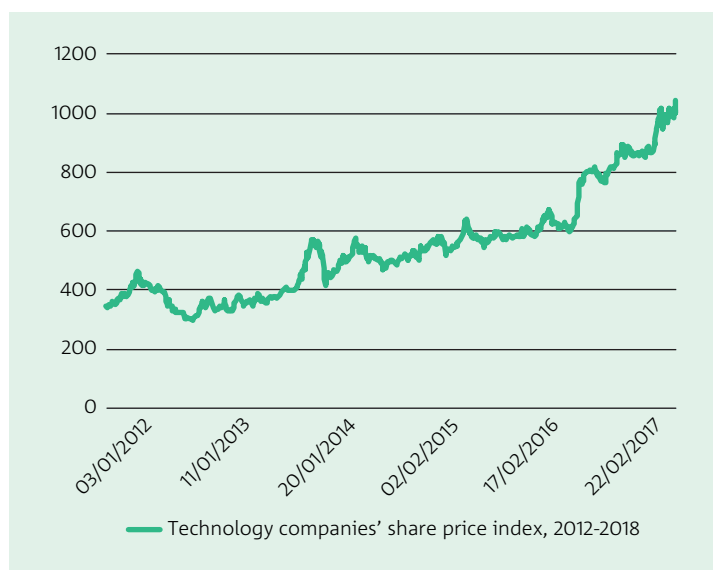
The digital economy is booming in Vietnam. In 2016, *PC Magazine* described the country as South-East Asia's Silicon Valley.²⁴ Emerging sectors and fast-growing sunrise industries in Vietnam include finance technology (fintech), telecommunications, electronics and computer manufacturing, and ICT services.





In 2016 Vietnam was home to an estimated 24,501 businesses spanning IT hardware, software and digital content. There are specialist training centres and technology parks for IT programmers and engineers in eight locations, including the major cities of Hanoi, Ho Chi Minh City and DaNang.^{94,24}




The Vietnam government has prioritised IT sector development with the *IT Master Plan*,⁶ giving tax incentives and building education infrastructure to support new ICT firms looking to develop or invest.⁹⁵




The country has a thriving community of software developers and start-ups, developing digital products and services for use within Vietnam as well as undertaking software development offshored and outsourced from advanced economies.⁹⁶

VIETNAM'S DIGITAL ECONOMY AT A GLANCE



 AVERAGE DOWNLOAD SPEEDS 9.5MBPS	 49% BUSINESSES WITH A WEBSITE
 MOBILE SUBSCRIBERS 128 MILLION	 9 MILLION FIXED BROADBAND CONNECTIONS

 BUSINESSES IN THE ICT SECTOR 24,501	 EMPLOYED IN IT 780,925
	 IT GRADUATES 305,601

 IT INDUSTRY REVENUES \$US 67.6 BILLION
 TOTAL IT EXPORTS \$US60.8 BILLION
 TELECOMMUNICATIONS INDUSTRY TURNOVER \$US 6.2 BILLION

Source: Akamai, Ministry of Information and Communication, VNDIRECT, World Bank Development Indicators

2.2 What is the digital economy?

The ‘digital economy’ is notoriously hard to define and measure, with definitions from diverse organisations such as the Organisation for Economic Co-operation and Development (OECD),⁹⁷ G20⁹⁸ and Oxford Dictionary⁹⁹ varying in breadth and scope. This study will adopt a broad definition:

All businesses and services that have a business model based primarily on selling or servicing digital goods and services or their supporting equipment and infrastructure.

The digital economy includes emerging phenomena such as blockchain-based networks, digital platforms and social media, e-businesses (e.g. e-commerce, parts of traditional sectors which use digital-enabled technologies in Industry 4.0 or precision agriculture); businesses involved in the development of software, apps and other content and media creation, and associated training and services; and businesses engaged in creating and manufacturing ICT equipment.



Figure 18 Broadest and narrowest definitions of the digital economy

TECHNOLOGY

WHAT IT DOES AND HOW IT'S USED



Sensors networks and the Internet of Things (IoT) – including drones and automated vehicles

Environmental monitoring and remote automation on smart farms, smart cities, autonomous vehicles, drones, remotely operated mines and defence systems. These are often integrated into advanced GPS or geospatial systems. Requires supportive wireless broadband networks and cloud-based services.

Can create cyber-physical-biological systems – used to monitoring plant, animal or environmental systems or human health through sensors and wearable technology.



Big Data Analytics

Customised services and profiling, security assessments, large systems modelling such as environmental and weather systems, markets, transport systems, health and genetic research. Can produce predictive analytics to anticipate behaviour, weather or maintenance for infrastructure for example.



AI, machine learning, robotics

Systems and robotics that can self-correct and adjust to changing environments, respond to a variety of circumstances or queries, and build on previous data inputs.

Applications in natural language processing and voice recognition, robotics including automated vehicles and factories, and health, transport and business services.



Blockchain technologies

Distributed ledgers and third party trust networks that have been used to create digital 'crypto' currencies – such as Bitcoin. They also have widespread applications in food and mining provenance, voting systems, payment networks, social networks, smart contracts, and trading platforms.



Virtual and Augmented Reality

Visual overlays to enhance performance, create games (such as Pokemon Go), or allow visualisation of new structures. Applications are found in medicine, training and development, entertainment, mining, real estate, tourism and in vehicles, eyewear and 'smart' homes.



Platform-based economy on cloud-based and mobile-accessed services

Although cloud-services and smart phones are no longer 'new' or emerging technology, the number of applications moving to cloud-based/mobile accessed services is still increasing, and changing behaviour. Mobile payment services (such as WePay, Samsung Pay, Apple Pay, AlibabaPay) – as well as the OTT services - particularly chat applications and entertainment services – are enabling new platform-based business models.

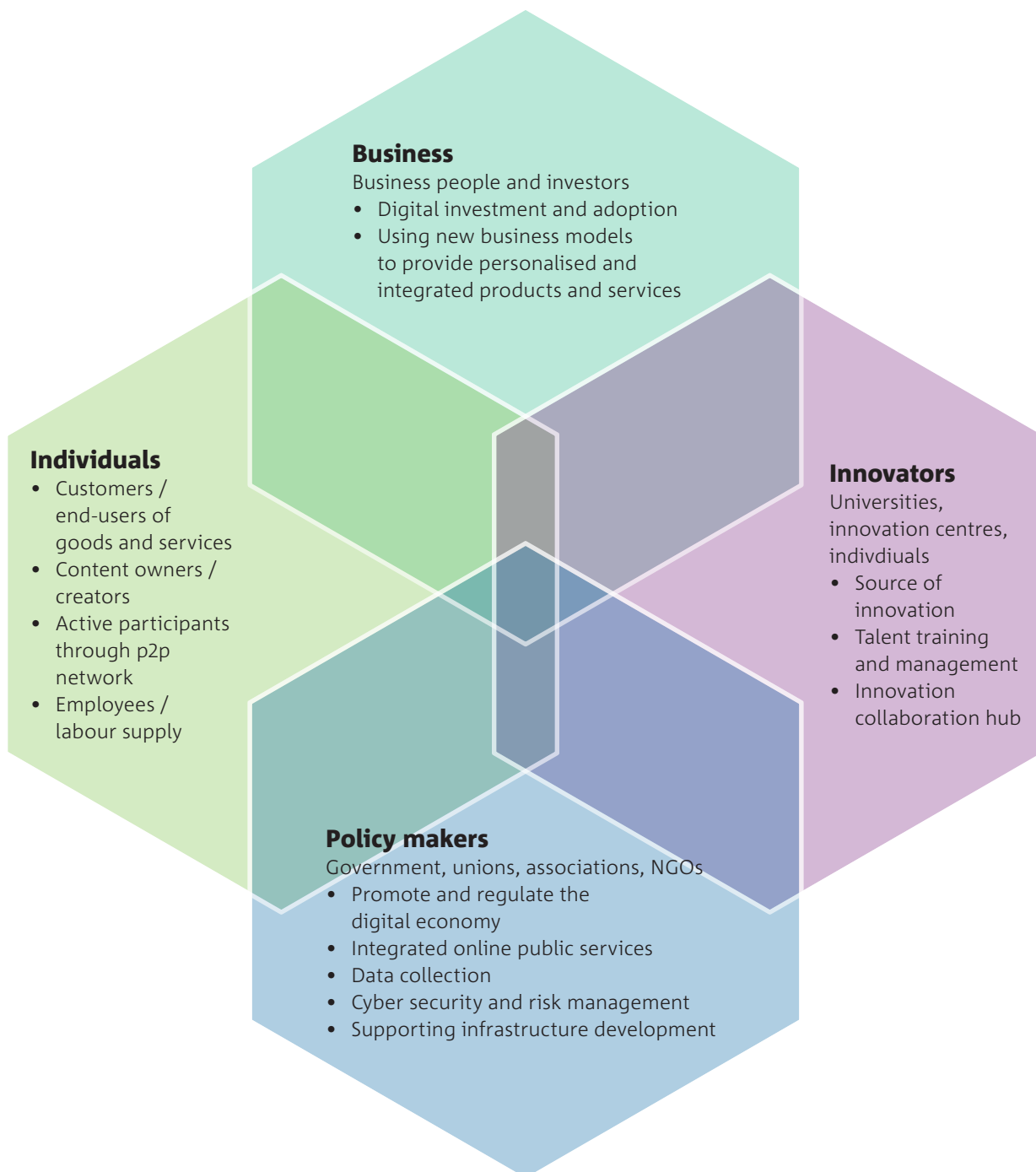


Figure 19 Digital economy stakeholders

2.3 Policies supporting the digital economy

The Vietnam Government views digital transformation across the broader economy as critical to continued growth and prosperity. Its commitment is seen in the number of policies, master plans and directives published over the last 30 years that have stressed the need to invest in critical infrastructure, build the ICT industry, promote e-commerce, and adopt technology as a means of lifting productivity. Recent policy documents to build the digital economy include:

- *Decision No. 392/QD-TTg* (2015), which sets targets on information technology development through to 2020 with a vision toward 2025;
- *Decision No. 149/QD-TTg* (2016), which sets goals for broadband and telecommunications infrastructure development through to 2020; and
- *Directive 16/CT-TTg* (2017), issued by Prime Minister Nguyen Xuan Phuc to strengthen progress towards Industry 4.0.

These directives and decisions address the need to dramatically expand Vietnam's national information infrastructure, strengthen its human resource base (especially IT professionals), and liberalise its legal and regulatory environment to encourage greater foreign investment and in the ICT sector.

For example, in Directive 16 above, Mr Prime Minister Nguyen Xuan Phuc directed the Vietnam Government to further support to technological modernisation of industry specifically through:

- **Focusing on developing new digital infrastructure and networks**
- **Speeding up reform to encourage businesses to adopt new technology** – including implementing e-government across government agencies and reviewing related regulation and services.

- **Prioritising the development of the Vietnamese ICT industry** in government policy and reform, and promoting the take-up of smart technologies across all industries.
- **Building the innovation eco-system** through further funding for scientific and research infrastructure and institutions, creating international relationships, and promoting tech start-ups.
- **Building technological skills** through a focus on STEM education and training from early childhood through to adult education.
- **Raising awareness at all levels, and in all sectors, of the opportunities and challenges of the 4th Industrial Revolution**, ensuring at all areas of Vietnam's society and industry are prepared for the changes ahead.

INCREASING EMPHASIS ON CREATIVITY AND FREEDOM TO PROMOTE ENTREPRENEURIALISM AND INNOVATION

The Vietnam Government has also linked increased innovation (including the development of the digital economy) as a driver of economic growth, with increasing creativity and experimentation, and a culture of openness and freedom.

In 2016 Vietnam's Ministry of Planning and the World Bank published *Viet Nam 2035: Toward Prosperity, Creativity, Equity and Democracy* which stated:

In the long term, countries with more open and inclusive political institutions generate greater room for innovation and personal creativity, thus stimulating productivity improvements and higher standards of living. For Vietnam, finding ways of building more open and accountable political institutions will eventually be essential.⁴⁹

IMPROVING THE REGULATORY FRAMEWORK

Multiple agencies are charged with supporting and regulating different aspects of the digital economy in Vietnam, and no single regulation governs all its aspects: the current regulatory framework is a patchwork of commercial regulations and decrees under various ministries. The main agency regulating telecommunications and the ICT industry is the Ministry of Information and Communication. Other agencies involved in supporting the digital economy in Vietnam can be seen in Figure 20. The most important legislation in the area is summarised in Figure 21. A more detailed list of digital regulations can be found in Appendix 2.

Modern laws are in place for electronic transactions (2005), information technology (2006), telecommunications (2009), radio frequencies (2009) and network information security (2015). The government has issued a series of decrees and decisions to provide detailed guidance on these laws. The regulatory framework is further enhanced by Vietnam’s international trade and free trade agreements (e.g. AEC, EU-VN) and bilateral agreements with Korea and Japan.

