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Insight

Investigating potential booming industries in the EEC

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Executive summary

The Eastern Economic Corridor (EEC) is an important government initiative aiming to attract investments into 10 targeted industries to help drive the economy. The initiative sets out roles and duties of the government, as well as a framework for development in 3 pilot provinces including Rayong, Chonburi, and Chachoengsao, which are currently major manufacturing bases of Thailand. The EEC is expected to attract a new wave of investments into 10 targeted industries, comprising 5 First S-curve industries (those with existing investments and operations) and 5 New S-curve industries (future industries leading toward creating new knowledge base for country's development).

In addition to the EEC Act which is a development policy framework, the government also supports both hard and soft infrastructure. Most of hard infrastructure development projects are transport projects covering all modes of transport and shipping -such as via rail, road, water, and air- and energy and public utilities infrastructure projects. The latter includes development of supply and distribution system of electricity, water storage and distribution system for consumption, environmental development for tourism and public health. In terms of soft infrastructure, support measures include tax benefits (both corporate and income taxes), exemptions of import duties on machinery and raw materials used for production of export products, as well as funding and facilitation for businesses investing in the EEC.

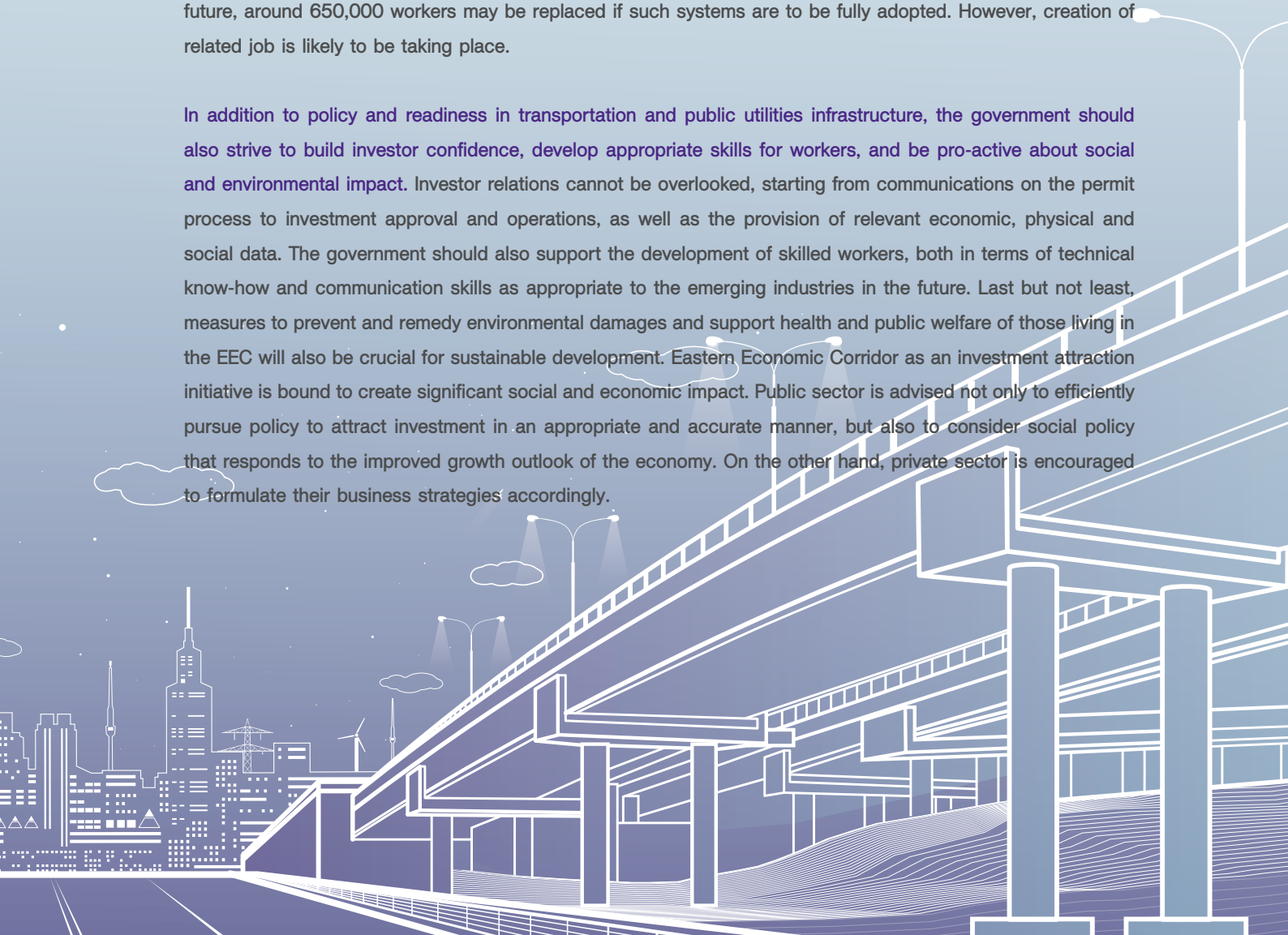
EIC sees strong potential for 3 industries of the future in the EEC during the initial stage including digital, aviation and logistics, and robotics and automation, taking into account capabilities and skills of labor, economic impact, and types of related industries.

The Maintenance, Repair, and Overhaul (MRO) tailored for narrow-body aircrafts will open doors for Thai businesses into aircraft manufacturing industry in the future. The narrow-body aircrafts used by low-cost carriers account for over 70% of all aircrafts flying in and out of Thailand's airports and are expected to grow by over 1.5 times in the Asia-Pacific region. Moreover, development of the U-Tapao International Airport to cater for rising tourism will be important driver for Thai businesses in aircraft maintenance and manufacturing of main parts (tier 2) and secondary parts (tier 3) of the aircrafts.Currently, Thailand's exports of aircraft parts are valued at over 50 billion baht per year. These comprise of 60% of exports of aircrafts parts, 30% exports of electrical wire systems, and the rest are engine and tires exports.

Digital infrastructure can potentially attract investment in the Internet of Things (IoT) which will offer opportunity for IoT solution development in various industries. Today, Thailand's expenditure on IoT are still concentrated in manufacturing industry and logistics, Meanwhile, agricultural sector has only limited use of such technology as suggested by only 0.1% usage of embedded software which is a technology that enables communications among devices, compared to as much as 76% in manufacturing. Thus, EIC believes that applications of IoT in agriculture for water control, disease and pest control systems, and soil monitoring can help raise production per rai by 30-50% and if used in economic crops, such as in rice farms, production per rai will increase to the global average production of 480 kilograms per rai.

Value on investment in robotics and automation at present and a move toward aging society are opportunities for Thai businesses to set foot into the System Integrator (SI) businesses. Considering capabilities of robots to replace human labor and costs of investment, EIC found that adoption of robotics and automation will likely breakeven within 6-10 years. Meanwhile, current industrial robots, which last approximately 12 years, will create opportunity for Thai businesses to step into SI businesses by providing advisory and design services, and seek automation system from manufacturers of robots and software developers to be installed for end-users as requested. In the future, around 650,000 workers may be replaced if such systems are to be fully adopted. However, creation of related job is likely to be taking place.

In addition to policy and readiness in transportation and public utilities infrastructure, the government should also strive to build investor confidence, develop appropriate skills for workers, and be pro-active about social and environmental impact. Investor relations cannot be overlooked, starting from communications on the permit process to investment approval and operations, as well as the provision of relevant economic, physical and social data. The government should also support the development of skilled workers, both in terms of technical know-how and communication skills as appropriate to the emerging industries in the future. Last but not least, measures to prevent and remedy environmental damages and support health and public welfare of those living in the EEC will also be crucial for sustainable development. Eastern Economic Corridor as an investment attraction initiative is bound to create significant social and economic impact. Public sector is advised not only to efficiently pursue policy to attract investment in an appropriate and accurate manner, but also to consider social policy that responds to the improved growth outlook of the economy. On the other hand, private sector is encouraged to formulate their business strategies accordingly.



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Introduction

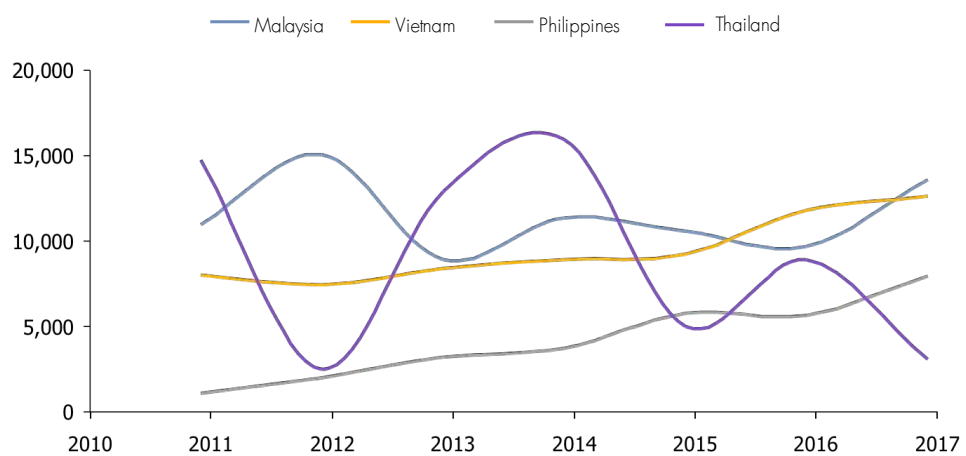
Eastern Economic Corridor (EEC) is Thailand major economic initiative that attracted the most public attention in 2017. The Thai government hopes to leverage the EEC as a revenue-generating hub that will upgrade the country from an increased investment in targeted industries, and also as an economic growth engine for Thailand in the future. In this light, EIC believes that the digital industry, aviation and logistics industry, and robotics industry are the three most promising industries to take place in the EEC during the initial phase of the development plan.

The development of the eastern part of the country commenced 40 years back under the Eastern Sea Board Development (ESB) project, which prioritized on investment in the fundamental industries of the country including oil and natural gas, petrochemicals, steel, and fertilizers. Although such project has garnered constant support from the government, the level of foreign direct investment (FDI) is not sufficiently high while significant decline has been observed over the past three years. This is opposed to the FDI outlook of other countries in the Southeast Asia that are major manufacturing bases, such as Malaysia, Vietnam, and the Philippines.