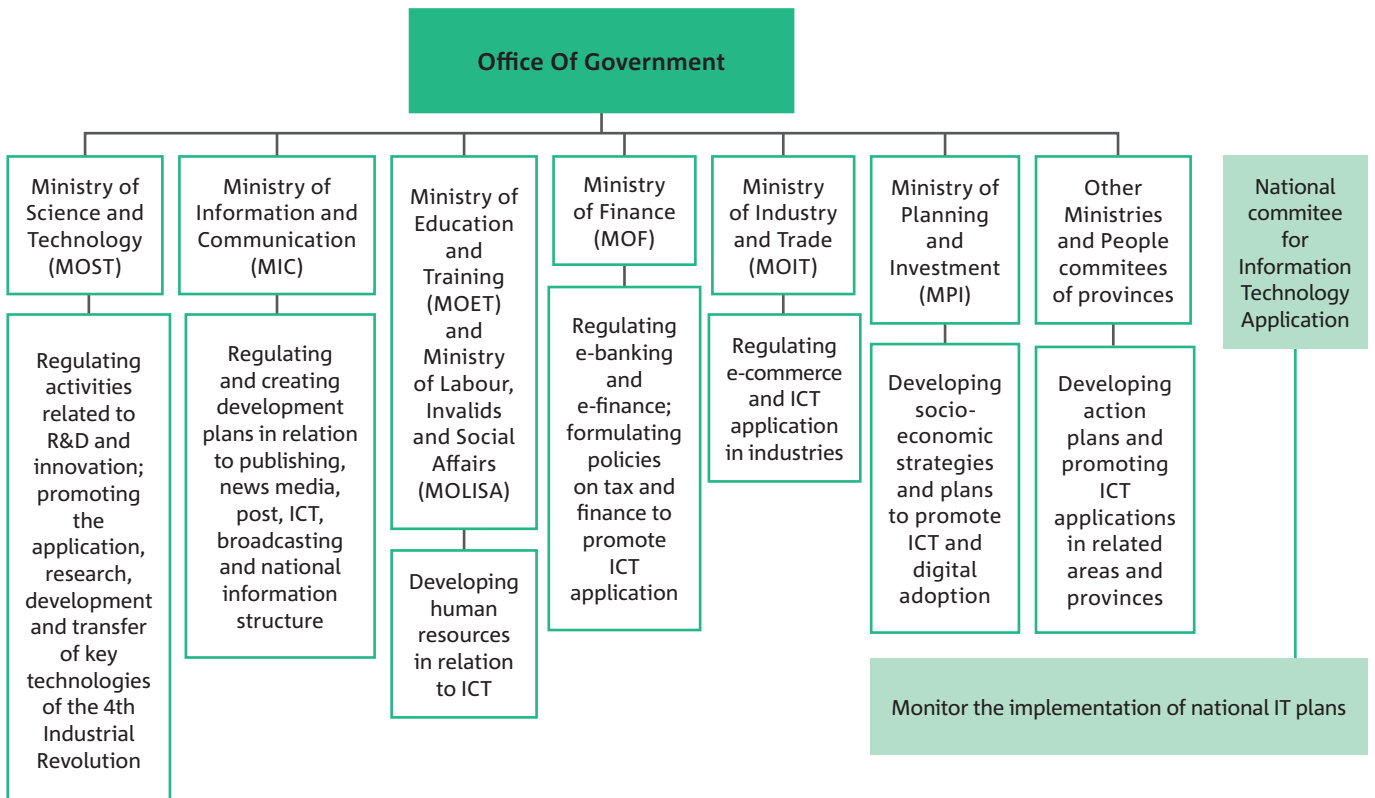


Figure 20 Main regulators of the digital economy in Vietnam

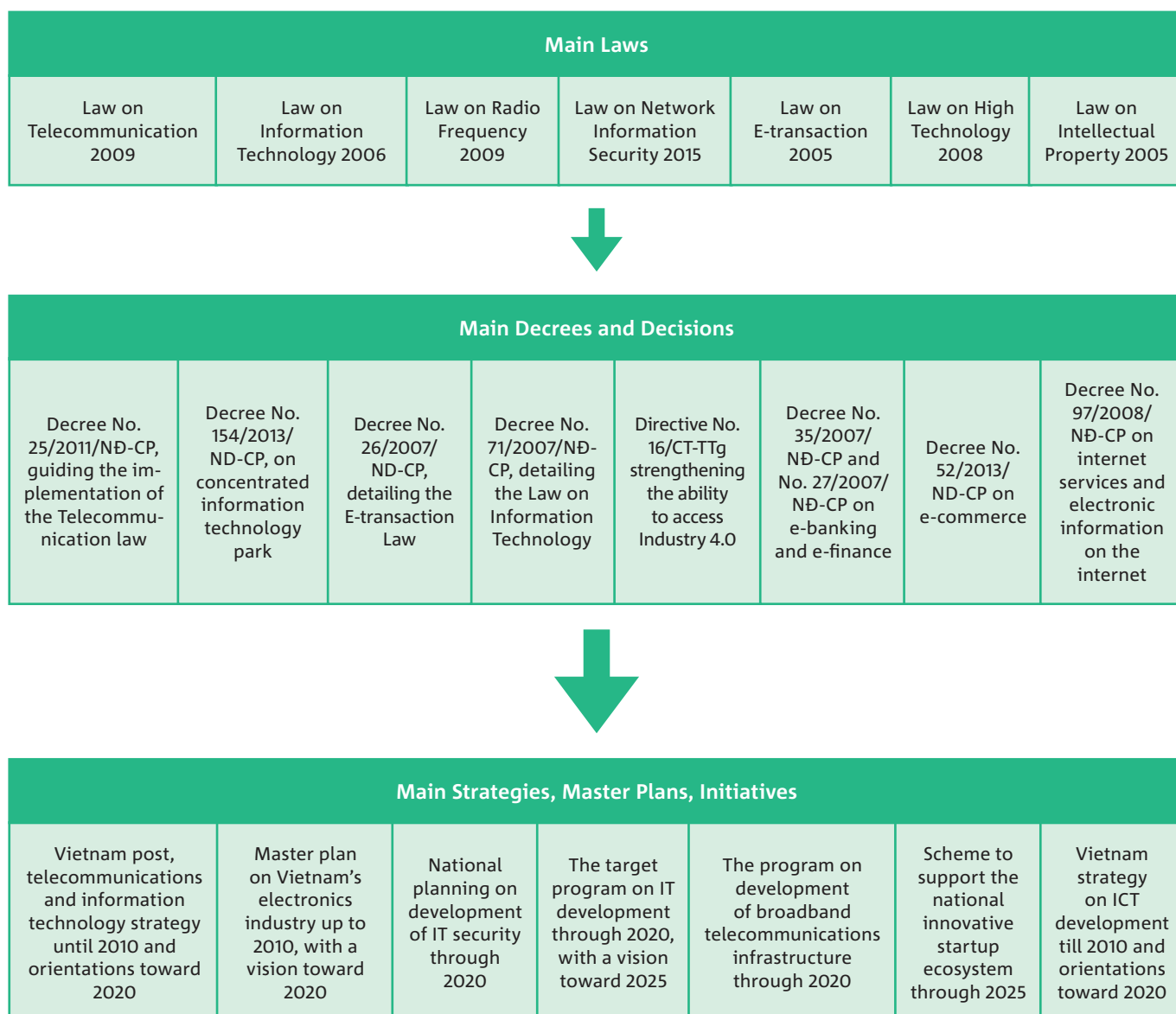


Figure 21 Updates on major regulations relating to the digital economy

2.4 Supportive telecommunications infrastructure

EXPANDING DIGITAL INFRASTRUCTURE AND COVERAGE

Reliable telecommunications infrastructure is critical to the development and expansion of the digital economy in Vietnam. Existing infrastructure has so far accommodated the voracious demand for bandwidth, but issues are arising with dropouts from undersea cables, local congestion on the network, and mobile phone connectivity and coverage.

BACKBONE INFRASTRUCTURE

The backbone Internet network in Vietnam is built on fibre optic technology using dense wavelength division multiplexing and synchronous digital hierarchies. One overland and six submarine cables connect Vietnam to the rest of the world. The submarine cables include the Asia America Gateway (AAG) cable, which runs via Hawaii to the USA; the Intra Asia cable; the SMW3 cable (Southeast Asia, Middle East, Western Europe); and TVH cable (Thailand, Vietnam, Hong Kong). Most of the country's connectivity relies on the AAG cable.¹⁶ Unfortunately, it seems to be the least reliable connection, and has already suffered serious outages.^{100,101}

The Vietnam National Internet Exchange (VNIX) was launched in 2003. It transfers domestic Internet traffic between service providers across three regions: the North (Hanoi), the South (Ho Chi Minh City) and the Middle (DaNang). In January 2018, the VNIX bandwidth was 211 Gbps with total network traffic reaching nearly 40 million gigabytes.¹⁰²

In 2008 Vietnam successfully launched its third satellite service, the Vinasat I satellite, to supplement terrestrial Internet connections and reach areas that are too expensive to connect via overland cables. However, while Vinasat I has high capacity and can transmit Internet services to all regions of the country, satellite signals tend to be weaker and less reliable in a range of weather conditions.

MOBILE PHONE COVERAGE AND SPECTRUM USE

Terrestrial 3G mobile wireless services were launched in Vietnam in 2009 and 4G services were licensed in early 2016. In October 2016 four telecommunications companies were granted licences to install 4G LTE networks, with a view to supporting Internet of Things applications and Smart City infrastructure. These networks are currently being rolled out.¹⁰³

In early 2018 the mobile network covered all 63 provinces of Vietnam: 43,000 4G stations have been deployed nationwide, covering 95% of the country's population. Vietnam also has plans to introduce 5G networks by 2020.¹⁶ Viettel, VNPT and Mobifone are the dominant companies in the telecommunications market, together holding more than 90% of total market share.¹⁰³

Despite the improved Internet coverage, a substantial gap remains in access to mobile broadband services between remote rural or mountainous areas and urban areas.¹⁰⁴

CONNECTION SPEEDS AND NETWORK SECURITY IMPROVING

With average download speeds of 9.5 Mbps, Vietnam is ranked ninth in the Asia Pacific region and 58th in the world in terms of average connection speed, above China, Malaysia, Indonesia and the Philippines.¹⁰⁵

Vietnam has a growing number of secure Internet servers. These are critical to e-commerce as they encrypt online transactions, helping customers to trust and engage with online retail. However, at 19 secure Internet servers per 1 million people¹⁰⁶ Vietnam still has significantly less secure servers per capita than the world average (215), South Korea (2201) and Thailand (33).¹⁰⁶ It is close to the number in China (21), and greater than Indonesia (10).¹⁰⁶

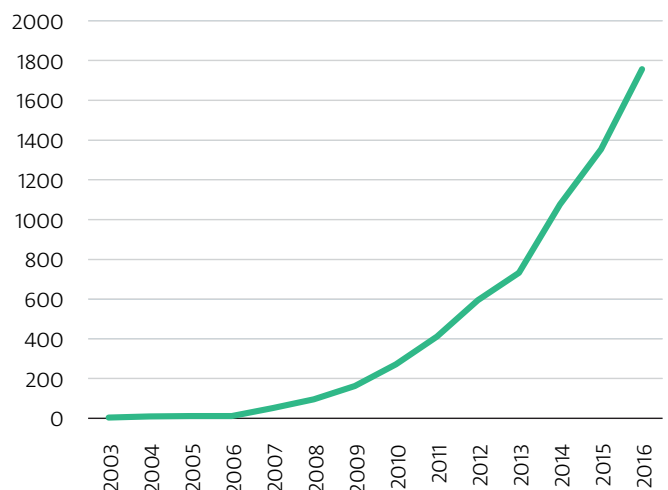


Figure 22 Number of secure Internet servers in Vietnam

Source: World Bank¹⁰⁶

SPECTRUM USE AND ALLOCATION

Spectrum allocated for use by the mobile phone and broadband sector in Vietnam sits in the 630 MHz range. Economic returns are higher than for spectrum allocated for other purposes, such as radio and television. Some US\$5021 million economic benefit was generated by the mobile network spectrum in 2015. This is expected to reach US\$8211 million in 2020.¹⁰⁷ The efficiency of the mobile spectrum has increased over time.¹⁰⁷

There is increasing demand for more spectrum to be allocated for mobile broadband use.¹⁰⁷ Mobile subscriptions have grown by 2 million per year since 2012, and millions of new services are predicted to come online over the next decade.¹⁰ It is highly likely that most people connected to the Internet in the future in Vietnam will be connected through mobile devices alone. The expanding Internet of Things will create further traffic and congestion on the existing spectrum allocated for mobile use. It is estimated that around 75% of connections in 2020 will be to machine-to-machine devices via short-range wireless services.¹⁰⁸

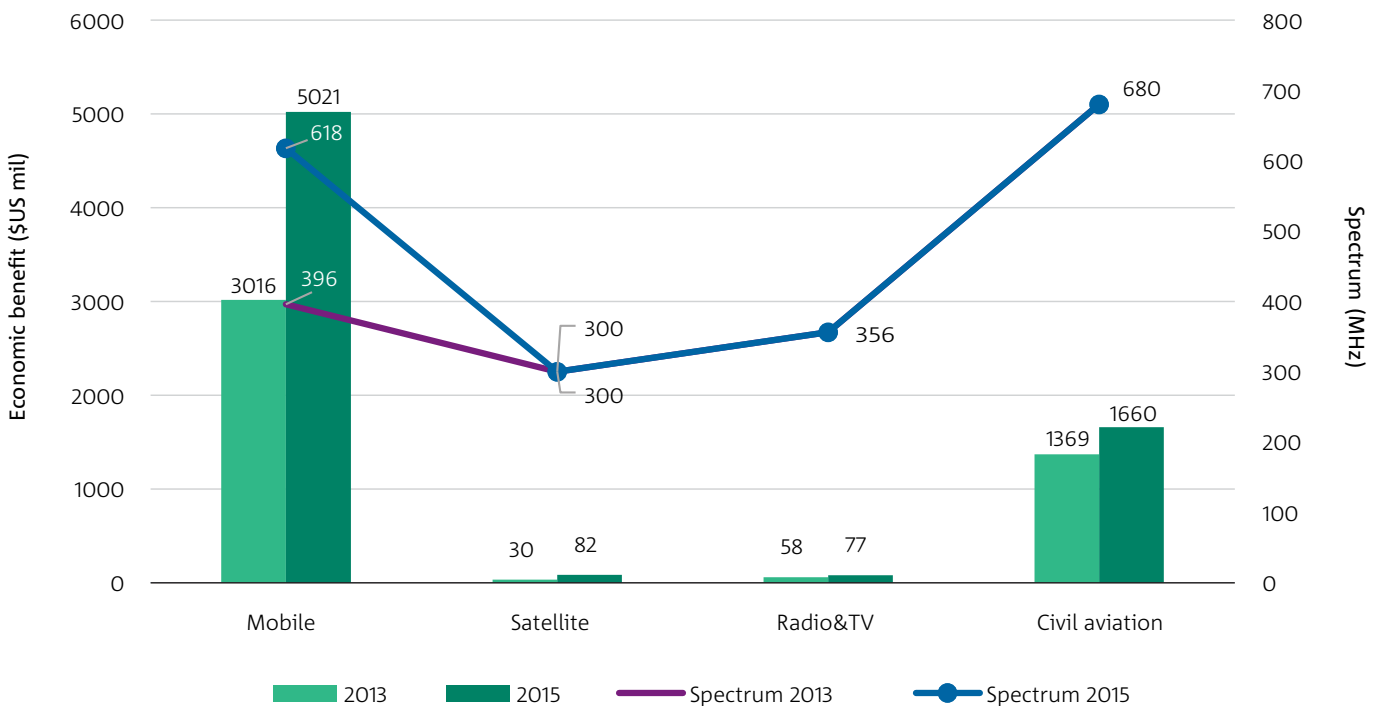


Figure 23 Economic benefit from spectrum based sectors, 2013-2015

Source: Vietnam National University and Economic Research Institute of Post and Telecommunication¹⁰⁷

2.5 Digital adoption

VIETNAM'S APPETITE FOR DIGITAL IS INCREASING

The adoption of high-speed Internet services, smart devices and mobile phones in Vietnam has been comparatively high since 2003, outstripping adoption in countries such as Pakistan, India and Indonesia. In 2017, more than half of the country had Internet access, compared to around 15% a decade ago.¹⁰⁹ Rural areas still lag behind metropolitan areas, although the provision of satellite and wireless services is now boosting take-up rates in even the most remote provinces.

The adoption of broadband Internet services is also increasing in the business sector. The share of manufacturing and service firms using the Internet for business activities rose to 71% in 2007 and 86% in 2011.¹¹⁰ Around 500,000 Vietnamese business accounts had been created on Alibaba.com by 2016. Over the last three years, the number of accounts increased by an average of 100,000 per year.¹¹¹

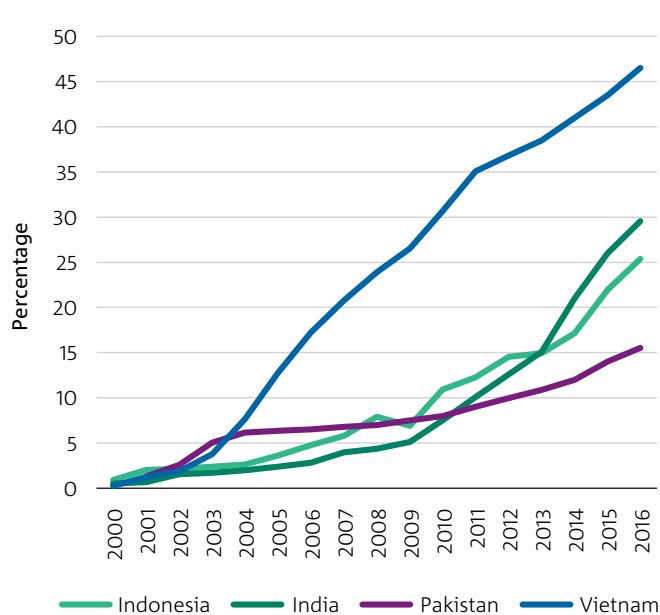


Figure 24 Proportion of population using the Internet by country

Source: World Bank⁶⁸

Vietnam has the highest number of registered domains in ASEAN: there are around 422,000 active '.vn' domain names, from a total of nearly 1 million domains registered in ASEAN nations. Vietnam also has around 16 million allocated IPv4 addresses.¹⁰²

WIRELESS RATHER THAN FIXED BROADBAND

Vietnam's Internet use is dominated by mobile phones. From 2005 to 2016, the number of mobile subscriptions increased nine-fold. By 2017, Vietnam had 136 million mobile subscriptions. This is 144% of the total population, with many Vietnamese have more than one mobile subscription.¹¹² More than half the mobile phones used in Vietnam are smartphones able to access the Internet.

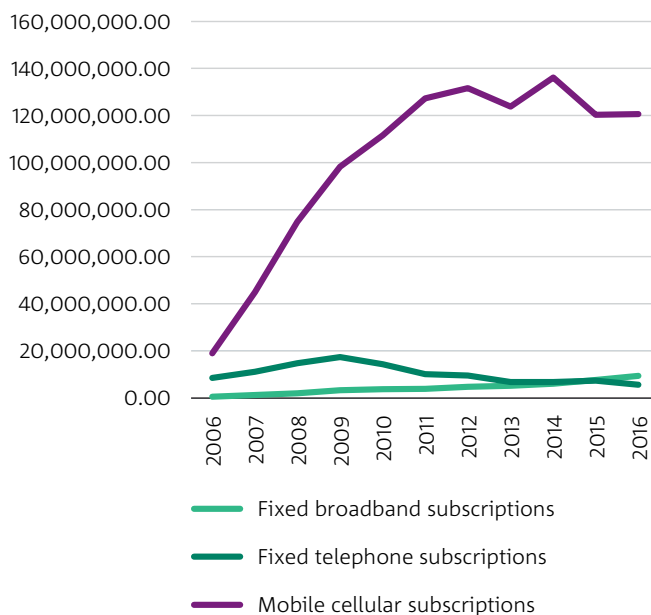


Figure 25 Broadband take-up in Vietnam – number of connections, 2006-2016

Figure: World Bank⁶⁸

2.6 ICT – the booming base of Vietnam’s digital economy

Information and communications technology (ICT) is one of the fastest-growing industry sectors in Vietnam. In 2016 total revenues from the ICT industry were US\$67.7 billion, nearly ten times the figure in 2010 (US\$7.6 billion).¹¹³ The hardware industry is the largest subsector of Vietnam’s ICT industry, contributing around 85% of total revenue.¹¹²

ICT equipment accounted for around 25% of total exports from Vietnam in 2016, up from less than 10% as recently as five years ago.⁶⁷ It is now the country’s largest export sector, with telephone and broadcasting equipment particularly important. Leading Vietnam-located manufacturers such as Samsung, Intel, Dell and LG are expanding their businesses and increasing investments in the country.^{114,115} Vietnam assembles electrical and electronic products, and increasingly exports sophisticated computing devices: half of Samsung’s high-end S8 and S8 Plus phones and more than 80% of Intel’s personal computer central processing units are produced in Vietnam.¹¹⁶ Over the last decade, Vietnam has surpassed

most regional neighbours including India and Thailand in terms of high-tech exports as a percentage of total manufactured exports.

Local companies in the ICT sector are experiencing remarkable growth, with share prices increasing more than three-fold since 2012.¹¹⁷ Larger companies include VC Corporation, Viettel and FPT.

The software industry is also growing steadily and starting to attract global attention as a significant regional hub.²⁴ Local businesses account for the majority of the market, supplying low-cost software products.

In 2016, a total of 7,433 businesses in Vietnam created digital software for sectors such as finance, telecoms, smart agriculture and government. IT outsourcing services generated around US\$3 billion.¹¹⁸ Vietnam has overtaken India to be Japan’s second-largest software outsourcing destination, behind only China.¹¹⁹

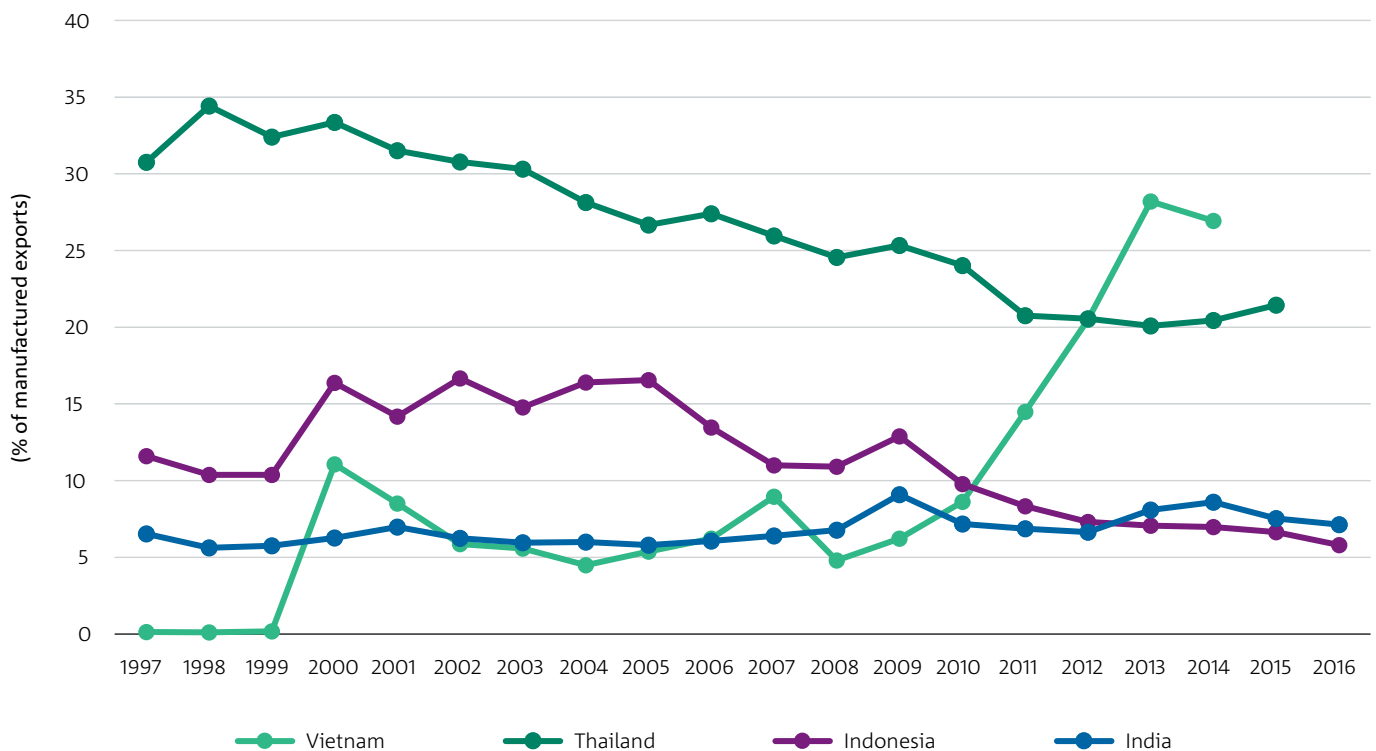


Figure 26 High-technology exports across economies (% of manufactured exports), 1997-2016

Source: Vietnam Customs⁶⁷

TOTAL REVENUES VIETNAM ICT INDUSTRY

	2015 (US\$ MILLIONS)	2016 (ESTIMATED, US\$ MILLIONS)	GROWTH RATE (ESTIMATED)
Revenue of hardware: electronic industry	53,023	58,838	10.97%
Revenue of software industry	2,602	3,038	16.80%
Revenue of digital content industry	638	739	15.83%
Revenue of IT services (not including trade and distribution)	4,453	5,078	14.04%
Total revenue of IT industry	60,715	67,693	11.49%