Figure 1 : The Thailand Foreign Direct Investment (FDI) has been decline in past 3 years

The comparison of historical FDI among the ASEAN countries

Unit: million USD

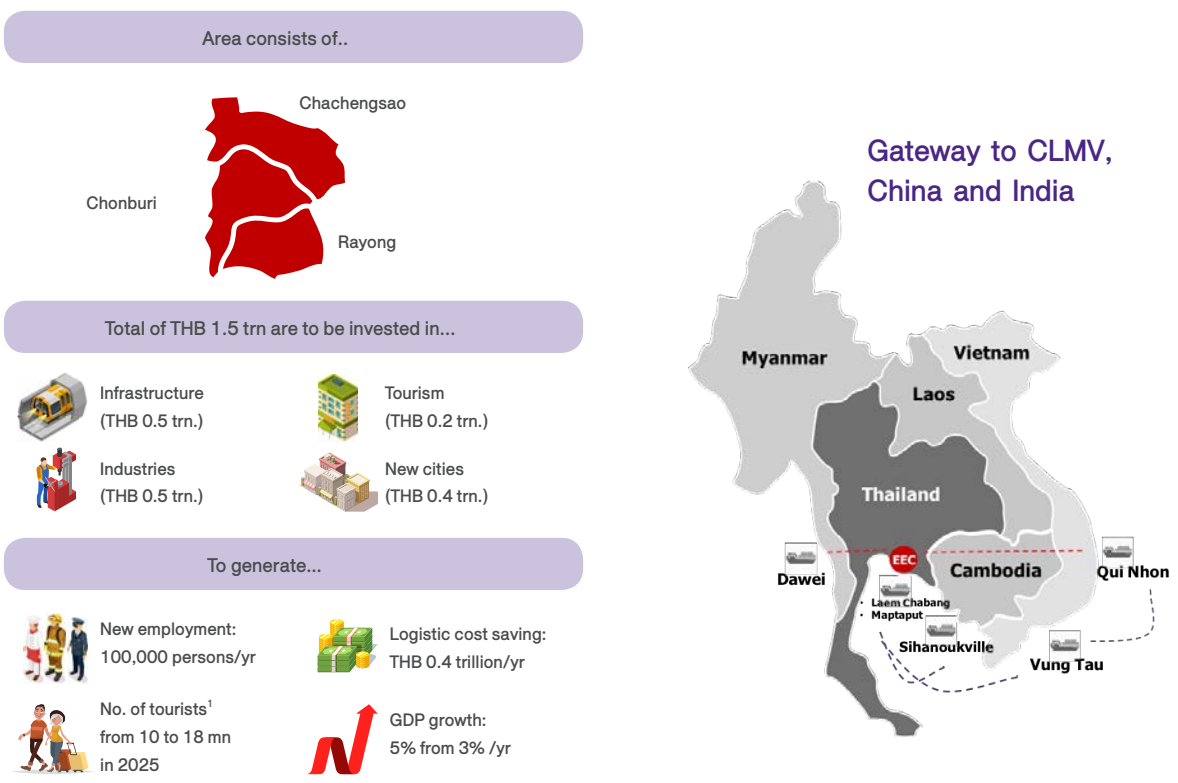


Source: EIC analysis based on data from CEIC

In recent years, EEC development plan had been perceived as one of the engines in driving the economy. Nowadays, the global economy has been largely driven by the knowledge-based economy, where the dynamic is created such that the knowledge base is the key driver of manufacturing, services, and distribution of products. Such dynamic leads to a sustain job creation and long-term growth of the economy and also prompt Thailand to innovate and develop new knowledge base in order to increase efficiency of its fundamental industries. At the same time, Thailand should aim to generate new industries in order to upgrade the country's competitiveness in the future. As a result, the Eastern Economic Corridor Act was drafted as a policy framework to promote investment in the 10 targeted industries which will be important economic growth drivers going forward. In addition, it will also support industrial and urban developments in order to build investor confidence and attract investment into investment promotion zone in the three eastern provinces namely Rayong, Chonburi, and Chachoengsao.

The government estimates that such investment will generate employment of over 100,000 positions per year. Moreover, development of transportation infrastructure and public utilities will help reduce transportation and logistic costs by over 400 billion baht per year, and also attract tourists into the area where the total number of tourists will double last's year total of 1 million persons per year. As a result, Thailand's GDP growth is projected to grow from current growth of 3% to 5% in the future. Moreover, the government's strategy is also for the eastern region to become a manufacturing and distribution hub for CLMV countries (Cambodia, Laos, Myanmar, and Vietnam).

Figure 2 : EEC aims to attract investment in targeted industries to become industrial hub of ASEAN & gateway to CLMV



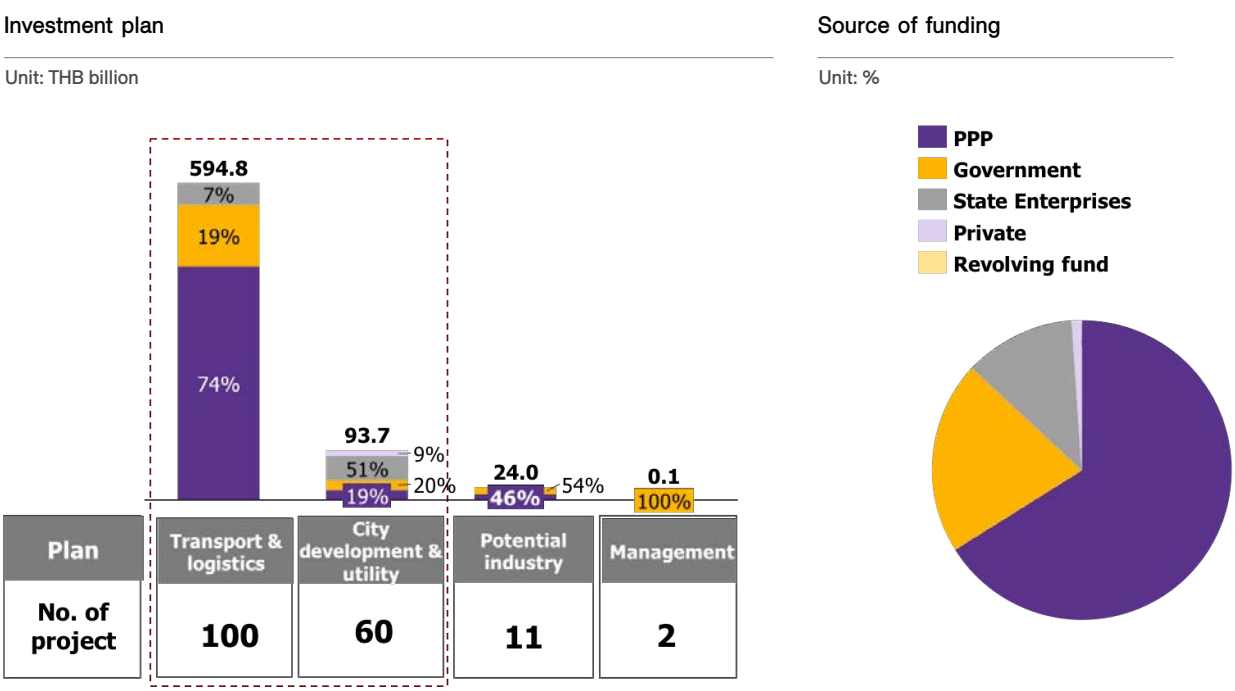
Note: 1. Number of tourist visiting Pattaya

Source: EIC analysis based on data from Ministry of Industry

In addition to having EEC Act as a development policy framework, the government also supports development of both hard infrastructure and soft infrastructure.

Most of the development plan on hard infrastructure are transportation development, whose investment will mainly rely on public-private partnership. The government has a plan to develop the infrastructure to support the ECC development during 2017-2021, consisting of 4 small plans worth 713 billion baht in total namely: 1) transportation and logistics development plan (595 billion baht); 2) development plan on urban, public utilities, environment, tourism, and public health (94 billion baht); 3) development of potential industries (24 billion baht); and 4) management (1 billion baht). The government has also planned on the sources of funding, where 70% of the total funding will come from PublicPrivate Partnerships (PPP). The second source, which accounts for 20% of the total funding, will be from the regular annual allocation of government budget. The third source, 12% of the total funding, will be contributions from the State Owned Enterprises (SOEs). The rest will be from private investment.

Figure 3 : EEC infrastructure investment plan during 2017-2021 and the sources of funding



Source: EIC analysis based on data from NESDB

The transportation infrastructure development plan will cover all modes of transportation, including road, air, rail, and water. In fact, some of the key megaprojects have already been invested and are currently in the construction process. For example, the Pattaya-Maptaphut Motorway, worth 18 billion baht, will provide convenience in travelling between Pattaya and Rayong, where the U-Tapao Airport is to be developed to serve tourism and aviation industry. Another example is the Chachoengsao-Khlong 19-Kaeng Khoi dual track rail (11 billion baht) which will improve efficiency in rail transportation between the eastern and northeastern regions. The development plan also includes the Laem Chabang seaport, which consists of two projects: Quay A construction project (1.8 billion baht), which will accommodate both river and coastal freight transport, and the Single Rail Transfer Operator (SRTO) project (2.9 billion baht) to support rail transportation.

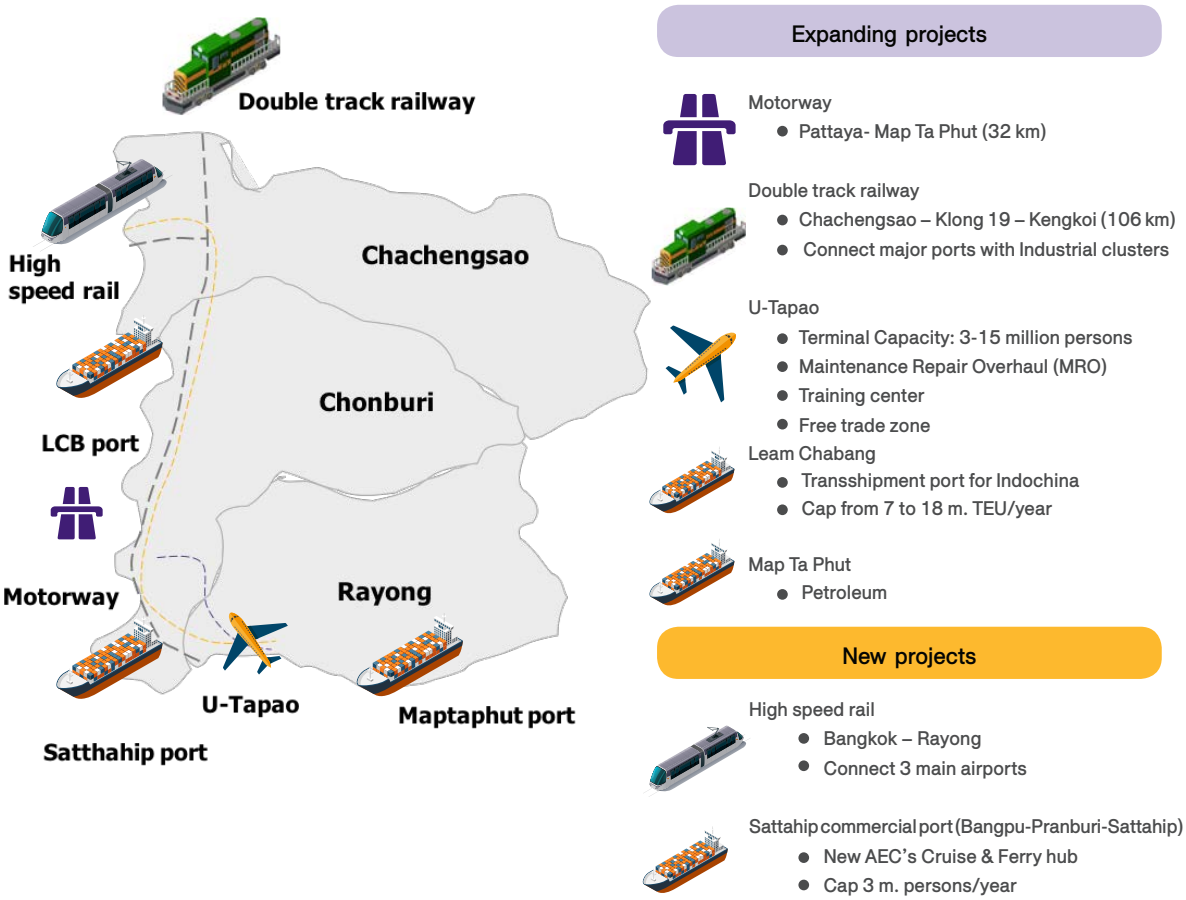
In the next phase, the government aims at new projects that will accommodate the expansion of EEC, including high-speed rail connecting three major airports (Don Mueang, Suvarnabhumi, and U-Tapao). All of which will increase convenience in travelling for tourists, working professionals in the area, and the general public. Moreover, the third-phase expansion of Laem Chabang seaport will enhance efficiency of the seaport from an increased capacity to 18 million TEUs (Twenty-Foot Equivalent Unit) from the current capacity of 7.7 million TEUs. Other development plans include the third-phase expansion of Maptaphut seaport to facilitate shipment of petroleum and natural gas products, and development of Sattahip naval base to promote tourism via ferries and cruises, as well as accommodate shipping to other commercial ports.

In addition, there are also the plans to develop infrastructure on energy, and water resource and environmental management. Examples include electricity projects such as efficiency improvement in electricity supply and distribution system (40 billion baht), development on water storage and distribution for consumption (30 billion baht), development on environmental management and tourism (16 billion baht), and development of public health (7 billion baht).

EIC expects an investment of over 40 billion baht in 2018 for infrastructure projects on both transportation and public utilities with further investment of 110 billion baht thereafter*. Such investment will not only strengthen capabilities in transportation of both passengers and cargo, but also enhance readiness to accommodate the upcoming industries in the EEC in the future.

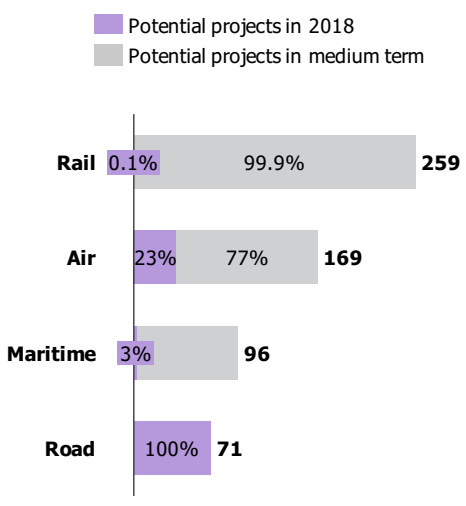
** excluding a large amount of investment on the high-speed rail and the third phase of Laemchabang seaport and only based on the ongoing and upcoming projects.*

Figure 4 : Infrastructure and utility investment plan in the EEC



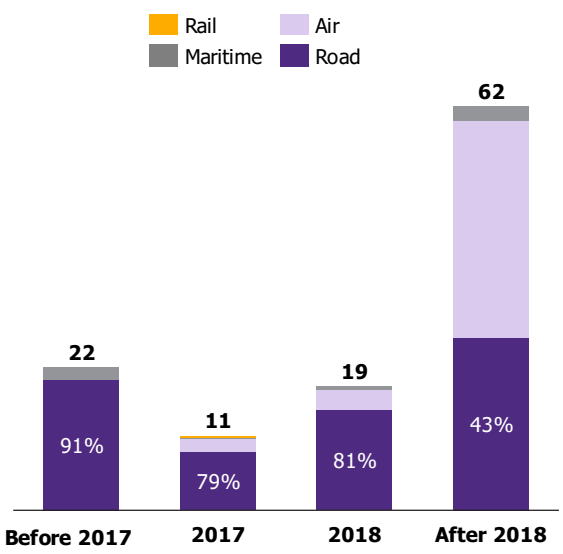
Potential transport infrastructure project in short and medium term

Unit: THB billion



Expected disbursement in infrastructure projects in Short term

Unit: THB billion



Source: EIC analysis based on data from NESDB

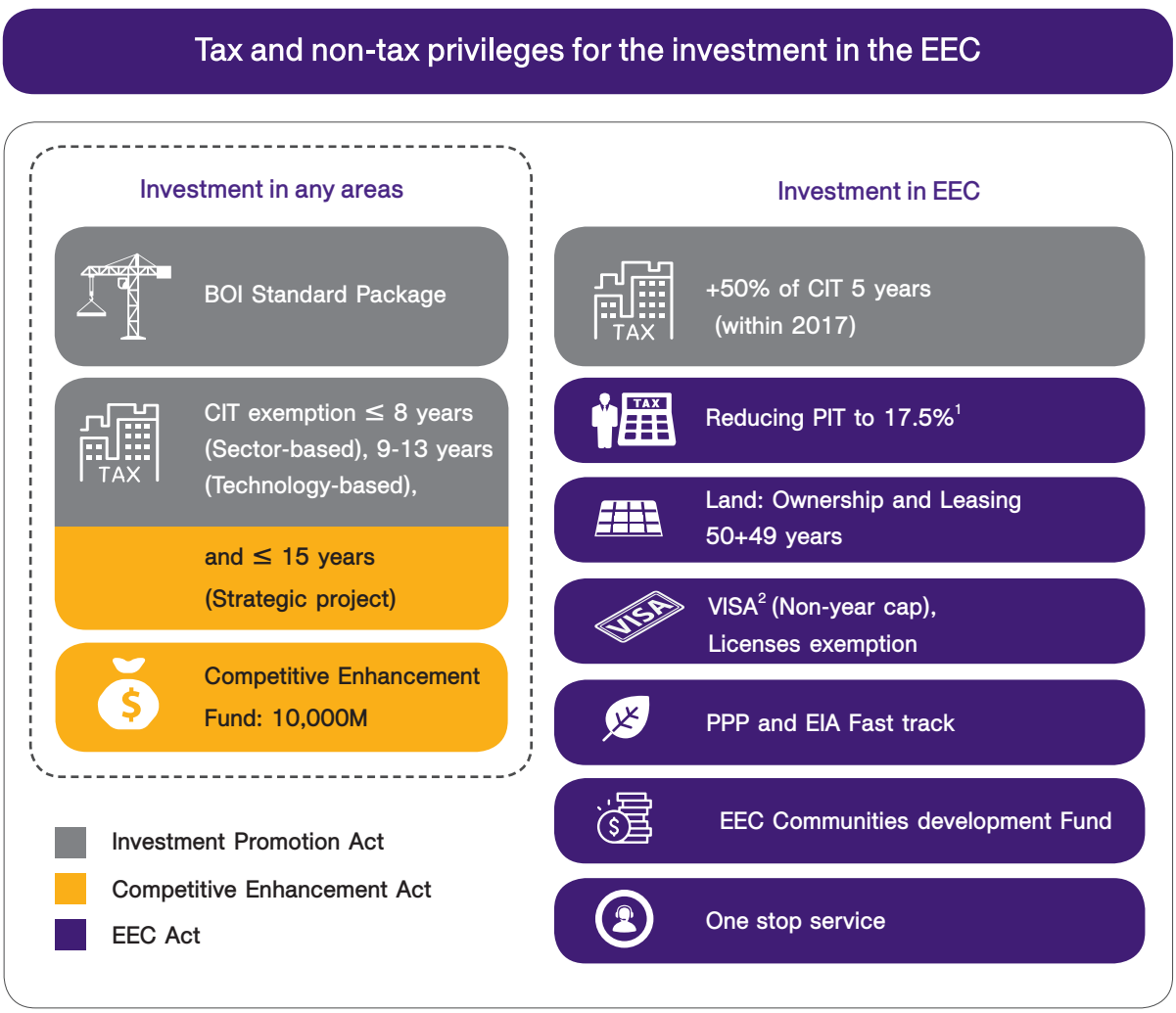
In addition to promotion in infrastructure development, investors in the EEC will receive tax benefits, funding support, and facilitation for investment in the EEC which comprises of 2 parts. The first is incentives gained from the Investment Promotion Act B.E. 2560 (2017) and the National Competitive Enhancement Act for Targeted Industries B.E. 2560. (2017). These incentives are guaranteed upon the satisfaction of Board of Investment's (BOI) requirements. The second is incentives received from the Eastern Economic Corridor Act, which offers additional benefits for investment in the EEC.

The first set of investment benefits is granted in accordance with the conditions set by BOI, who seeks to provide both activity-based and merit-based incentives in order to attract and encourage investment increasingly beneficial to the country. Activity-based incentives include exemption up to thirteen years of corporate income tax (CIT), and exemption of import duties on machinery and raw materials for exports. In addition, investors may receive additional merit-based tax incentives provided that the investment assists in enhancement of competitiveness, decentralized for regional development, and industrial development. Moreover, according to the National Competitive Enhancement Act, investors may qualify for CIT exemption for another two years and are eligible for funding from the National Competitive Enhancement fund.

For the second set of incentives, investors in the EEC are eligible for additional incentives both in the form of tax and other privileges. The additional tax incentives fall into two categories: 1) incentives on CIT including exemption of CIT for another two years and a 50% CIT reduction for another five years thereafter for investment in the targeted industries and designated areas, and 2) incentives on personal income tax (PIT) with the rate of 17% for foreign executives and specialists of the companies situated in the EEC.

In terms of soft infrastructure, the government plans to offer incentives to facilitate investors, particularly foreign investors. Examples include granting of 50-year land lease and an extra 49-year extension, five-year work permit for foreigners, unrestricted rights in shareholding of foreign investors, and the establishment of EEC One Stop Service (EEC TSE) that will provide a more convenient and comprehensive approval process for business license application.

Figure 5 : EEC Act offers more comprehensive benefit package than any other areas including investment facilitation



Noted: 1 and 2 For specialists/investors/executives

Source: EIC analysis based on data from Investment promotion, Competitive Enhancement and EEC Act

Additionally, in comparison to other ASEAN countries, EIC believes that the EEC offers a highly competitive incentive package ranging from CIT and PIT benefits to favorable duration of land lease. Thailand now offers CIT exemption up to fifteen years, which is on par with Singapore and Indonesia, but is much longer than Malaysia, the Philippines, and Vietnam that offer CIT exemption between 8 and 10 years. As for PIT, foreign executives and specialists in Thailand only pay PIT of 17%, the lowest rate among regional competitors where the PIT ranges from 22% to 35%. Lastly, Thailand offers the 99-year land lease for investors which is on par with Singapore, but considered higher than other countries which only offer lease of 50-70 years.

Figure 6 : Compare with other ASEAN nations, the incentives provided by EEC are on a par or better than others

Country	CIT	CIT exemption (For pioneer firm[1])	PIT	Land lease (Years)
TH	20%	15 years (Strategic), 9-13 years (Technology-based), <8 years (Sector-based)	35% (17% for Experts)	50+49
SG	17%	5-15 years plus >5% plus reduction in CIT < 10 years	22%	33+60
IN	25%	10-100% in 5-15 years, 20-100% in 10-25 years (Special Economic Zone)	30%	30+20
MH	20-24%	10 ปี	28%	50
PH	30%	6 years, Max 8 years	32%	50
VT	20%	4 years plus 5 or 9 years of 50% CIT	35%	70

Noted: 1. For example: High technology company

Source: EIC analysis based on data from PWC and KPMG

By mobilizing both legal measures and hard and soft infrastructure, the EEC aims at attracting foreign investment and development of the 10 targeted industries crucial for development of the country. Such measures will boost efficiency of five industries, or the First S-curve, that have already begun investment and operation. The First S-curve includes next-generation automotive, smart electronics, affluent, medical, and wellness tourism, agriculture and biotechnology, and food for the future.

Moreover, EEC also strives to create 5 industries of the future, or the New S-curve, consisting of robotics, aviation and logistics, biofuels and biochemicals, digital industry, and the medical hub. Development of these new industries will capitalize on the industries for which Thai people have expertise and have been familiar with. More importantly, the New S-curve will serve as important foundation in moving toward the knowledge-based economy.