Source: Ministry of Information and Communication¹⁰³

NUMBER OF ENTERPRISES VIETNAM ICT INDUSTRY

	2015	2016 (ESTIMATED)	GROWTH RATE (ESTIMATED)
Hardware, electronic industry enterprise	2,980	3,404	12.46%
Software industry enterprise	6,143	7,433	17.36%
Digital content industry enterprise	2,339	2,700	13.37%
IT services enterprise (not including trade and distribution)	10,196	10,965	7.01%
Total number businesses	21,658	24,502	11.61%

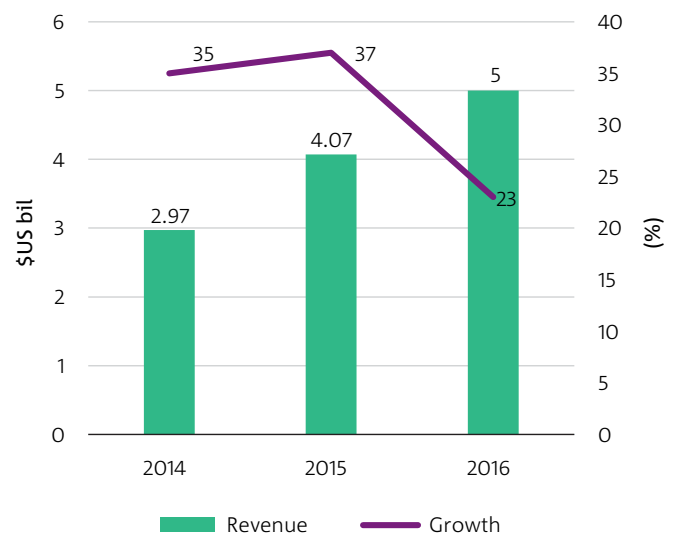
Source: Ministry of Information and Communication¹⁰³

MOVING TOWARDS DIGITAL ECONOMY MATURITY WITH E-COMMERCE

E-commerce is one of the fastest-growing segments of Vietnam's digital economy. According to the Vietnam E-commerce and Information Technology Agency (VECITA), the country's e-commerce market is growing by 35% per year – 2.5 times faster, for example, than Japan.¹²⁰

Vietnam's online retail revenues reached US\$5 billion in 2016, more than double those of 2013 (US\$2.2 billion). VECITA expects the number of online shoppers will increase by 52% by 2020.⁷

The Internet has become important in information exchange between enterprises, especially firms exporting or importing. Almost half of Vietnam's businesses own a website (49%) and a third of businesses (32%) have set up relationships with foreign partners through online channels.¹²¹



	2014	2015	2016
% of Internet users involved in e-commerce	58%	62%	65%
Estimated e-commerce expenditure per person (US\$)	145	160	170

Figure 27 Vietnam B2C e-commerce landscape

Source: Vietnam E-commerce Association¹²²

E-commerce within Vietnam and around the world is evolving with the rapid development of mobile payment applications – such as WePay, ApplePay, SamsungPay – and the emergence of global cryptocurrencies that can use digital wallets to allow people to both transfer funds peer-to-peer across the Internet, as well as pay for goods and services locally. Payments in global crypto-currencies are often able to avoid transactional costs associated with currency exchanges, bank fees and credit card payments.

EMERGING AND EXPANDING SHARING AND PLATFORM ECONOMY

The sharing economy has been facilitated by cloud-computing platforms, the high rate of adoption of smartphones, and Vietnamese consumer preferences for low personal asset ownership.

For example, in the last five years ride-sharing platforms and apps such as Uber and Grab have created competition for traditional taxi businesses. Vietnam was the first country in Asia to attract Uber, and, excluding China, was Uber's fastest-growing market globally in 2015.¹²³ More people use Grab in Vietnam than in any other country. Traditional taxi services in Vietnam are increasingly developing their own platforms and mobile apps to compete with the newer market entrants.

Peer-to-peer lending also on the rise in Vietnam, with platforms such as Timma, Vaymuon and Mofin offering loans to individuals and Lendbiz offering business loans. Through the Lendbiz service, businesses can apply for up to 1 billion VND (US\$44,000) loans without collateral, and these can be approved within 24 hours. The Lendbiz platform is attractive to investors: barriers are low, with only 500,000 VND (US\$22) needed to join, and there is the potential to achieve high returns with yearly interest rates up to 20%.¹²⁴

The platform economy benefits a range of groups, including companies, investors, employees, and consumers, who now have more efficient access to services. Their new business models offer new income streams and employment opportunities, either full-time or part-time through freelance or contracting.

DIGITAL CONTENT ON A ROLL

Social media

While television and newspaper maintain their footholds, growing mobile device ownership is fuelling demand across the country for digital content and news. There are 240 social networking sites and 63 integrated digital news outlets in Vietnam.¹¹² Facebook is by far the most popular social network, with a third of the population owning Facebook accounts.¹¹³ The Vietnam Government is promoting the development of local social media networks through initiatives such as *The Digital Vietnamese Knowledge Platform*. This open platform encourages users to develop apps and other software (including social networks and media) using government data and infrastructure.^{125,126}

Online ads

Vietnam's online ad industry is growing rapidly, reaching US\$390 million in revenues in 2016. This is expected to triple by 2020.¹²² In 2014, social networks overtook search engines to become the most-used online advertising method for enterprises in Vietnam.¹²² Apart from enterprises, most ad patrons are household businesses and individuals selling goods and services online. These groups have contributed the most to the growth of advertising on social networks.

Over-the-top services

Over-the-top (OTT) services such as Zalo, Skype and Viber are replacing traditional voice and SMS services. Mobile messaging via apps surpassed traditional messaging via SMS in Vietnam in 2012.¹⁶ Major operators including Viettel and VNPT are now shifting to offer their own OTT services, such as Viettel Mocha or Viettalk, to compete.

Games

Vietnam has become one of the biggest markets for online games in South-East Asia. In 2017, Vietnam ranked 28th out of 100 countries in total game revenue (US\$367 million), exceeding the Philippines and Singapore.¹²⁷ VNG, Vietnam's largest provider of online games, is valued at US\$1 billion by market research firms.¹²⁸ Most of the growth comes from the mobile games market: game apps in smartphones increased by 37% in 2016,¹²⁹ and as much as 60% of smartphone app revenue in Vietnam comes from games. Flappy Bird, by Vietnam's Nguyen Ha Dong, was the most-downloaded free game in the iOS App store in 2014.¹³⁰

DELIVERING E-GOVERNMENT SERVICES

E-government services have diffused rapidly in Vietnam. As in other developing countries, government agencies and service providers have adopted digital services before many businesses.¹³¹ This is not surprising, as most firms in Vietnam are small and many operate informally.

In 2015, Vietnam issued Resolution 36a/ND-CP to:

Promote the development of e-government, improve the quality and effectiveness of state agencies to better serve people and enterprises, improve Viet Nam’s position on e-government under the UN ratings, and ensure openness and transparency in state agencies.

Between 2014 and 2016, Vietnam rose 10 places to rank 89th out of 193 countries and territories on the United Nations’ e-government development index (EGDI).²¹ It was among ten countries which made the leap from middle-EGDI to high-EGDI values.²¹

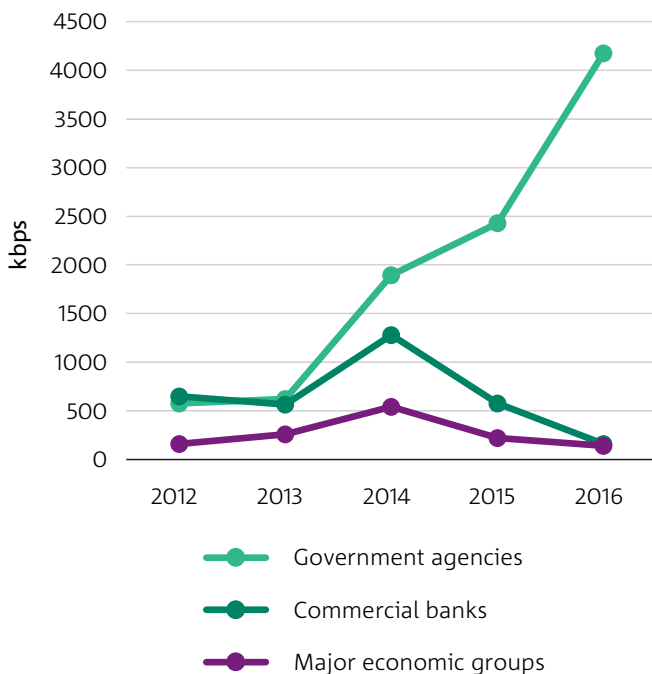


Figure 28 Internet broadband bandwidth per employee across agencies in Vietnam

Source: Ministry of Information and Communication and Vietnam Association for Information Processing⁹⁴

The main focus of Vietnam’s e-government initiatives is on developing governmental administrative systems in finance, customs and tax management. These efforts seem to be paying off. In a survey by the Ministry of Industry and Trade in 2016, 74% of firms reported using the online public service. Online tax management was the most frequently used public service (88%), followed by online business registration (41%) and customs declarations.

The Government has also focussed on developing and supporting underlying platforms and infrastructure including for IoT and Smart Cities development, Open Data and Right to Information portals, and inter-agency communication.¹³²

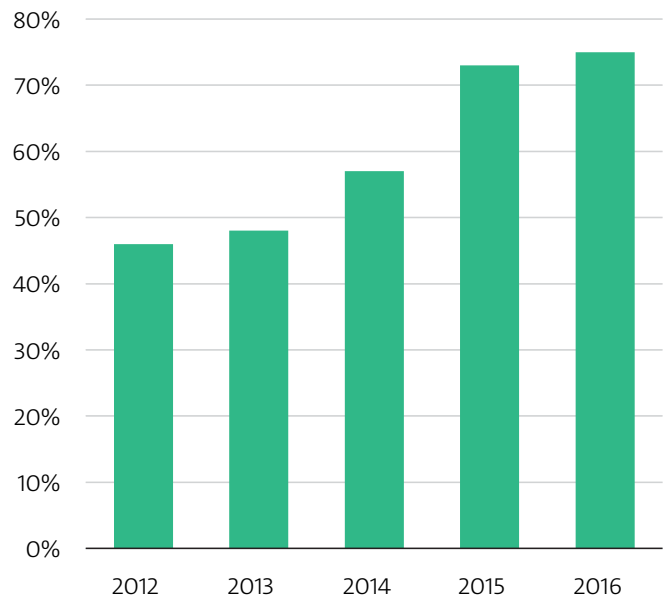


Figure 29 Business usage of online public services in Vietnam (%)

Source: Vietnam E-commerce Association¹²²

SUNRISE INDUSTRIES

Fintech

Digital technologies have given rise to new business models and emerging 'sunrise' industries. Financial technology (fintech) services and products have been among the fastest growing. In 2017, Vietnam had 48 fintech firms providing services from payment to remittances and cryptocurrency.¹³³

Though payments still accounts for a large proportion of fintech startups (48%), emerging segments such as insurtech (insurance), wealthtech (wealth) and regtech (regulation) are attracting interest from both local and international investors.

Telehealth

Government health agencies are examining how e-health can provide services to an aging, diverse and geographically dispersed population. For example, the Department of Health in Quang Ninh Province is deploying a telehealth network system to provide immediate healthcare services to rural and remote communities in mountainous regions or islands, which can be a day away from city centres by car. Vu Xuan Dien, Director of Quang Ninh Department of Health, states:

The telehealth network has completely changed our levels of service to communities in the province and reduced the workload pressures on our clinical staff.¹³⁴

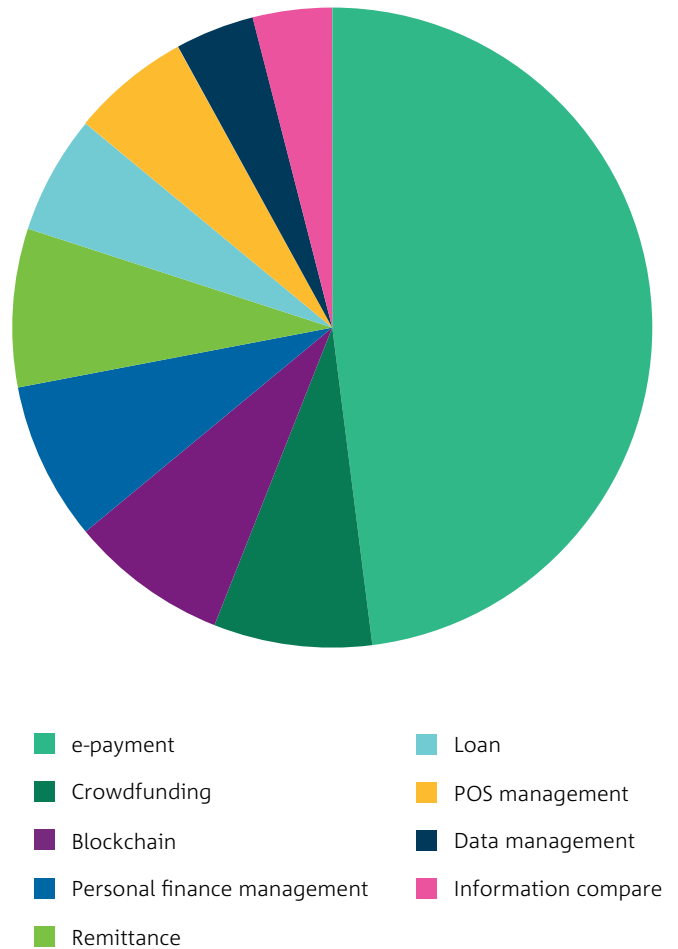


Figure 30 Fintech segments in Vietnam

Source: State Bank of Vietnam¹³³

2.7 Industry 4.0 – the next wave

There is a long history of industries, particularly manufacturing, being revolutionised by waves of new technology. In the early 1800s, the First Industrial Revolution started the transition from hand production methods to machine production powered by steam and water engines. The Second Industrial Revolution saw the introduction of electricity, assembly lines and mass production. The third wave, or the Digital Revolution, started to harness the power of computers and automation in manufacturing.