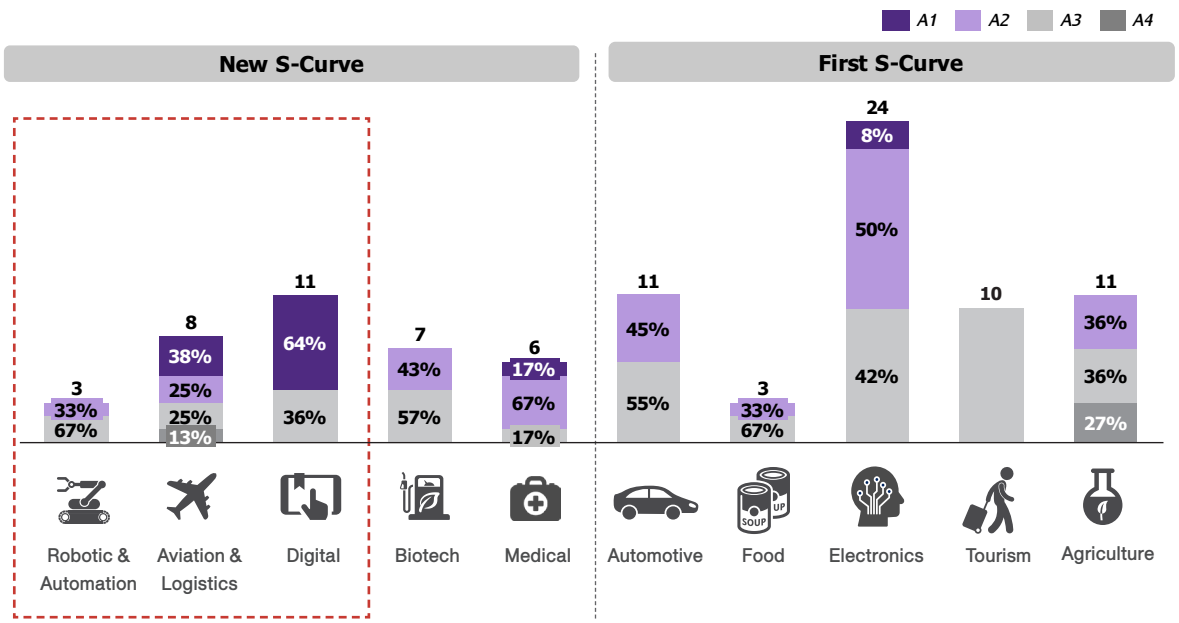
EIC assesses that, during the initial phase, the digital industry, aviation and logistics, and robotics and automation are three industries with high prospects in the EEC. The three are industries of the future that will serve as key foundation in creating new knowledge for moving country toward the knowledge-based economy. This will thus sustain long-term growth of the economy. Considering the ability and skills of labor, economic impact, and types of currently existing related industries, EIC believes that the digital industry, aviation and logistics, and robotics and automation are the 3 industries with the highest possibility to take place in the EEC. This is because personnel and workers currently employed in the three industries now have adequate knowledge and skills in software programming and development, aircraft maintenance and manufacturing, and automation and robotics design and integration. Meanwhile, the digital industry and the aviation and logistics industry are considered industries having high economic impact, as reflected in the highest share of companies qualified for investment incentives (Group A1, which consists of knowledge-based

industries that focus on design, R&D to enhance national competitiveness), representing 19% and 8% of the total number of companies in the 5 industries of the future. Furthermore, robotics and automation will enhance work efficiency and are also compatible with almost all types of manufacturing. At present, there are already many industries in Thailand that are related to these three industries, such as electronics parts and automotive parts manufacturing. Therefore, these 3 industries are among top ranks for their readiness and potential to be invested in the EEC.

Figure 7 : Digital, Aviation and logistics and Robotics and automation have high economic impact and likely to occur in early EEC development

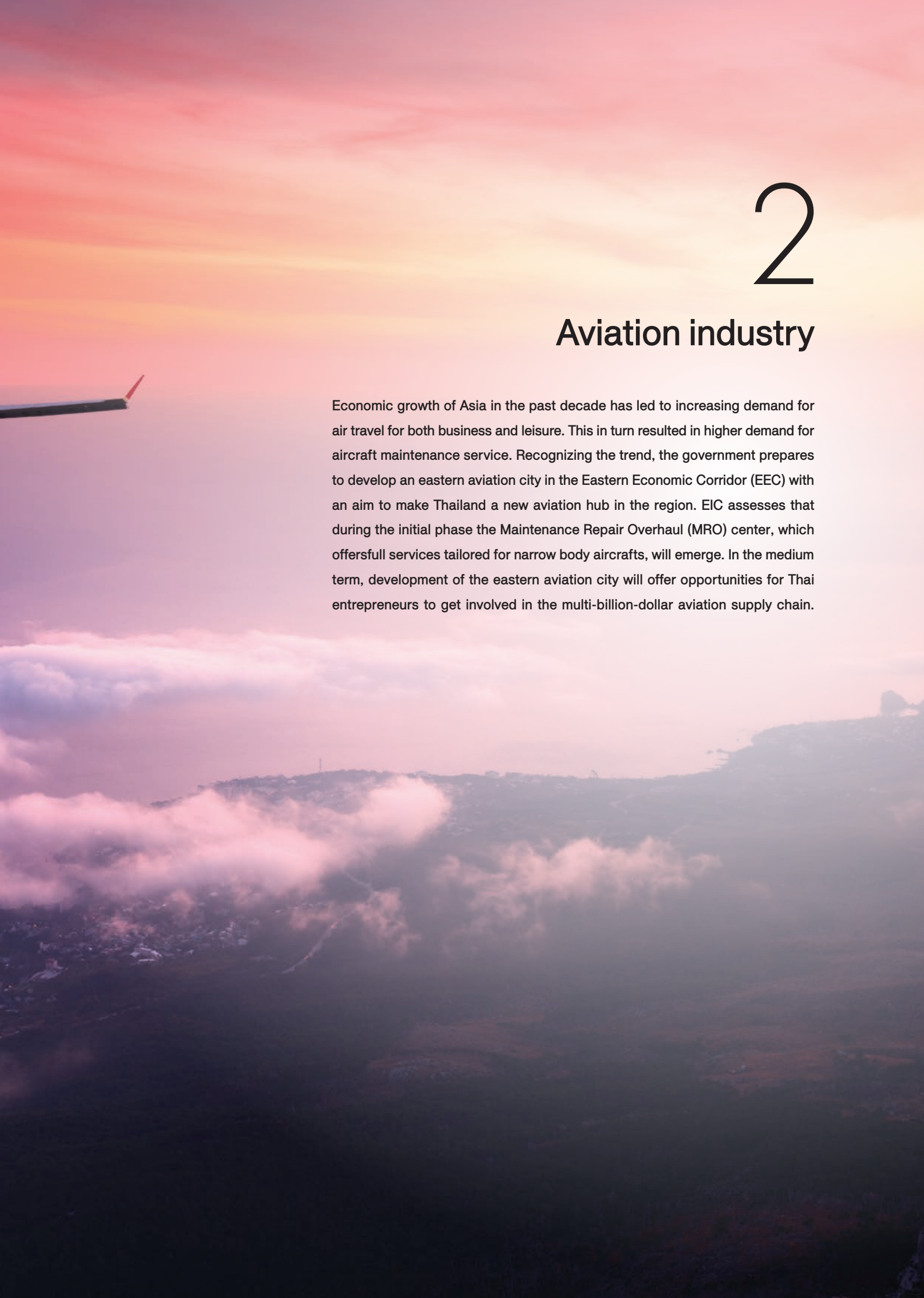
10 target industries and the level of incentive categorized by eligible business activities

Unit: business activities



Noted: A1 - CIT 8-years exemption (No cap), A2 - CIT 8-years exemption, A3- CIT 5-years exemption, A4 - CIT 3-years exemption

Source: EIC analysis based on data from BOI



2

Aviation industry

Economic growth of Asia in the past decade has led to increasing demand for air travel for both business and leisure. This in turn resulted in higher demand for aircraft maintenance service. Recognizing the trend, the government prepares to develop an eastern aviation city in the Eastern Economic Corridor (EEC) with an aim to make Thailand a new aviation hub in the region. EIC assesses that during the initial phase the Maintenance Repair Overhaul (MRO) center, which offersfull services tailored for narrow body aircrafts, will emerge. In the medium term, development of the eastern aviation city will offer opportunities for Thai entrepreneurs to get involved in the multi-billion-dollar aviation supply chain.

2.1 Outlook of aircraft maintenance industry

There has been an increasing demand for aircraft maintenance in Asia-Pacific region following increasing popularity of air travel. However, the capacity in aircraft maintenance in this region remains relatively limited. It is thus an opportunity for Thailand to develop its aviation industry. The economy in the Asia-Pacific region is expected to expand by around 4%CAGR over the next 20 years, making it the fastest-growing economy in the world and resulting in increasing volume of air travels. According to research by the International Air Transport Association (IATA), economic growth of the Asia-Pacific region in the past decade is significantly correlated with the rise in air passengers. It finds that the growth in number of air passengers tends to be twice that of the economy. This surge in air travel is a result of the growing demand for overseas business travel, as well as leisure travel by middle class, who is growing in number as well as purchasing power.

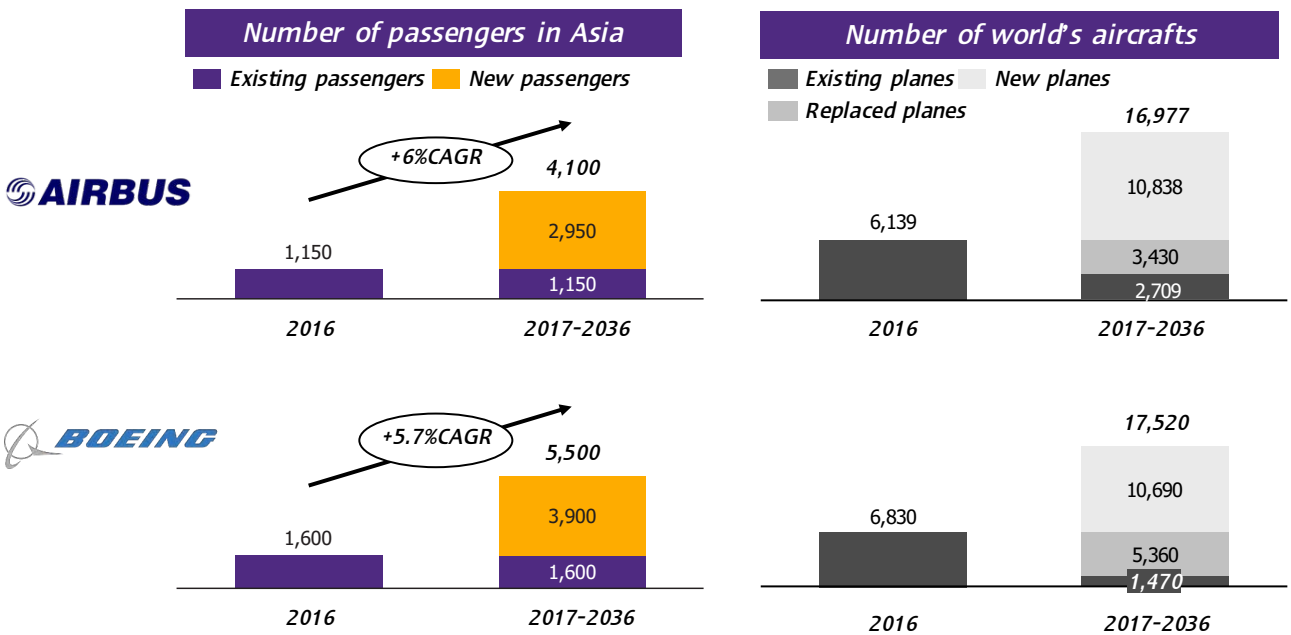
Such trend was consistent with the report from Boeing and Airbus, which confirm that air transport in Asia is expected to grow at 5-6%CAGR during 2017-2036, with the number of passengers recording 4-5 million seats-km and making up 45% of total passengers worldwide. This will lead to an increase in number of aircrafts to roughly 34,000-41,000 fleets in 2036, or double the count in 2016. In addition, 45% of the new aircrafts will fly in the Asia-Pacific region. Also, most of them will be narrow-body models, in line with the growth of low cost carriers. Hence, expenses on maintenance, repair, and overhaul in the Asia-Pacific region are expected to rise by 80% from 2017, or approximately 20 billion USD, in the next 10 years.