Industry 4.0 is the next, and possibly most dramatic, wave of digital and online transformation. It will change the structure and dynamics of many industries through further automation, cyber-biological-physical systems, big data analytics, sensor networks, artificial intelligence and the Internet of Things.

MANUFACTURING 4.0

There are many opportunities for manufacturing to utilize Industry 4.0 technologies.

The 4.0 factory will have machines-to-machine communication, use artificial intelligence for machines to make automatically make routine production decisions, and provide human operators with rich data to inform more complex decision-making. Analytics can be used to forecast consumer demand, predict machine failures, show indicators of production quality in real-time, and help optimise the entire production process.¹³⁵

Operations management within factories will be seamlessly linked to market intelligence and analytics, with greater ability for consumers to order customised low-volume products directly from the factory. Supply chains and distribution can also be assessed, communicated with, and adjusted based on varying market conditions and consumer demand. This will result in greater responsiveness, efficiency and agility in getting products to market, and reducing production waste.^{136,137}

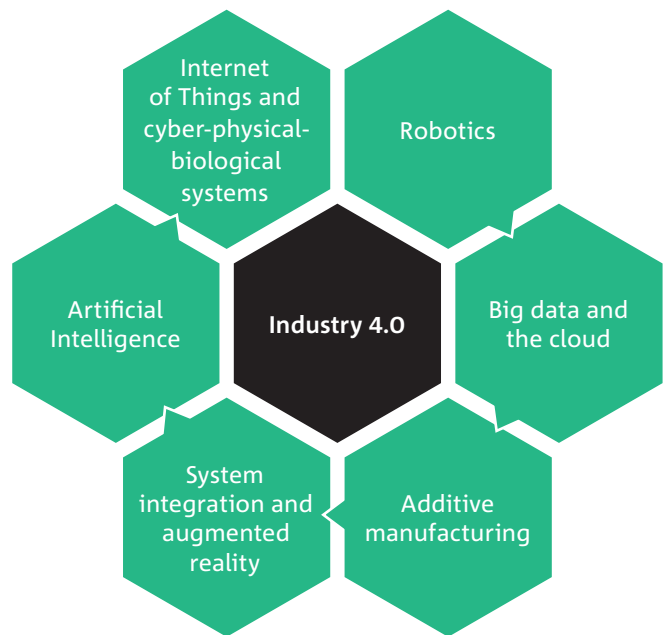


Figure 32 Main technologies in Industry 4.0

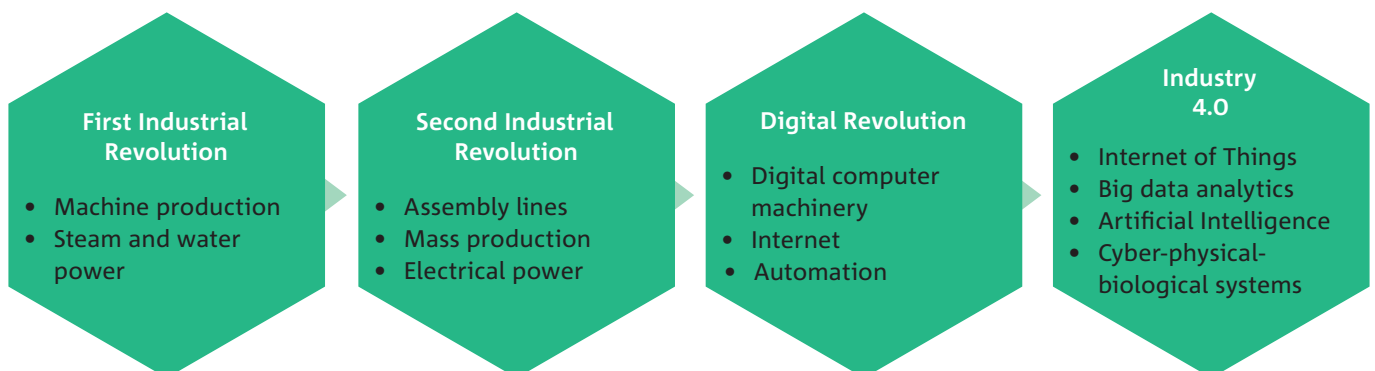


Figure 31 Stages of industrial revolution

AGRICULTURE 4.0

The agriculture sector is also set to see radical change through the implementation of Agriculture 4.0, also called ‘smart agriculture’ or ‘precision agriculture’.

Agriculture 4.0 optimises crop inputs based on actual crop needs with the aid of technologies such as GPS, remote sensing networks and the Internet to create cyber-physical-biological systems.¹³⁸ These systems can provide real-time intelligence on soil conditions, plant and animal needs, weather conditions, crop yield and market demand. All of this information can dramatically improve yields, nutritional value, animal welfare, and systems waste.¹³⁹

Agriculture 4.0 can also harness blockchain distribution networks. Blockchain can provide paddock-to-plate visibility of food available in shops. This has the potential increase consumer trust in Vietnamese produce, and improve value-added components of food – such as nutritional value, geographic sourcing, animal welfare, and ‘organic’ attributes.^{140,141}

Agriculture 4.0 has begun to be implemented in Vietnam’s rural areas, especially with high value-added products such as aquaculture, flowers and fruits. For example, in 2016 a wireless sensor network was set up in a Vietnamese fish farm in Dong Thap Province, next to the Mekong River, to control water quality and prevent fish diseases. If implemented more widely, real-time monitoring on fish farms could help cut production losses by 40-50%, equating to a difference in turnover for each farm of at least US\$12,000 every six months.¹⁴² Similar projects are being conducted across the country, with support from government policy and lower loan interest rates.



IMPLEMENTING INDUSTRY 4.0.

Introducing Industry 4.0 across large sectors such as manufacturing and agriculture is not without its challenges. For instance, legacy systems in both agriculture and manufacturing are expensive and complex, and introducing Industry 4.0 technologies often requires capital-intensive investments across the entire business operation. Most equipment currently used in both the agriculture and manufacturing sectors is analogue and managers and staff have not been trained in implementing or using more digitally connected systems.

In many rural areas, there is not the telecommunications infrastructure to support Internet of Things and sensor-based networks – such as low-powered wide area networks – and there is low trust in the security of networks.

It is likely that the take-up of Industry 4.0 technologies will take a number of years across both sectors, but will be driven by large productivity and profits gains.¹³⁹

DISRUPTING JOBS

Overall industry 4.0 has the potential to markedly lift labour productivity across sectors. However, because this can be done through high levels of labour replacement, there is also the risk of significant job losses and higher unemployment, particularly at a local level. The International Labour Organization reports that more than two-thirds of South-East Asia’s 9.2 million textile and footwear jobs (including 86% of those in Vietnam) are at risk from automation through smart technologies.¹¹

There is also growing anxiety in the Vietnamese population about the impacts of Industry 4.0. A recent survey among SMEs in Hanoi found 55% of the SMEs interested in Industry 4.0 believe that Industry 4.0 will have a profound impact on Vietnam’s economy, mostly through job losses to due to automation.¹⁴³



3 CHALLENGES AND OPPORTUNITIES

Vietnam has transformed rapidly over the last three decades, and the next 20 years are likely to see it transform at an even greater pace. This will present a number of opportunities and challenges.

CHALLENGES FOR VIETNAM:

- Increasing labour productivity and moving from a middle-income to high-income country:** Only a little over 10% of countries that had achieved middle-income status by 1960, according to the World Bank, went on to achieve high-income status by 2008.¹⁴⁴ Vietnam faces a significant challenge over the next two decades to avoid being caught in the ‘middle-income trap’. One risk is that investment and growth may taper off due to reduced competitiveness caused by increasing labour costs and too little investment in infrastructure and labour-saving technology. Alongside a failure to invest in productive technology, infrastructure, skills and enterprise, reasons why other countries have

remained trapped at middle-income level include political instability and inefficient public administration, regulation and expenditure. Over the last three decades the economy of Vietnam has expanded rapidly on the increased availability of labour inputs, but increases in labour productivity through the implementation of technology have been limited.⁵ For Vietnam to escape the middle-income trap, labour productivity must increase sharply over the next decade.

- Digital disruption:** While labour productivity must rise through technological innovation, rapid job losses due to job replacement are a significant risk for the economy of Vietnam. The International Labour Organization reports that around 70% of jobs in Vietnam are at high risk of being replaced through automation over the next two decades.¹¹ Vietnam was identified as the country most at risk of digital disruption in the examined five ASEAN nations – Philippines, Thailand, Indonesia and Cambodia.¹¹



Figure 33 Percentage of wage workers at high risk of automation in ASEAN-5

Source: International Labour Organization¹¹

This is due to high levels of employment in the manufacturing sector in Vietnam, particularly in the clothing, agricultural and retail sectors. The occupations identified to be most at risk include shop sales assistants, garden labourers and sewing machine operators. Women, workers with less education and those in low-paying jobs are more likely to be impacted by automation than other parts of the workforce.¹¹ Large and discrete populations of the Vietnam workforce will need to be reskilled and new industries will need to develop to avoid rises in unemployment.

- **Urbanisation and increased internal population migration:** As noted above, Vietnam will continue to urbanise quickly over the coming two decades. It will be a challenge to manage population growth and infrastructure provision in rapidly growing urban areas, and the economic and social consequences of declining populations, particularly youth populations, in regional areas.
- **Climate change and increases in severe weather events:** The International Monetary Fund has placed Vietnam among the world's top five countries most likely to be affected by climate change and extreme weather events.¹³ Heatwaves, cold snaps, severe storms, typhoons, flooding and storm surges are increasing in frequency along its long sea coast and in the low-lying rich deltas of the Mekong and Red Rivers.¹³ Vietnam's two largest cities, Hanoi and Ho Chi Minh City, are both on low-lying coastal deltas and prone to flooding and storm events. Increased salinity in soils and water due to rising sea levels is already impacting food production in the river deltas, which supply most of Vietnam's domestic fresh produce as well as significantly contributing to the country's exports.¹³
- **Debt levels:** Public and private debt in Vietnam has been growing over the last five years. Public sector debt levels were 61.3% of GDP at the end of 2017, up from 45.8% in 2011.¹⁴⁵ Investing in infrastructure while managing debt will remain a challenge for Vietnam as the economy expands and the population urbanises. Private sector debt is also growing rapidly, with total debt (public and private) reaching 124% of GDP – exceeding the ASEAN-5 countries (Malaysia, The Philippines, Singapore, Indonesia and Thailand), other middle income countries and other countries at comparable stages of development.¹³ While inflation at the end of 2017 was low at 3.53%,⁵⁰ in the past sharp increases in debt in Vietnam have caused financial instability followed by surges in inflation to over 20%.¹³
- **Maintaining foreign direct investment:** FDI is an important driver of growth in Vietnam, accounting for 71.6% of total exports.¹⁴ Over the last 30 years, the government has introduced many regulations to bolster the climate for investment in Vietnam – for example, the 2015 Law on Investment and Law on Enterprise, which increased investment incentives and permitted foreign investment into a wider range of business sectors. While such changes have increased FDI,¹⁵ analysts warn that more reform is needed to maintain growth in the longer term.¹⁶ *The Master Plan on Economic Restructuring in 2013-2020* aims to address this issue by improving the country's business environment and providing more support to private enterprises.⁵ It focuses on the development of the digital economy and prioritises attracting more FDI into areas such as infrastructure and high tech manufacturing.¹⁴⁶
- **Increased inequality:** As noted in the introduction of this report, despite impressive reductions in poverty, there are growing concerns about inequality. With a small group of citizens now controlling large business interests that affect the lives of many Vietnamese people, increasing inequality has the potential to cause political and civil instability that could impact on FDI and the country's growth trajectory.
- **Skills shortages:** Vietnam faces considerable skills shortages. Unskilled workers still made up a substantial portion (38%) of the labour force in 2016,³⁸ despite large demand for skilled labour.⁴⁷ Across nine sectors, between 50% and 88% of employers reported problems with recruiting due to a lack of candidate skills.⁴⁷ Among 633 Japan-affiliated firms in Vietnam, 42.5% reported the quality of employees as a management problem.¹⁴⁷ Demand for IT workers is increasing by 47% per year, and to meet this demand Vietnam will need an estimated one million more workers in the sector by 2020.¹⁹ The lack of highly skilled IT professionals is leading to vulnerabilities, particularly in cyber security: Vietnam was ranked 101 out of 193 countries, below Myanmar, Laos and Cambodia, in a global cyber security index in 2017.¹⁴⁸ The first half of 2016 saw more than four times as many cyber security attacks and incidents as all of 2015.¹¹⁴

OPPORTUNITIES FOR VIETNAM INCLUDE:

- **Location and geography:** The centre of the global economy is moving from west to east and by 2050 will be located between China and India, which will by then be the world's largest economies.²⁰ Vietnam is a sizeable market in its own right, but is also well situated to operate across economies and cultures in the heart of Asia's fast-growing nations. It has overland trade routes between China and neighbouring countries Laos and Cambodia. Crucial maritime trade routes run along Vietnam's long coast through the South China Sea and Hanoi is on one of China's Belt and Road maritime trade routes, which are being developed to facilitate the transport of goods and services from China to Europe and the rest of the world.