Thailand has seen over 7%CAGR growth in foreign tourist arrivals in the past 5 years, reaching 35 million in 2017. Indeed, the number is expected to continue growing at 4.5%CAGR over the next 3 years. As a result, Thailand's air traffic will grow remarkably, followed by an increase in demand for aircraft maintenance, both in the forms of light maintenance for each transit, and heavy maintenance. If Thai provides these services, it will help lower the airlines' cost of travelling to other maintenance hubs, as Thailand has the geographical advantage that facilitates connections with international airports around ASEAN. The EEC area is also the connecting point to other modes of transports including rail, sea, and road. Combining that with existing industrial bases and pool of skilled workers, growth opportunities for Thailand in the aviation industry seem vast.

Figure 8 : For the next 20 years, a sharp increase in the volume of air travels, especially in Asia, will drive demand for air travel and aircraft maintenance

A forecast of growth in number of passengers and aircrafts between 2016-2036

Unit: million seat-kilometers , aircrafts

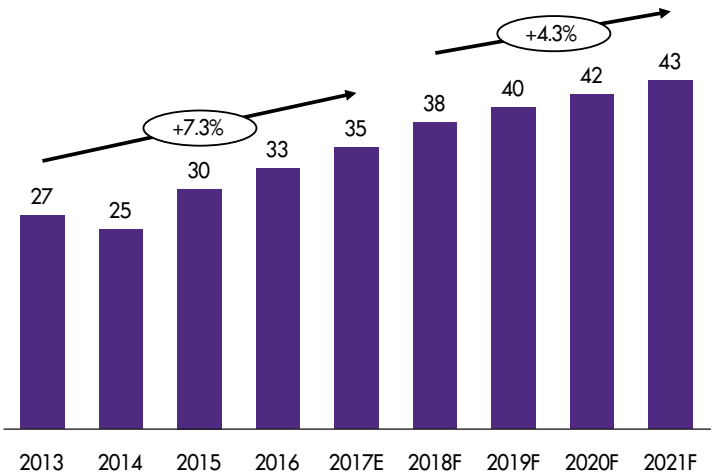


Source: Data from Airbus (2017) and Boeing (2017)

Figure 9 : An increase in international air traffic in and out Thailand will stimulate the aircraft maintenance

Number of foreign tourists travelling to Thailand

Unit: million persons



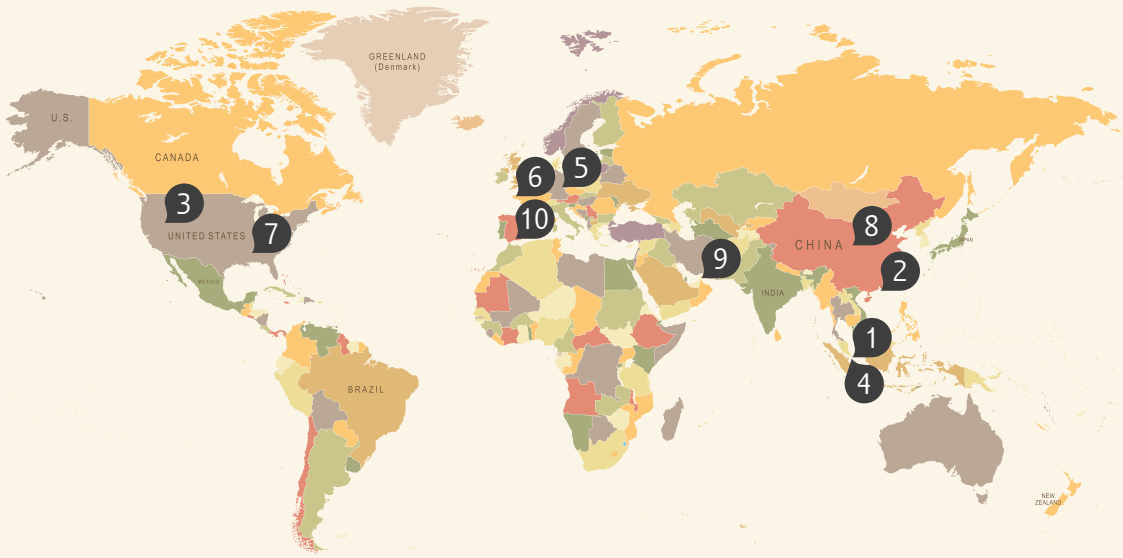
Source: EIC analysis based on data from the Ministry of Tourism

However, according to Oliver Wyman's research on aircraft's MRO, the capacity of aircraft maintenance, repair, and overhaul (MRO) in Asia may not be able to keep up with the demand. Moreover, large MRO centers in the region nowadays are facing problems in service provision. For instance, the largest MRO hub in Singapore operated by the ST Aerospace, offering the highest maintenance man-hours, is now confronting shortages of maintenance technicians. As of now, Singapore has to rely on human resources from China and the Philippines, while it is unable to expand further due to geographical constraints.China's MRO hubs are also facing rising wages, infrastructure constraints, and limitations in service provisions.

Figure 10 : Leading MRO players are located all over the world. Singapore and China are major MRO centers in Asia

Leading international MRO players

Unit: man-hours per year



1	Singapore Technologies Aerospace Singapore / 11.5 million	6	AFI KLME&M Holland/ France / 3.9 million
2	Haeco Group Hong Kong / 7.4 million	7	Timco Aviation Services USA / 3.2 million
3	AAR Corp. USA / 4.6 million	8	Ameco Beijing China / 2.8 million
4	SIA Engineering Co. Singapore / 4.2 million	9	Mubadala Aerospace United Arab Emirates / 2.5 million
5	Lufthansa Technik Germany / 4.1 million	10	Iberia Maintenance Spain / 2.3 million

Source: Data from Viera (2016)

2.2 Development of Aviation Industry in EEC

Given aforementioned developments, the Thai government aims to transform U-Tapao International Airport into an Aerotropolis of eastern Thailand, just like Schiphol in the Netherlands, Songdo in South Korea, and Zhengzhou in China, all of which are important transportation hubs that crowd in urbanization in the surrounding areas. The 6500-rai U-Tapao International Airport in Rayong province is the strategic location for the plan to promote aviation industry in Thailand, which consists of 3 major components. First, the plan to develop U-Tapao Airport to be the third commercial airport in the country serving 60 million passengers within 15 years. Second, investment in 5 key businesses namely aircraft repair, passenger terminals and commercial areas, manufacturing of aircraft parts, air transportation, and training center for aviation personnel and business.Third, a future plan to promote three additional businesses, namely 1.commercial ports, 2.specialized medical centers, and 3.defense technology. All these developments will not only make U-Tapao International Airport a center for aviation industry, but also lead to urbanization in the areas within 20-30 kms. radius from the airport.

During the initial phase, MRO centers will be the first project to be developed in collaboration with Thai Airways, Airbus and governmental agencies. TheMRO project, worth 11 billion baht, will comprise investment in 2 parts. The first part includes buildings and civil works such as hardware repair building, aircraft coating station, and maintenance hangar, which the Royal Thai Navy will invest a total sum of 7 billion baht. The second part includes tools and equipment for aircraft maintenance totaling 4 billion baht, which will be in a form of joint venture between Thai Airways and Airbus. As of now, the two companies have signed the agreement to assess business opportunities of the MRO center project at U-Tapao. Once the findings are in, the two parties will consider signing a joint-venture agreement within the first quarter of 2018, so that the operation can commence by 2021. Moreover, regarding the development of personnel for the maintenance services, Thai Airways has signed a Memorandum of Understanding (MOU) with the Civil Aviation Authority of Thailand to set up aviation training centers for this purpose.

BOX

Zhengzhou Aerotropolis

Aerotropolis, or a center for aviation and business , is a new form of urban development that makes airports not only a transportation facility, but also urbanization growth driver. The idea is to use the convenient air transport as a selling point to attract investment in manufacturing and services to the surrounding area, eventually turning the area into a new city. The concept of Aerotropolis was developed from the previous century's model of using transportation, such as sea or water transport, as economic growth driver. This model was widely adopted in many countries, such as Amsterdam Schiphol Airport City in the Netherlands, Paris Charles de Gaulle Airport City in France, Songdo International Business District in South Korea, and the recently developed Zhengzhou Airport Economy Zone in China.

In 2010, the Chinese government began developing the Zhengzhou Airport Economy Zone (ZAEZ) in the south of Zhengzhou, Henan province in central China, with Zhengzhou Xinzheng airport as a center. The airport has been successful and is now considered one of China's large transportation centers. This is indicated by the increase in number of passengers in the airport from 8.7 to 15.8 millions during 2010-2014, a 80% growth. Meanwhile, the amount of shipments rose markedly from 85,800 to 370,000 tons during that same period, or a 300% growth. This has made Zhengzhou Xinzheng airport China's 7th busiest airport for shipping within just 5 years.

The area of over 415 squarekilometers of the ZAEZ is divided into 3 main parts. The first part, which constitutes 40% of the area, will be an airport district that houses aviation-related businesses including the airport itself, passenger transport and shipping, aircraft parts manufacturing and maintenance, and warehouse area for cold storage warehouse and e-commerce. The second part, which makes up 40% of the area, will be a high-end manufacturing district to cater for R&D in aviation and high-end electrical appliances. An example of companies housed in this area is Foxconn, an assembler for iPhone, who imports raw materials and exports final goods to many countries around the world. The last part of the project will be an urban services district for public utilities and amenities such as office buildings, schools, hospitals, recreational areas, and mixed-use projects, etc.

The key factors that have made ZAEZ China's transportation hub in such a short period of time are the following.

1. Location of the ZAEZ is suitable as a center for transportation and manufacturing, as it is situated in the central part of the country. This makes it convenient to connect with other cities in China. Notably, the area within 500-km radius of the ZAEZ covers 30% of the Chinese population.

2. Connectivity among modes of transportation is convenient, as the ZAEZ is a gateway to road transport via trucks, and rail transport via trains and high-speed trains. Also, it is a key city linking China with Europe through the rails along the Belt and Road initiative, China's strategic plan.

3. Support from the government in terms of transport infrastructure and economic promotion has led to a coherent plan for the development of ZAEZ, the airport, motorways, trains, and high-speed trains in the area. Moreover, economic promotion measures such as project planning, establishment of special economic zone, and provisions of import-export tax incentives, have attracted investors and garnered their confidence in the project.