Vietnam's long coastline and bio-diverse regions also provide opportunities for further building the fast-growing tourism sector. The country is home to 10% of the world's fauna, and 40% of the country's flora exist only in Vietnam.¹⁴⁹ According to the Ministry of Natural Resources and Environment, Vietnam is ranked the world's 16th-richest country in terms of bio-diversity.^{150,151} This may contribute to Vietnam's economy not only through eco-tourism but also through biodiscovery.

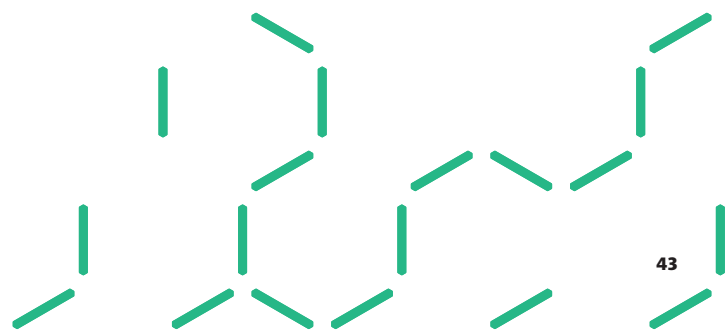
- **Young and educated population:** The median age in Vietnam is only 30.4 years,²¹ compared to 42.6 years in the European Union and 37.4 years in China.¹⁵² This means a relatively high proportion of the population in Vietnam (70%) is of working age.²² The workforce is well-educated. Universal primary education in Vietnam has been compulsory since 1991,¹⁵³ and adult literacy levels are high, at around 95%.²³ Youth literacy is even higher, at 98%.²³ Vietnam's students score highly on international rankings, comparing well with many OECD countries.¹⁵⁴ Although Vietnam has a skills shortage in a number of areas, there is a concerted government effort to invest in education, especially technical education.¹⁵⁵ Youth and education can be considered assets in economic and digital transformation.
- **A growing and entrepreneurial ICT industry:** As described above, Vietnam has fast-growing sunrise industries such as fintech, and the government has prioritised IT sector development with the *IT Master Plan*.⁶ Many Vietnamese software firms are also attracting software development outsourced and offshored from other countries.⁹⁶

- **Closer to global innovation and venture capital:**

Along with the shift in the centre of global economic gravity to the east, the world's technological centre is also moving towards the Asia Pacific region. Vietnam is growing its innovation capability, performing at least 10% above countries with a similar GDP level.¹⁵⁶ The 2017 Global Innovation Index (GII) ranked Vietnam 47th out of 127 countries, up 12 places since 2016, and the top lower-middle income country on the list.¹⁵⁶

Increasing numbers of patents are being filed by neighbouring countries, particularly China,²⁵ which now also ranks second only to the United States in providing global venture capital.²⁶ This may be advantageous for emerging technology start-ups in the region seeking access to finance for innovation.

- **A growing Asian middle class:** The global middle class is expanding rapidly: by around 2020 it is projected to make up over 50% of the world's population, compared to about 30% in 2010.²⁷ Future middle-class expansion is projected to be heavily concentrated in Asia (88% of the next billion new entrants), especially in China and India.²⁷ Vietnam will see a huge increase in the middle class: roughly 10% of the Vietnamese population were part of the global middle class in 2015,⁴¹ and by 2035 this is projected to increase to over half.⁴¹ As the Asian middle class grows, so will their spending. Middle-class spending in the Asia Pacific region is predicted to nearly triple between 2015 and 2030.²⁷
- **Booming tourism in South-East Asia:** Related to opportunities associated with location, geography and the growing Asian middle class, is the boom in tourism in Vietnam. Tourism is one of Vietnam's growing service sectors – contributing 13.9% to GDP in 2015 but predicted to grow to over 15.2% by 2026.²⁸ In 2015 the tourism sector employed over 6 million people directly and indirectly (close to 10% of the total workforce in Vietnam), and saw over six million international visitors. This number is predicted to grow to over 11 million in 2026. Most international tourists visiting Vietnam came from China, South Korea, Russia and the US. The growth of tourism is a region-wide phenomenon, with Thailand, Malaysia, Indonesia and Singapore all experiencing increased visitor numbers since 2009.¹⁵⁷



- **Leapfrogging technology:** Vietnam has seen rapid development in its mobile communication technologies, with 4G networks now covering over 95% of households.¹⁶ Vietnam aims to introduce 5G by 2020.¹⁶ In many areas 5G wireless connectivity will negate the need to install costly fibre-to-the-premises infrastructure. It will also enable a new generation of Internet of Things (IoT) technologies. The most promising use cases for 5G in Vietnam are connected healthcare, smart cities, autonomous vehicles, industrial IoT and fixed wireless connections.²⁹ These applications can support advanced manufacturing in Industry 4.0 and help to make healthcare more efficient as the population ages. Widespread wireless coverage, along with high consumer mobile adoption, can help prevent digital divides and ensure the country's digital development can be harnessed by all.

NEXT STEPS

- To investigate how Vietnam should navigate the challenges and opportunities it faces over the next 20 years, the next step in this study will be to further investigate the impacts of Industry 4.0 on the manufacturing and agriculture sectors, and to create and describe plausible scenarios for Vietnam's Future Digital Economy in 2038.
- Selected members of industry, government and the Vietnamese community will be interviewed and further information will be gathered on the trends described above, and any other trends which can be uncovered.
- Plausible future scenarios will then be created by developing axes describing the trends that create the greatest impact and the greatest uncertainty for Vietnam.
- When complete, these scenarios will provide a vision for leaders of government, industry and community so Vietnam can plan to accommodate future uncertainties, creating resilience and prosperity over the coming decades.





APPENDIX 1

COMPANIES OPERATING IN THE DIGITAL ECONOMY IN VIETNAM

ICT GOODS AND SERVICES

FPT, intel, DTT TECHNOLOGY GROUP, TECHPRO Beyond Expectations, GIGABYTE™

E-COMMERCE

Sendo.vn Trăm người bán - Vạn người mua, TIKI.VN, LAZADA .VN, admicro, NEXTTECH Group of Technopreneurs, adtima Leader in mobile, ADSOTA Boost Mobile App's Install & Revenue, Shopee, criteo.

INDUSTRY 4.0

AGRICULTURE

DTK, TH, TẬP ĐOÀN VIỆT - ÚC CHAI LƯỢNG - DỊCH VỤ - CÔNG NGHỆ, DABACO GROUP, VINASEED, VINAFOOD

MANUFACTURING

4P Company Ltd, THACO TRƯỜNG HẢI AUTO, VINGROUP

TELECOMMS

vietnamobile, mobifone GLOBAL, VIETTEL, VNPT, vinaphone



E-GOVERNMENT

VIETTEL, VNPT, DTT TECHNOLOGY GROUP, FPT

DIGITAL CONTENT

ZING MP3, VTV go, FPT, Fpt Online, NhạcCuaTui.Com, VCCORP

EMERGING INDUSTRIES

mo mo mobile money, VIETEDUTECH, timo POWERED BY VPBank, TrustCircle

SHARING ECONOMY

airbnb, Grab, UBER

APPENDIX 2

MAIN REGULATIONS ON INFORMATION TECHNOLOGY IN VIETNAM

- Law on Information Technology No 67/2006/QH11 of June 29, 2006.
- Decree No. 71/2007/NĐ-CP of May 03, 2007, detailing and guiding the implementation of a number of Articles of the Law on Information Technology regarding information technology industry.
- Decree No. 154/2013/ND-CP of November 08, 2013, stipulating on the concentrated information technology park.
- Circular No. 99/2003/ND-CP of August 28, 2003, promulgating the regulation on hi-tech parks.
- Circular No. 64/2007/NĐ-CP of April 10, 2007, promulgating ICT application in governmental agencies.
- Circular No 102/2009/NĐ-CP of November 03, 2009 on the management of investment in information technology application using the state budget.
- Circular No. 43/2011/NĐ-CP of June 13, 2011 on provision of online information and public services on websites or web portals of state.
- Circular No. 31/2015/TT-BTTTT of October 29, 2015 on the list of used IT products that are prohibited from importation.
- Resolution No. 41/NQ-CP of May 26, 2016 on tax incentives for development and application of information technology in Vietnam.
- Circular No. 14/2010/TT-BTTTT of June 29, 2010 detailing articles in Decree No. 97/2008/NĐ-CP of August 28, 2008 on the management, provision and use of Internet services and electronic information on the Internet.
- Circular No. 18/2012/TT-BTTTT dated November 15th, 2012 by Minister of Information and Communications promulgating a list of telecommunications enterprises, groups of telecommunications enterprises with market dominant position for important telecommunications services and Circular No. 15/2015/TT-BTTTT revising some regulations of Circular No. 18/2012/TT-BTTTT.
- Circular No. 15/2015/TT-BTTTT of June 15, 2015, revising some regulations of Circular No. 18/2012/TT-BTTTT dated November 15th, 2012 by Minister of Information and Communications promulgating a list of telecommunications enterprises, groups of telecommunications enterprises with market dominant position for important telecommunications services.
- Circular 48/2016/TT-BTTTT of December 26, 2016 detailing and guiding the operating licenses of newspapers, electronic newspapers, publishing additional publication, opening specialized page of electronic newspapers and specialities.
- Decision No. 05/2017/QĐ-TTg dated March 16, 2017, providing for emergency response plans to ensure national cyber security.

A.2.1 MAIN REGULATIONS ON POST, TELECOMMUNICATION, INTERNET AND BROADCASTING

- Law on Telecommunication No. 41/2009/QH12 of November 23, 2009.
- Law on Radio Frequency No. 42/2009/QH12 of November 23, 2009.
- Law on Network Information Security No. 86/2015/QG13 of November 19, 2015.
- Decree No. 97/2008/NĐ-CP of August 28, 2008 on the management, provision and use of Internet services and electronic information on the Internet.
- Decree No. 142/2016/NĐ-CP of October 14 2016 on the prevention of online information conflicts.
- Decree No. 25/2011/NĐ-CP of April 06, 2011, detailing and guiding the implementation of the Telecommunication Law.
- Joint circular No. 02/2005/TTLT-BCVT-VHTT-CA-KHĐT of July 14, 2005 on management of Internet agents.
- Joint circular 60/2006/TTLT-BVHTT-BBCVT-BCA of June 01, 2006 on management of games online.
- Circular No. 09/2008/TT-BTTTT of December 24, 2008 guiding the management and use of Internet resources.

A.2.2 REGULATIONS ON DIGITAL TRANSACTIONS

- Law on E-Transactions No.51/2005/QH11 of November 29, 2005.
- Decree No.35/2007/ND-CP of March 08, 2007 on E-transactions in the banking activities.
- Decree No.26/2007/ND-CP of February 25, 2007, detailing the implementation of the Electronic Transaction Law on digital signatures and digital signature certification services
- Decree No. 35/2007/NĐ-CP of March 08, 2007 on banking e-transactions.
- Decree No. 27/2007/NĐ-CP of February 23/02/2007 on e-transaction in financial activities.
- Decree No. 106/2011/ND-CP of February 25, 2011 revising some articles in Decree No.26/2007/ND-CP of February 25, 2007 of the Government detailing the implementation of the Electronic Transaction Law on digital signatures and digital signature certification services.
- Decree No. 52/2013/ND-CP of May 16, 2013 on ecommerce.
- Decree No. 170/2013/ND-CP of November 13, 2013 revising some articles in Decree No.26/2007/ND-CP of February 25, 2007 of the Government detailing the implementation of the Electronic Transaction Law on digital signatures and digital signature certification services.

- Decree No. 156/2016/ND-CP of November 21, 2016 revising some articles in Decree No. 27/2007/NĐ-CP of February 23/02/2007 on e-transaction in financial activities.
- Circular No. 78/2008/TT-BTC of September 15, 2008 detailing articles in Decree No. 27/2007/NĐ-CP of February 23/02/2007 on e-transaction in financial activities.
- Circular No. 59/2015/TT-BCT of December 31st 2015, prescribing the management of e-commerce activities via applications on mobile equipment.
- 1.2.4. Regulations on Industry 4.0.
- Law No. 21/2008/QH12 on high technologies.
- Directive No. 16/CT-TTg of May 04, 2017, on the strengthening of the ability to access the Fourth Industrial Revolution.
- Decision No. 66/2014/QĐ-TTg of November 25, 2014 on the list of high technologies prioritized for development investment and the list of hi-tech products eligible for development promotion.
- Decision No. 19/2015/QĐ-TTg of June 15, 2015, prescribing criteria for identifying hi-tech enterprises.
- Decision No. 4246/QĐ-BCT of November 10, 2017 detailing the action plan to implement Directive No.16/CT-TTg on the strengthening of the ability to access the Fourth Industrial Revolution in Industry and Trade.
- Decision No. 844/QĐ-TTg of May 18, 2016 on promulgating the scheme to support the national innovative startup ecosystem through 2025.

A.2.3 MAIN REGULATIONS ON INTELLECTUAL PROPERTY

- Law No. 50/2005/QH11 of November 29, 2005 on Intellectual Property.
- Law No. 36/2009/QH12 of June 19, 2009, amending and supplementing a number of articles of the law on intellectual property.
- Decree No. 105/2006/ND-CP of September 22, 2006, detailing and guiding the Implementation of a Number of Articles of the Law on Intellectual Property on Protection of Intellectual Property Rights and on State Management of Intellectual.
- Decree No. 103/2006/ND-CP of September 22, 2006, detailing and guiding the Implementation of a Number of Articles of the Law on Intellectual Property regarding Industrial Property.
- Circular No. 44/2011/TT-BTC of April 01, 2011 guiding the struggle against smuggling and protection of intellectual property rights in customs.
- Joint Circular No. 07/2012/TTLT-BTTTT-BVHTTDL of June 19, 2012, stipulating the liabilities of intermediary services providers in protection of copyright and related rights in the Internet and telecommunication network.

- Joint Circular No. 14/2016/TTLT-BTTTT-BKHCN dated June 8, 2016, guiding the order and procedures for changing and revoking domain names infringing upon the intellectual property rights.

A.2.4 MAIN ICT AND DIGITAL DEVELOPMENT STRATEGIES/PLANS

- Vietnam post and telecommunications development strategy till 2010 and orientations till 2020 (Decision No. 158/2001/QĐ-TTg of October 18, 2001).
- Vietnam strategy on information and communication technology development till 2010 and orientations toward 2020 (Decision No. 246/2005/QĐ-TTg of October 06, 2005).
- Telecommunication development master plan till 2020 (Decision No.23/2012/QĐ-TTg of July 17, 2012).
- Programs on development of Information Technology Human Resources to 2020 (Decision No. 05/2007/QĐ-BTTTT of October 26, 2007).
- Master plan on development of Vietnam's electronics industry up to 2010, with a vision toward 2020 (Decision No. 75/2007/QĐ-TTg of May 28, 2007).
- Program on software industry development and the Program on Vietnam's digital content industry development (Decision No. 50/2009/QĐ-TTg of April 03, 2009).
- National planning on development of digital information security through 2020 (Decision No. 63/QĐ-TTg of January 13, 2010).
- Scheme to early make Vietnam a country strong in information and communication technologies (Decision No. 1755/QĐ-TTg of September 22, 2010).
- The target program on information technology development through 2020, with a vision toward 2025 (Decision No. 392/QĐ-TTg of March 27, 2015).
- The program on development of broadband telecommunications infrastructure through 2020 (Decision No. 149/QĐ-TTg of January 21, 2016).
- List of prioritized areas to ensure network and information security (Decision No. 632/QĐ-TTg of May 10, 2017).
- List of national database should be prioritised to create a foundation to deploy e-government development (Decision No. 714 / QĐ-TTg dated 22/05/2015 of the Prime Minister).

A.2.5 OTHER REGULATIONS TO BE DEVELOPED

- Decree to replace decree No.27/2007/NĐ-CP of February 23/02/2007 guiding e-transactions on financial activities.

REFERENCES

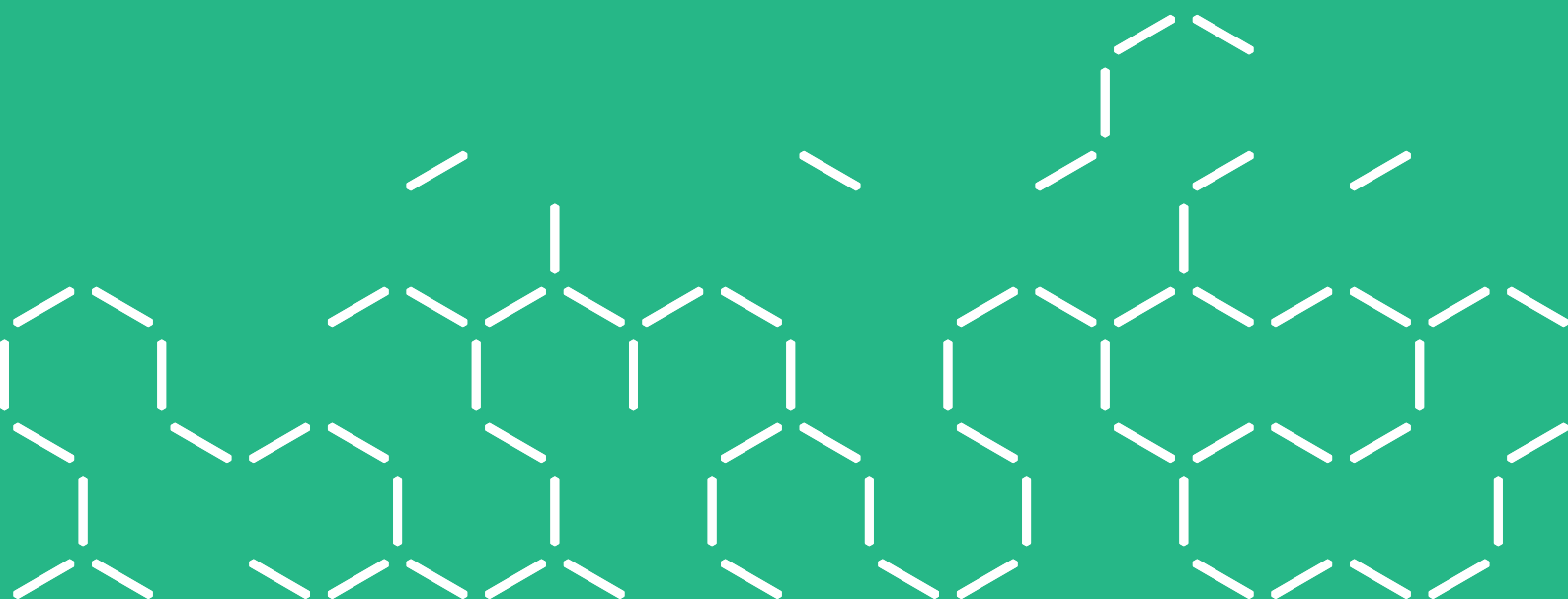
- 1 United Nations. 2015. Millennium Development Goals Report.
- 2 Vietnam Customs. 2017. Merchandise Export and Import Ministry of Planning and Investment:
- 3 United Nations - Population Division. 2014. World Urbanisation Prospects - Vietnam.
- 4 General Statistics Office. 2016. Gross domestic product at current prices by economic sector GSO: Hanoi, Vietnam.
- 5 Ministry of Planning and Investment. 2018. Summary report on economic restructuring plan for period 2016 - 2020. Hanoi.
- 6 Ministry of Information and Communications. 2011. IT Masterplan Approved. Hanoi, Vietnam.
- 7 Vietnam E-commerce, Industry and Trade Agency,. 2017. National e-commerce development program 2014 - 2020.
- 8 Anh D. 2017. Vietnam sets out plans for Industry 4.0.
- 9 Cooper T. 2017. Vibrant Vietnam.
- 10 Appota. 2017. Vietnam Mobile Report 2017.
- 11 International Labour Organization. 2016. ASEAN in Transformation: How technology is changing jobs and enterprises. Geneva, Sweden.
- 12 Schirmbeck S. 2017. Vietnam's Environmental Policies at a Crossroads Salinated Rice Fields, Hunted-Out National Parks, and Eroding Beaches – and What We Can Do About It. Hanoi, Vietnam.
- 13 International Monetary Fund. 2017. Vietnam - Selected Issues Paper. Washington DC.
- 14 Ministry of Planning and Investment. Brief on foreign direct investment of the first 8 months 2017. Available from: <http://www.mpi.gov.vn/en/Pages/tinbai.aspx?idTin=38160&idcm=289>.
- 15 World Bank. 2016. Foreign direct investment, net inflows (% of GDP) World Bank Group: Washington D.C, United States.
- 16 Oxford Business Group. The Report: Vietnam 2017. Oxford Business Group; 2017.
- 17 World Bank. 2017. Vietnam Country Overview. Hanoi, Vietnam.
- 18 World Bank. 2014. Inequality in Vietnam: A Special Focus of the Taking Stock Report July 2014 - Key Findings.
- 19 Ministry of Information and Communications. 2017. Vietnam lacks high quality IT workforce.
- 20 Quah D. 2011. The Global Economy's Shifting Centre of Gravity. *Global Policy*, 2(1): 3-9.
- 21 United Nations. 2017. World population prospects: The 2017 revision. Nations United: New York, United States.
- 22 World Bank. 2016. Population ages 15-64 (% of total).
- 23 General Statistics Office. 2016. Percentage of literate population at 15 years of age and above by sex and by residence by year and iterns Vietnam General Statistics Office of: Hanoi, Vietnam.
- 24 Marvin R. 2016. Vietnam's Tech Boom: A Look Inside Southeast Asia's Silicon Valley.
- 25 World IP Organisation. 2017. China Tops Patent, Trademark, Design Filings in 2016. Geneva.
- 26 Hardin T. 2017. China now rivals U.S. in VC investments.
- 27 Kharas H. 2017. The Unprecedented Expansion of the Global Middle Class. Institute The Brookings: Washington, DC.
- 28 World Travel and Tourism Council. 2016. Economic Impact 2016 Vietnam.
- 29 Gabriel C, Wilson S, Cooperso D. 2017. The impact of 5G on fixed wireline networks in Asia Pacific. London, England.
- 30 Le Thanh Nghiep, Le Huu Quy. 2000. Measuring the impact of Doi Moi on Vietnam's Gross Domestic Product.
- 31 ASEAN Stats. 2018. Trade in Services Dashboard.
- 32 General Statistics Office. 2018. Land use (As of 31 February 2015)(*) by Type of land and Use.
- 33 World Bank. 2016. Population, total Group The World Bank: Washington D.C, United States.
- 34 General Statistics Office. 2016. Area, population and population density by province GSO: Hanoi, Vietnam.
- 35 World Bank. 2016. Population density (people per sq. km of land area) Group The World Bank: Washington D.C, United States.
- 36 Organization for Economic, Co-operation and Development,. 2018. Urban Policy Reviews - Vietnam.

- 37 General Statistics Office. 2016. In-migration rate, out-migration rate and net-migration rate by province Vietnam General Statistics Office of: Hanoi, Vietnam.
- 38 General Statistics Office. 2016. Annual employed population at 15 years of age and above by occupation and year GSO: Hanoi, Vietnam.
- 39 International Organization for Migration. 2017. Viet Nam Migration Profile 2016. IOM: Hanoi, Vietnam.
- 40 World Bank. 2016. Population growth (annual %) Group The World Bank: Washington D.C, United States.
- 41 World Bank, The Ministry of Planning and Investment of Vietnam. 2016. Vietnam 2035: Toward prosperity, creativity, equity, and democracy. Washington D.C, United States.
- 42 General Statistics Office. 2016. Labour force at 15 years of age and above by age group Vietnam General Statistics Office of: Hanoi, Vietnam.
- 43 General Statistics Office. 2016. Some key social indicators by social indicators and year Vietnam General Statistics Office of: Hanoi, Vietnam.
- 44 UNESCO Institute for Statistics. 2016. Education (full dataset) UIS:
- 45 Bodewig C, Badiani-Magnusson R. 2013. Vietnam development report 2014 - Skilling up Vietnam: Preparing the workforce for a modern market economy. Group The World Bank: Washington D.C, United States.
- 46 General Statistics Office. 2016. Percentage of trained employed workers at 15 years of age and above by qualification by qualification and year Vietnam General Statistics Office of: Hanoi, Vietnam.
- 47 Valerio A, Puerta M, Pierre G et al. 2012. Skills for productivity: An analysis of employer skills survey 2011. Group The World Bank: Washington D.C, United States.
- 48 Ministry of Education and Training. 2015. Education for All 2015 national review: Viet Nam. MoET: Hanoi, Vietnam.
- 49 World Bank Group and Ministry of Planning and Investment. 2016. Viet Nam 2035: Toward Prosperity, Creativity, Equity and Democracy.
- 50 General Statistics Office (2017) Social and economic situation in 2017, Vietnam General Statistics Office of: Hanoi, Vietnam.
- 51 International Monetary Fund. 2017. World Economic Outlook (October 2017) IMF: Washington D.C, United States.
- 52 World Bank. 2015. GDP (Current US\$) Washington D.C, United States.
- 53 World Bank. 2016. Trade (% of GDP) Group World Bank: Washington D.C, United States.
- 54 World Bank. 2016. Exports of goods and services (% of GDP) Group World Bank: Washington D.C, United States.
- 55 World Bank. 2016. GDP per capita growth (annual %) Group The World Bank: Washington D.C, United States.
- 56 World Bank. 2016. GDP per capita, PPP (current international \$) Group The World Bank: Washington D.C., United States.
- 57 World Bank. 2016. GDP per capita (current LCU) Group The World Bank: Washington D.C, United States.
- 58 World Bank. 2014. GINI index (World Bank estimate) Group The World Bank: Washington D.C., United States.
- 59 Knight Frank Research. 2017. The Wealth Report, 11th Edition.
- 60 Viet Nam News. 2017. SBV aims to hold inflation under 4% in 2017.
- 61 VOV5.vn. 2017. Government aims to curb inflation in 2018.
- 62 World Bank. 2016. Inflation, consumer prices (annual %) World Bank: Washington D.C.
- 63 Breu M, Dobbs R, Remes J et al. 2012. Sustaining Vietnam's growth: The productivity challenge. Institute McKinsey Global: Hanoi, Vietnam.
- 64 General Statistics Office. 2017. Report on labour force survey. GSO: Hanoi, Vietnam.
- 65 Ministry of Planning and Investment. 2016. Decision 58/2016/QĐ-TTg on restructuring State-owned enterprises in the period of 2016-2020.