Figure 11 : ZAEZ has become China's transportation hub due to its location, which covers over 30% of the Chinese population within 500-km radius, and multimodal connectivity

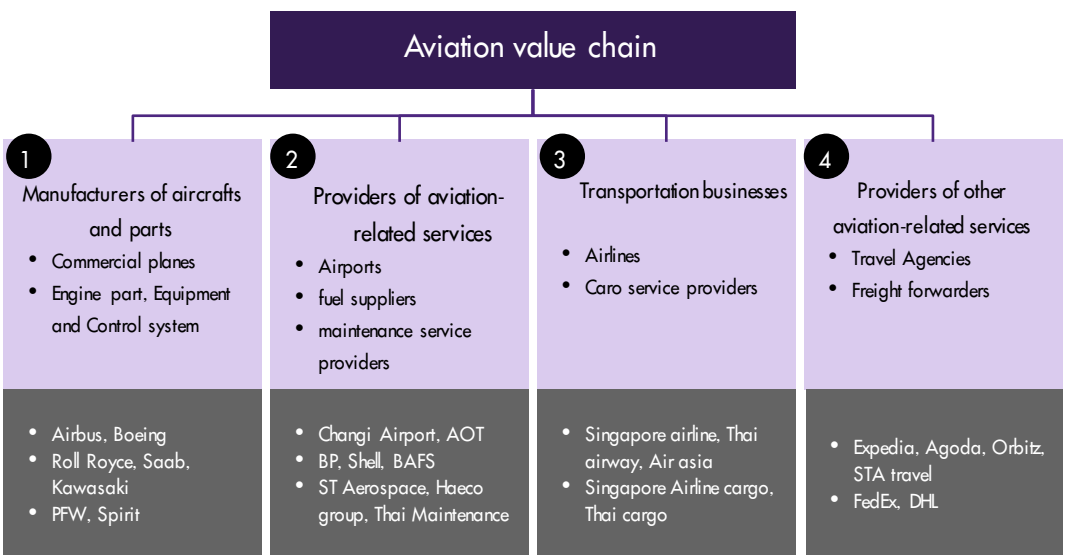
City	2004 Rank	2009 Rank	2014 Rank	%Change, 13-14
Hong Kong	2	1	1	2.3
Memphis	1	2	2	4.0
Shanghai	14	3	3	8.6
Anchorage	4	6	5	-0.7
Louisville	12	7	7	2.7
Miami	9	12	12	5.1
Beijing	26	14	14	2.0
Los Angeles	6	13	15	2.3
Guangzhou	NA	21	18	11.0
Chicago	13	19	19	9.9
Additional China only ranking				
Shenzhen	4	4	4	5.5
Chengdu	5	5	5	8.7
Hangzhou	8	7	6	8.3
Zhengzhou	25	20	7	44.9

Source: Data from Kasarda (2012, 2013, 2015), citiscope (2016)

2.3 Aircraft maintenance and aircraft parts manufacturing businesses

Speaking of aviation industry, many people may first think of the airline business, which is most relevant for consumers. However, there are many other interesting businesses within the aviation value chain such as manufacturing of aircraft parts, MRO, freight forwarder, and travel agency. The aviation value chain consists of 4 main groups of businesses, namely 1) manufacturers of aircrafts and parts, including manufacturers of commercial planes like Boeing or Airbus, and those of engine parts, equipment, and control systems, such as Rolls Royce, Saab, and Kawasaki; 2) providers of aviation-related services, such as airport operators like Changi Airport Group and Airports of Thailand PCL, fuel suppliers such as BP Shell and Bangkok Aviation Fuel Services PCL (BAFS), maintenance service providers such as ST Aerospace, technical department of Thai Airways, and on-board catering services; 3) transportation businesses, namely passenger transport services such as Singapore Airlines, Thai Airways, and cargo service providers such as Singapore Airlines cargo, Thai Cargo; and 4) providers of other aviation-related services, including travel agencies such as Agoda, Expedia, and transportation management companies such as FedEx, DHL, etc.

Figure 12 : Apart from airline business, there are many other interesting businesses within aviation value chain



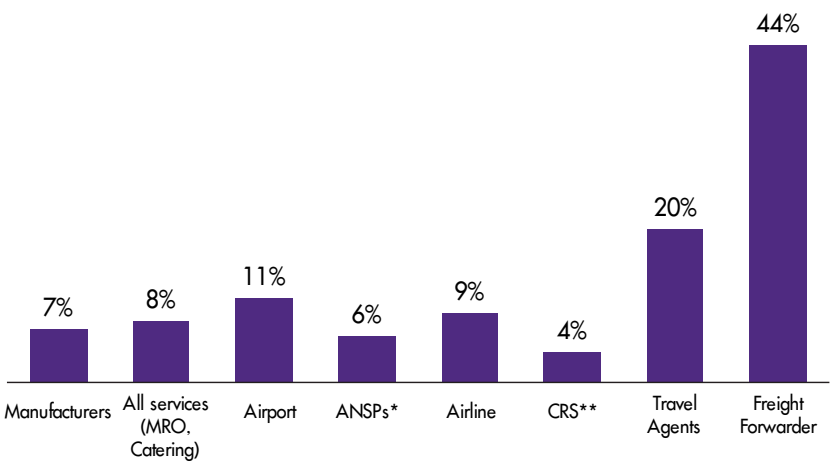
Source: Analysis by EIC based on data from Tretheway and Markhvida (2013)

Among the businesses in aviation value chain, MRO business and manufacturing of aircrafts and parts promise high returns. Comparing Returns on Invested Capital (ROIC) across businesses in aviation value chain, McKinsey, a leading consulting firm, found that transport service providers, namely airlines, have recorded the smallest ROIC of only 4%. This is because airlines have to face the risks pertaining to the number of passengers and volatility of fuel prices. On the contrary, other aviation-related service providers have enjoyed higher ROIC of 20-44%, but also face with intense competition from a large number of operators. The two remaining groups of businesses, namely aviation-related service providers, particularly MRO, and manufacturers of aircraft and aircraft parts, have recorded 11% and 7% ROIC, respectively. Thus, they present an attractive business opportunity, thanks to higher returns and lower competition compared to other aviation-related businesses.

Figure 13 : MRO business and manufactures of aircrafts and parts promise high returns

Return on invested capital in aviation industry

Unit: %



*Note: *Air navigation service provider, **Computer reservation system*

Source: Report by McKinsey (2013)

In general, aircraft maintenance services can be categorized into 3 main types: 1) engine 2) components and 3) air frames. Maintenance of the first two types is mostly done by Original Equipment Manufacturers (OEMs), as it is a highly complex task and the parts are usually under warrantees. Meanwhile, airframe maintenance is usually completed by independent MRO such as ST Aerospace, and Haeco Group.

Airframe maintenance can be divided into 2 groups. The first group is light maintenance or line maintenance, including 1.1) daily checks, which are daily inspections of various systems before and after take-offs, 1.2) A-checks, general maintenance checks of conditions such as fuel levels, tires and brakes, which are done every 2 months and take around 10 hours, and 1.3) B-checks, more sophisticated maintenance checks which are done every 6 months and require at least 1-3 days. The second group of maintenance is base maintenance, including 2.1)

C-checks, replacements of aircraft components and detailed inspections of both structure and surface of the aircrafts, which are done every 20 months and take 1-2 weeks, 2.2) D-checks, heavy maintenance that requires removing aircraft components for inspection, which is done every 6 years and requires 4-6 weeks.

At present, there are only 7 players in the aircraft maintenance business in Thailand. There are 3 line maintenance service providers - Austrain Technik, Delta TechOps, KASE aviation - , 3 service providers for both base maintenance and engines or aircraft parts maintenance - technical department of Thai Airways, Thai aviation industries and SAMTHAI - , and 1 aircraft parts supplier - Triumph aviation service. These companies combined make up of only 20 billion baht or merely 1% of the total revenue in the global aircraft maintenance market per year.

Figure 14 : Types of air frame maintenance check

Maintenance check	Maintenance type	Schedule	Duration	Description
Daily/ during	Line or Light Maintenance	At gate		System inspection before and after takeoffs
A-check		2 months	10 hours	General maintenance check such as fuel levels, tires and brakes
B-check		6 months	1-3 days	Detailed maintenance check at hangar
C-check	Base or Heavy Maintenance	20 months	1-2 weeks	Aircraft components replacement and detailed maintenance check for both structure and surface of aircraft
D-check		6 years	4-6 weeks	Removal of aircraft parts for maintenance check

Source: EIC analysis based on data from Viera (2016)

Regarding aircraft component manufacturing, the aircraft supply chain can be divided into 5 main groups, including OEMs and tier 1 to tier 4 manufacturers:

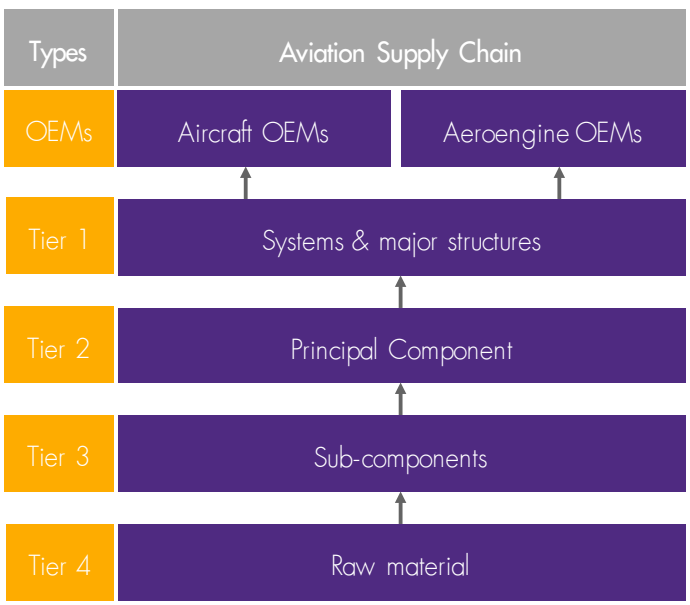
- OEMs – manufacturers of aircrafts and engines, such as Airbus, Boeing, and Rolls Royce
- Tier 1 manufacturers - manufacturers and installers of systems in the aircrafts such as avionics, navigation systems, and fuel systems. Examples of these companies are PFW and Spirit.
- Tier 2 manufacturers – manufacturers and assemblers of the main parts of the aircrafts, such as

airfoils, ribs, and compressor blades. Examples of these include Northern aerospace, Hyde Group, and Senior aerospace.

- Tier 3 manufacturers – manufacturers of secondary parts such as gears, knots, screws, electrical wires, and steel parts. Examples of these include Precision Components, Crane Aerospace & Electronics and EME.
- Tier 4 manufacturers - manufacturers and suppliers of raw materials for aircraft parts, including aluminum, titanium, steel, plastic. Some examples include Cytec Engineered Materials and Allegheny Technologies.

Currently, Thailand's manufacturing and exports of aircraft parts are valued at over 50 billion baht. This consists of

Figure 15 : Aviation Supply Chain



Source: Data from AeroDynamic Advisory

EIC believes that the coming MRO center should be able to offer comprehensive services and focus mainly on narrow-body aircrafts. Currently, among 7 MRO companies, only the technical department of Thai airways is able to offer full maintenance services for airframe, engines and components. Investment in an MRO center equipped with modern technology, under collaboration with aircraft manufacturers like Airbus, will significantly upgrade Thailand's capabilities in airframe maintenance services. Regarding the aircraft size, air traffic data in and out of Thai airports reveal that over 70% of the aircrafts are narrow-body ones used by low-cost airlines. This number is expected to increase by 1.5 times in the Asia-Pacific region. The rest are wide-body aircrafts used by full-service airlines.

With respect to aircraft manufacturing, opportunities for Thai companies are promising in tier 2-3 manufacturing of the aircraft supply chain. Since manufacturing of OEMs and tier 1 parts requires highly complex technology, it is still done by large foreign manufacturers who own the technology. Meanwhile, manufacturing of tier 2 and tier 3 components can offer greater opportunities for Thai companies, as the technology required is not as complex and can be developed from the existing automotive manufacturing base in Thailand.

Establishment of MRO center is the first step for Thailand in the aviation industry, both in maintenance services and aircraft component manufacturing. Nevertheless, Thai companies should prepare themselves for entering the value chain.

As for the maintenance services, Thai companies should train and develop aircraft engineers and technicians who can be verified by aircraft maintenance courses offered by global aviation regulators such as the Federal Aviation Administration (FAA) in the U.S. and the European Aviation Safety Agency (EASA). Moreover, MRO business is a labor-intensive one that requires a large number of engineers and technicians for checking and testing aircrafts, aircraft repair, and part replacements, ensuring that aircraft conditions comply with standards. The skills required for maintenance services include steel structure repair, welding, coating, as well as English language proficiency. Nevertheless, not only will MRO businesses benefit from the opportunity,but in the future subcontractors will also benefit from the outsourcing of less complex or low-skilled tasks, such as soldering, painting, and cleaning.