- 66 Foreign Investment Agency. 2017. Vietnam FDI in the past 30 years. Ministry of Planning and Investment
- 67 Vietnam Customs. 2009 - 2017. Merchandise export by products Customs General Office of Vietnam:
- 68 World Bank. 2017. World Development Indicators
- 69 PwC. 2017. Spotlight on Vietnam - the leading emerging market.
- 70 Vietnam Customs. Merchandise Export and Import brief [press release]. General Office of Vietnam Customs, Available from:
- 71 World Integrated Trade Solution. 2011. Labor value added of all sectors for final output or exports of Vietnam in 2011 WITS:
- 72 Socialist Republic of Vietnam. 2016. Socio-Economic Development Plan 2016-2020.
- 73 Vietnam Customs. 2017. Merchandise export by products and major markets (2009-2017) Customs General Office of Vietnam:
- 74 General Statistics Office. 2016. Annual employed population and annual employed population at 15 years of age and above by kinds of economic activity by Economic activity, Items and Year GSO: Hanoi, Vietnam.
- 75 APEC 2017 National Secretariat. APEC Viet Nam 2017. [13 February 2018]. Available from: <https://www.apec2017.vn/>.
- 76 The ASEAN Secretariat. 2015. ASEAN 2025: Forging Ahead Together. Jakarta, Indonesia.
- 77 Foreign and Commonwealth Office, The Rt Hon William Hague. UK-Vietnam Strategic Partnership Declaration. [8/2/18]. Available from: <https://www.gov.uk/government/news/uk-vietnam-strategic-partnership-declaration>.
- 78 Jennings R. Vietnam Is Chasing India To Escape The Grip Of China. Forbes. 10 July 2017.
- 79 Turnbull M. Enhanced Australia-Vietnam Relations. [8 February 2018]. Available from: <https://www.pm.gov.au/media/enhanced-australia-vietnam-relations>.
- 80 Parameswaran P. What's Next for Japan-Vietnam Defense Ties? The Diplomat. 2 November 2017.
- 81 Vietnam National Assembly. Vietnam-Malaysia joint statement on strategic partnership. [12 February 2018]. Available from: <https://vneembassy-kualalumpur.mofa.gov.vn/en-us/News/EmbassyNews/Pages/Vietnam-Malaysia-joint-statement-on-strategic-partnership.aspx>.
- 82 Viet Nam News. Viet Nam, Philippines issue joint statement on strategic partnership. Viet Nam News. 19 November 2015.
- 83 Nguyen T D. 2016. On the approval of the Proposal "Direction for attracting, managing and using ODA and concessional loans from international donors for 2016 – 2020 period" (Decision No: 251/QD-TTg). Hanoi, Vietnam.
- 84 General Statistics Office. 2016. Some key social indicators by Social indicators and Year. Vietnam.
- 85 Ministry of Industry and Trade of Vietnam. 2017. Vietnam energy outlook report 2017. MOIT: Hanoi, Vietnam.
- 86 Dung N T. 2016. Decision on the approval of the revised national power development master plan for the 2011-2020 period with the vision to 2030. Hanoi, Vietnam.
- 87 World Bank. 2014. Electric power consumption (kWh per capita) Group World Bank: Washington D.C.
- 88 World Bank. 2014. Electricity production from coal sources (% of total) Group World Bank: Washington D.C.
- 89 World Bank. 2014. Electricity production from hydroelectric sources (% of total) Group World Bank: Washington D.C.
- 90 World Bank. 2014. Electricity production from natural gas sources (% of total) Group World Bank: Washington D.C.
- 91 World Bank. 2014. Electricity production from oil sources (% of total) Group World Bank: Washington D.C.
- 92 General Statistics Office. 2016. Volume of freight traffic by type of transport by Items, Year and Type of transport Vietnam General Statistics Office of: Hanoi, Vietnam.
- 93 World Bank. 2016. Container port traffic (TEU: 20 foot equivalent units) Bank World: Washington D.C.

- 94 Ministry of Information and Communication and Vietnam Association for Information Processing. 2016. Vietnam ICT index 2016.
- 95 Austrade. 2018. ICT to Vietnam: trends and opportunities.
- 96 Vietnam Information Technology Outsourcing Alliance. 2018. Why Vietnam?
- 97 Organisation for Economic Cooperation and Development. 2013. The digital economy 2012. OECD:
- 98 G20 Research Group. 2015. G20 Digital Economy Development and Cooperation Initiative. Group G20 Research: Hangzhou, China.
- 99 The Oxford Dictionary. 2018. Digital Economy - definition.
- 100 Tuoi tre News. 2017. Vietnam grapples with Internet cable problems.
- 101 Viet Nam News. 2015. Why does the AAG underwater cable have to be repaired so often?
- 102 Vietnam National Internet Exchange. 2017. Internet resource statistics. Hanoi , Vietnam.
- 103 Ministry of Information and Communication. 2017. ICT White Book.
- 104 Vietnam Economic Times. 2015. FMCG market to see growth 4%.
- 105 Akamai. 2017. State of the Internet Q1 2017.
- 106 World Bank. 2016. Secure internet servers Group World Bank: Washington D.C.
- 107 Vietnam National University and Economic Research Institute of Post and Telecommunication. 2015. The socio-economic impact of allocating spectrum for mobile broadband services in Vietnam.
- 108 World Economic Forum. 2015. Expanding participation and boosting growth: the infrastructure needs of the digital economy. Switzerland.
- 109 World Bank. 2017. World Development Indicators. Washington DC.
- 110 Nguyen H a M, Schiffbauer. 2015. Internet, Reorganization and Firm productivity in Vietnam. World Bank, Washington DC.
- 111 Alibaba Group. 2017. OSB Opportunity Solution and business.
- 112 Ministry of Information and Communication. 2017. Report on the national industry strategy 2016-2025 and vision by 2035. Hanoi, Vietnam.
- 113 Ministry of Information and Communication. 2017. ICT white paper. Hanoi, Vietnam.
- 114 Oxford Business Group. 2017. The Report - Vietnam 2017. Dubai, United Arab Emirates.
- 115 Foreign Investment Agency. 2017. Vietnam FDI in the past 30 years. Hanoi, Vietnam.
- 116 Pricewater Cooperhouse. 2017. Spotlight on Vietnam - the leading emerging market.
- 117 VNDIRECT. 2017. High-tech Index database. Hanoi Vietnam.
- 118 Philippines Statistics Authority. 2017. Busines Process Outsourcing. Manila, Philippines.
- 119 VietnamNet Bridge. 2016. Vietnam ranks second after China in software outsourcing for Japan.
- 120 Vietnam E-commerce, Industry and Trade Agency,. 2018. Vietnam seeks to boost its digital economy. Hanoi.
- 121 Vietnam E-commerce and Information Technology Agency. 2016. E-commerce survey Hanoi, Vietnam.
- 122 Vietnam E-commerce Association. 2017. Vietnam E-commerce Index. Hanoi, Vietnam.
- 123 VN Economic Times. 2015. Vietnam Uber's second fastest growing market.
- 124 Lendbiz. 2017. Project selection criteria. Hanoi, Vietnam.
- 125 Ministry of Science and Technology. 2018. Digital Vietnamese Knowledge System.
- 126 Vo Hai. 2018. Vietnam launches digital database aimed to increase public knowledge. Hanoi.
- 127 Newzoo. 2017. Top 100 countries by game revenue
- 128 EU-Vietnam Business Network. 2014. IT sector research report.
- 129 ITP. Vietnam is the biggest game market in Southeast Asia. Available from: <http://www.vnu-ity.edu.vn/vi/tin-tuc/thi-truong/178-viet-nam-hien-nay-la-thi-truong-game-lon-nhat-khu-vuc-dong-nam-a.html>.
- 130 Reuters. 2014. UPdate 1 - Popular game Flappy Bird flies no more.

- 131 World Bank. 2016. Digital Dividends. Washington D.C., United States.
- 132 Bhunia P. 2017. Brief look at open government data in 6 ASEAN countries.
- 133 Ha V D a H, Pham Diem Trang and Nguyen, Hoang My Le. Fintech ecosystem in Vietnam and other countries. State Bank of Vietnam.
- 134 Polycom. 2016. Vietnam's Quang Ninh Department of Health Selects Polycom Video Solutions for Remote Healthcare Consultation and Assistance.
- 135 Burke R, Mussomeli, Adam, Laaper, Stephen, Hartigan, Martin, Sniderman, Brenna. 2017. Smart Factory Connected Manufacturing.
- 136 BDO. 2016. Industry 4.0 Report.
- 137 PWC. 2016. Industry 4.0: How digitisation makes the supply chain more efficient, agile, and customer-focused. Munich.
- 138 Food and Agriculture Organization. 2015. Europe entering the era of 'precision agriculture'. Rome, Italy.
- 139 365FarmNet. 2017. Agriculture 4.0 – ensuring connectivity of agricultural equipment. Challenges and technical solutions for the digital landscape in established farms with mixed or analogue equipment. .
- 140 McDonald M. Blockchain technology and the food supply chain. Food & Beverage [Internet]. 2017 Available from: <https://foodmag.com.au/blockchain-technology-and-the-food-supply-chain-2/>.
- 141 Staples M, Chen S, Falamaki S et al. Risks and opportunities for systems using blockchain and smart contracts., Sydney: CSIRO; 2017.
- 142 Libelium. 2016. Fish Farm monitoring in Vietnam by Controlling water quality in ponds and tanks.
- 143 Truong Minh Vu, Nguyen Vu Nhat Anh. 2017. The Fourth Industrial Revolution - A Vietnamese Discourse. Working paper Friedrich Ebert Stiftung.
- 144 Global Economic Symposium. 2014. Escaping the Middle Income Trap.
- 145 VietnamNet - Business. 2018. Vietnam's public debt stands at 61.3% in 2017: Finance Ministry. Hanoi.
- 146 Hong Kong Trade Development Council Research. Vietnam: Market Profile. Available from: <http://emerging-markets-research.hktdc.com/business-news/article/Asia/Vietnam-Market-Profile/mp/en/1/1X000000/1X0010GK.htm>.
- 147 Japan External Trade Organisation. 2016. 2016 JETRO Survey on Business Conditions of Japanese Companies in Asia and Oceania. JETRO: Tokyo, Japan.
- 148 International Telecommunication Union. 2017. Global Cybersecurity Index (GCI) 2017. ITU: Geneva, Switzerland.
- 149 United States Agency for International Development. 2017. Biodiversity conservation.
- 150 Vietnam Ministry of Natural Resources and Environment. 2014. Vietnam's fifth national report to the united nations convention on biological diversity, reporting period: 2009-2013. MONRE: Hanoi, Vietnam.
- 151 Ministry of Natural Resources and Environment. 2016. Climate change and sea level rise scenarios for Vietnam. MONRE:
- 152 Central Intelligence Agency. 2016. The World Factbook. Washington D.C, United States.
- 153 Fredriksen B, Peng T J, Ndoye M et al. An African exploration of the East Asian education experience. Washington D.C, United States: World Bank; 2008.
- 154 Organization for Economic, Co-operation and Development,. 2012. PISA 2012 results: what students know and can do. Student performance in Mathematics, Reading and Science. Paris, France.
- 155 UNESCO. 2017. Vietnam takes action towards stem education for sustainable development.
- 156 Cornell University, INSEAD, World Intellectual Property Agency. The Global Innovation Index 2017: Innovation Feeding the World. 10th edn, Ithaca, Fontainebleau, and Geneva: WIPO, Cornell University, and INSEAD; 2017.
- 157 World Travel and Tourism Council. 2017. Travel and Tourism Economic Impact 2017 - South East Asia.



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