Companies wishing to enter the aircraft parts manufacturing industry have to make trust in products and promptly develop the technology to keep up global aviation industry. EIC believes that Thai companies are able to enter the aviation value chain in 2 ways. First, they can cooperate with technology owners who invest in Thailand, perhaps in the forms of joint ventures, as partnerships or alliances. Thai companies will have the opportunity to become tier-3 sub-suppliers of tier-2 technology owner. For instance, Senior Aerospace is a supplier for Rolls Royce in manufacturing of compressor blades, ribs and passenger seats, with Thai companies serving as contractors and sub-contractors.

Second, Thai companies can scale up in order to be certified for aircraft manufacturing standard such as AS9100 or NADCAP. To do this, they must find ways to develop their existing products for the use of aircrafts. For example, C.C.S Groups, with its original business in lathing, scaled up into manufacturing of metal parts used in brake systems, warehouse systems, aircraft sensors. Sahamit Machinery, with its base in processing and plating of steel, expanded to quenching steel parts of the aircraft.

EIC believes that the keys to success of the eastern aviation city are cooperation from key players, development of human resource, and becoming a connectivity hub. Cooperation among key players in aviation business will help boost service capacity and build trusts in the quality of service. Examples are the signing of MOU between Airbus and Thai Airways, and collaboration with other manufacturing industries, like Foxconn's investment Zhengzhou. Regarding human resource development, the government must develop sufficient human resource to support the growth of the industry, both technical skills and language skills. Finally, on becoming the connectivity hub, the city must be connected to other modes of transportation, in order to ensure speed, convenience, and accessibility. For instance, Zhengzhou is well connected to land transportation such as roads, railways, as well as to air transport.

However, technological advancement in aviation presents a key risk to MRO and manufacturing of aircraft parts. ICF International, a consulting firm, reported that the frequency in entering maintenance service of new-model aircrafts is considerably lower than that of older models. For example, over the same amount of time, a new-model like Boeing 787 will be need 3 light C-Checks and 1 heavy C-Check. However, an old model like Boeing 767 will need 6 light C-Checks and 2 heavy C-Checks. Therefore, newer aircrafts will significantly lower the revenue of MRO companies. As for aircraft parts manufacturing, new production technology like 3D printing presents a double-edged sword. On the one hand, it allows for easier production. On the other hand, it can have negative impacts on producers. For example, for large parts that used to be assembled from many small parts made in several different factories, 3D printing will enable a factory to make the whole large components all by itself. This, therefore, could render small factories irrelevant and could potentially force them out of business.

The lack of aviation human resource an important issue that the government should promptly address, in order to keep up with demand that is expected to rise by 6 folds. A variety of aviation personnel is in demand, such as maintenance workers, electronic mechanics, aeronautical engineers, pilots, and cabin crews. At present, Thailand can only produce 300 maintenance workers and 400-500 pilots per year. Moreover, it still lacks a maintenance examination center certified by EASA, the only one in Aseanis located in Malaysia. Moreover, English language proficiency are also necessary, as the aviation business requires interactions with foreigners. Also, maintenance workers and aeronautical engineers will have to pass a vocational skills test conducted in English before starting the job. To ease skills shortage, the Civil Aviation Authority of Thailand (CAAT) is prepared to produce more aviation workers by investing in new school buildings. The new facilities will raise the number of aviation personnel from 1,400 to 3,000. Moreover, it will expand the pilot training center, increasing the number of pilots trained per year from 80-100 to 160. Also, a training center for aviation maintenance will be established. The total 7.2 billion baht-plus investment is expected to help alleviate the shortage of aviation personnel in the future.

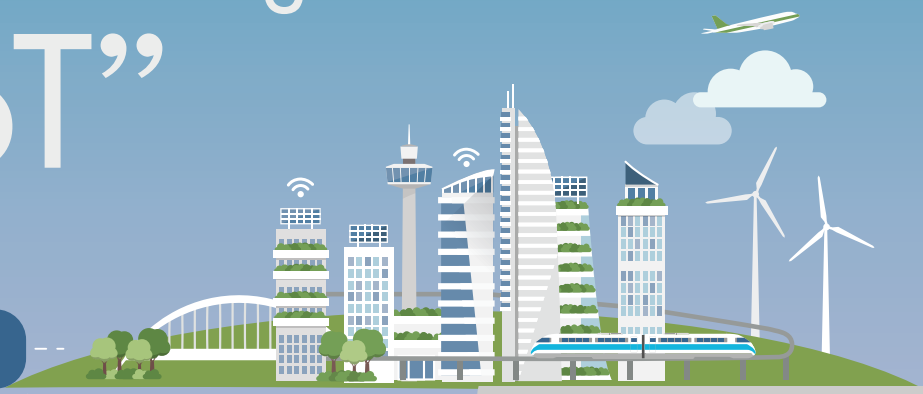

10.19
70.14
72.67
91.62
94.23
41.62
29.87
59.55
61.22
30.50
46.63
74.84
48.12
74.70
94.37
61.19

3

The digital industry

Nowadays, digital technology plays an pivotal role in manufacturing and services industries. The government recognizes the importance of this industry and thus plans to build the Digital Park Thailand in the EEC in order to encourage investment in new digital businesses. The emphasis will be on those businesses relating to Internet of Things (IoT), a new technology wave that helps enhance efficiency and lower production cost. IoT has now been adopted in various industries across the globe, but a key industry in Thailand like agriculture has only limited use of such technology. EIC finds that IoT solutions for water control, disease and pest control systems, and soil monitoring are interesting choice for Thai farmers. They can help raise production per rai by 30-50%. Nevertheless, farmers also have to consider the break-even points of investment. For example, for rice farmers, investment in IoT will only payoff with production size of more than 4 rai.

The new look of Thai agriculture with "IoT"



Which technology is emerging?

Internet of Things (IoT) as the third wave

- 1st wave Internet (1985-1999)
- 2nd wave Mobile Internet (2000-2015)
- 3rd wave IoT (2016...)

Spending on IoT in Thailand

73 bn. baht → 135 bn. baht

2015 — 2020

Supporting factors from EEC

- Hard Infrastructure

Digital Park Thailand

+

- Soft Infrastructure

Regulatory relaxations

Sandbox

Potential industries to adopt IoT

Agriculture

One of Thailand's key industries, but currently declining and not adopting much IoT

3 IoT solutions for agricultural industry

1. Water controlling

Estimate quantity of water and time needed to water plants

2. Pest and disease control system

Enhance efciency of disease and pest control e.g. use pesticide only when needed

3. Soil monitoring

Evaluate soil properties, moisture, temperature and minerals to recommend crop types and suitable soil conditions

EIC's View

Farmers

Use IoT in farming and livestock activities that require in special care and high economic value

Businesses

Provide IoT solution through in hardware and applications with affordable price

Government

Provide support and training for farmers and coordinate with businesses to develop new agricultural innovation

Source: EIC analysis based on data from IDC and Ministry of Digital Economy and Society

3.1 EEC and the digital industry

Adoption of digital technology is inevitable to survive the digital disruption era. Nowadays, industries with intensive use of digital technology include ICT, media, and finance. Examples from these industries have shown that even large companies are vulnerable to mergers, take-overs, or even going out of business if they fail to adapt to the new technology. For instance, Nokia made a wrong move by not focusing on touch screens and internet connectivity features. Consequently, it made huge losses and was forced to sell parts of the company to Microsoft. Indeed, digital technology is the key determinant of a company's survival or demise. As the technology advances, changes in the business landscape will happen at a faster pace than ever.

Digital industries are those with intensive use of digital technology, which can come in the forms of digital products, services, or infrastructure. Digital industries rely on intensive use of digital technology, employing digital information in creating value-added, reducing costs, and forming new industries that will develop into manufacturing and services in the future. Digital industries consist of 1) Digital products, which can be divided into 3 groups: digital content and data such as immersive animation, smart hardware such as smart devices, and smart software and systems such as IoT platform; 2) Digital services, such as cloud computing; 3) Digital infrastructures, such as high-speed internet networks.

Digital industry is among the 10 targeted industries in EEC, and will play important role in providing support for other targeted industries. Digital industry is named among the industries of the future (New S-curve industry) to receive government support. New digital businesses are encouraged to invest in the EEC, as they play a key role in upgrading manufacturing industries towards the Industry 4.0. They do so through raising production efficiency and reducing costs in other industries by 30%. Hence, the government also hopes to encourage applications of digital technology in other target industries, such as the next-generation cars, smart electronics, and processed food, in order for these industries to compete successfully in the international arena.

During the initial phase, Digital Park Thailand is designated as a flagship project in the EEC to attract investment in digital industries. On the 700-plus-rai piece of land in Sriracha district, Chonburi province, the project consists of 3 main zones: 1) Digital innovations zone, with centers for learning and sharing of digital technology, universities, and institutes for creations of digital innovations, such as IoT Institute. 2) Digital business investment zone for foreign companies investing in Thailand. 3) smart living residential zone.

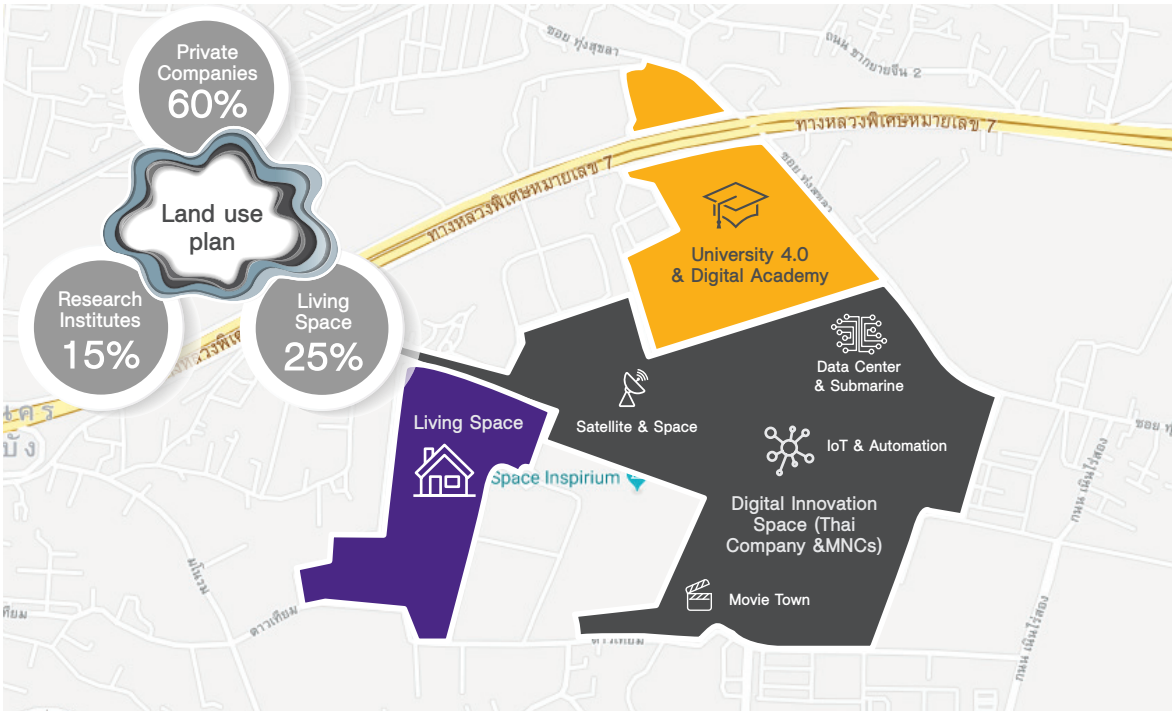
Nevertheless, the creation of Digital Park Thailand will be in the form of PPP, with the private sector contributing 70% of investment, mostly in digital industry and some infrastructures, while the government contributing 30%, mostly in infrastructures and the residential areas. Moreover, the government will be responsible for providing benefits and incentives to attract foreign investors and experts. The project is set to open in 2022.

In addition, the project is equipped with both physical infrastructures (hard infrastructures) and regulatory infrastructures (soft infrastructures). Currently, hard infrastructures include a satellite station and a submarine cable network connecting to global fiber optics network, making the area Thailand's strategic location for high-speed communication. Digital infrastructures will also later include the Digital Academy, the IoT Institute, an international submarine cable station, and a data center.

Key soft infrastructures include: First, some laws and regulations are exempt for those relating to the creations of digital innovations in Digital Park Thailand (Sandboxed for regulatory adjustment). The site thus serves as a sandbox for testing out new equipment, products, automation, platforms, and applications of smart technology. Second, to attract global digital firms to invest in Thailand, customized incentives will be offered, while transfer of knowledge to Thai companies will be facilitated. Third, tax incentives will be provided to draw in digital talents, both Thai and foreign.

Figure 16 : Digital Park Thailand consists of three areas: 1) A digital innovation zone, 2) A digital business investment zone, and 3) A residential area

Digital Park Thailand – Digital innovation and industry promotion zone



Source: EIC analysis based on data from the Ministry of Digital Economy and Society

EIC believes that once the digital infrastructures are in place, investment in Internet of Things (IoT) will follow. Digital businesses include 1) software development and services, 2) e-commerce, 3) analytics and data centers, 4) cloud computing and cyber security services, and 5) Internet of Things. EIC believes that the digital infrastructures that Digital Park Thailand provides, such as the IoT Institute, regulatory exemptions, and the living lab and testbed sandbox will spur new designs, research, explorations, and developments of IoT related businesses. Thus, investment in IoT will likely surpass that in other businesses.

3.2 Internet of Things (IoT)

Regulatory relaxations and sandboxes in Digital Park Thailand are at the heart of the ecosystem that supports IoT investment in the EEC. Investment in IoT and developments of new IoT products rely heavily on testing. This is especially the case for hardware products like self-driving cars and drones, which require permissions from relevant authorities before testing. For instance, in the case of Google, regulatory exemptions and testing centers in Silicon Valley have enabled the company to freely design, develop, and test new products. In the same token, regulatory easingin Digital Park Thailand will be key to making the EEC more attractive than its foreign peers.

IoT is the third wave of technology, following the Internet and mobile Internet. The Internet, the first technology wave, took place during 1985-1999 when personal computers were first used to connect to the Internet. The second technology wave, mobile Internet, emerged during 2000-2015, when the Internet was accessible via smartphones or tablets. Then, since 2016, IoT has emerged as the third wave and the number of IoT devices is predicted to be around 50 billion units in 2020, which is over ten times other internet devices. Such unprecedented popularity of these devices is thanks to faster Internet connection, less energy required in data processing, and lower costs of IoT parts, such as sensors. Besides, the advancement of IoT software has enabled the technology to be applied more widely.

With its potential to transform the world, IoT will inevitably impact manufacturing and service industries, as well as the consumers. IoT refers to the environment in which various devices such as smart phones, airplane engines, or factory machines, each with device identification, can connect to each other via the Internet, allowing them to communicate, work together, and respond to each other. With its vast potential and faster Internet connection, IoT is on course to change the way people live and work in the near future. IoT can be applied to many activities. In homes, it can be used for controlling room temperature or coffee machines. In factories, it can change the way machines work by enabling remote communication, tracking, and controlling. Also, data from sensors attached to manufacturing belts can be analyzed in order to improve the production process.

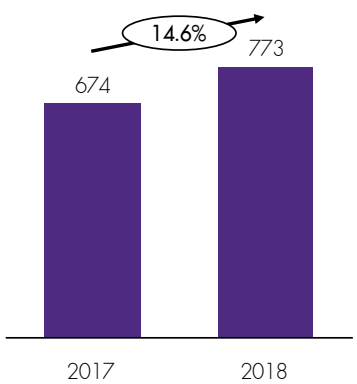
The growing popularity of IoT is shown in the rush in spending on the technology, especially on software. Today, more and more companies around the world are adopting IoT. Spending on IoT is set to expand by approximately 15%, reaching 770 billion dollars in 2018, and is expected to surpass 1 trillion dollars by 2020. Although companies have invested in everything—from hardware, software, connectivity, and service—the spending on software—such as application software, analytics software, security software, as well as platforms—has grown at the fastest pace of around 16%. Indeed, software is the foundation of every IoT application.

In addition, global IoT expenditures in 2018 will still be concentrated in manufacturing, transport, and public utilities industries, each accounting for 24%, 11%, and 9% of total expenditures, respectively. Demand for IoT differs across industries. For example, for manufacturing companies looking for assistance in operations and resource management, IoT can boost production efficiency and reduce the cost of machine maintenance by 30%. For transport companies, more than 70% of IoT spending is on tracking systems, which help cut costs and minimize delays, as they prevent damage from transportation and reduce fuel use. Meanwhile, expenditures in the public utilities industry have mostly been on smart grids that monitor electricity usage, collecting data that can be used for usage forecasts. Such information helps control electricity generation, pricing, and planning of new powerplants.

Figure 17 : Expenditures on IoT around the world are projected to reach 770 USD billion in 2018, a 14.6% growth from the previous year. The majority of them are concentrated in the manufacturing, transport, and utilities industries

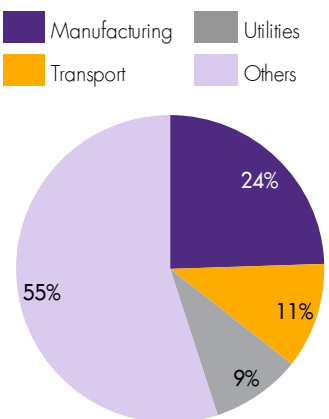
Global spending on IoT

Unit: USD billion



Shares of global spending on IoT by sector

Unit: %



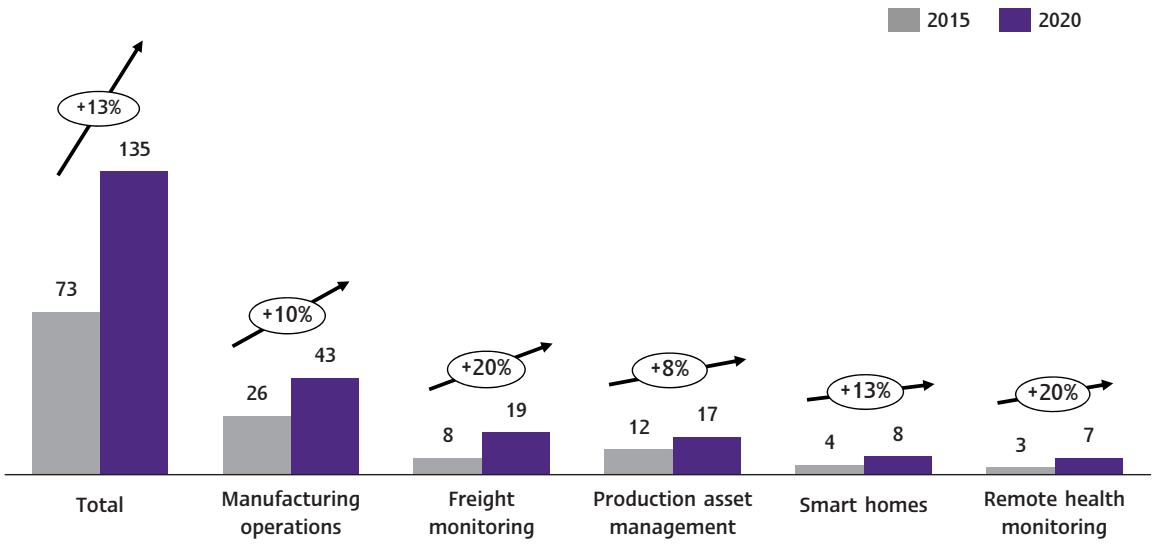
Source: EIC analysis based on data from the International Data Corporation (IDC)

Meanwhile, IoT spending in Thailand has mostly been in manufacturing and transport sectors, in line with the global trend. In 2015, IoT expenditure in Thailand totaled 73 billion baht. It is projected to grow by 13% per year, reaching 135 billion baht in 2020 on the back of growing IoT applications in remote health checkup services and transportation tracking, each growing at around 20% per year. Support also comes from investment in digital infrastructures, such as high-speed internet networks, and the 920-925 MHz frequency allocated for IoT applications.

Figure 18 : IoT spending in Thailand has mostly been in the manufacturing and transport sectors, in line with global trends

IoT expenditures in Thailand by application

Unit: THB billion



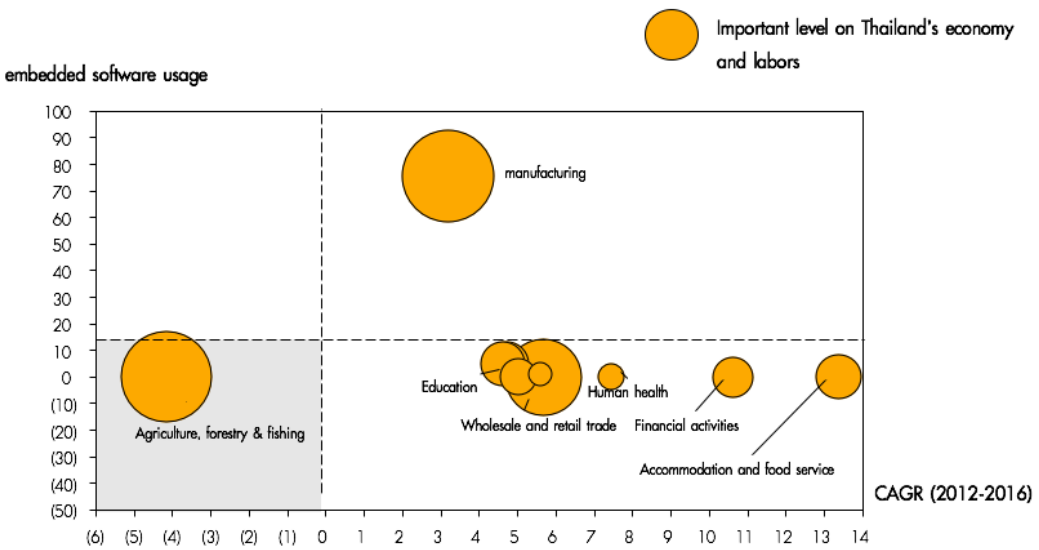
Source: EIC analysis based on data from IDC

However, in agriculture, an important industry in Thailand, IoT has not yet been used widely. Thailand's agricultural industry accounts for around 10% of GDP, making it the third largest industry after manufacturing and retail/ wholesale. Moreover, it is the largest employer in the economy, accounting for 34% of the labor force. However, over the past 5 years, the agricultural industry has been declining at around 4% per year, in sharp contrast to other industries, such as manufacturing, which are recording steady growth. More importantly, adoption of new technology has been limited in agriculture, as suggested by only 0.1% usage of embedded software, a technology that enables communications among devices, compared to as much as 76% in manufacturing.

Figure 19 : The agricultural sector is important for Thailand's economy and labors. However, it has been on the decline and has not adopted much digital technology

Comparisons industries based on embedded software usage and industry growth

Unit: %



Source: EIC analysis based on data from NESDB, NSTDA, and the Ministry of Labor

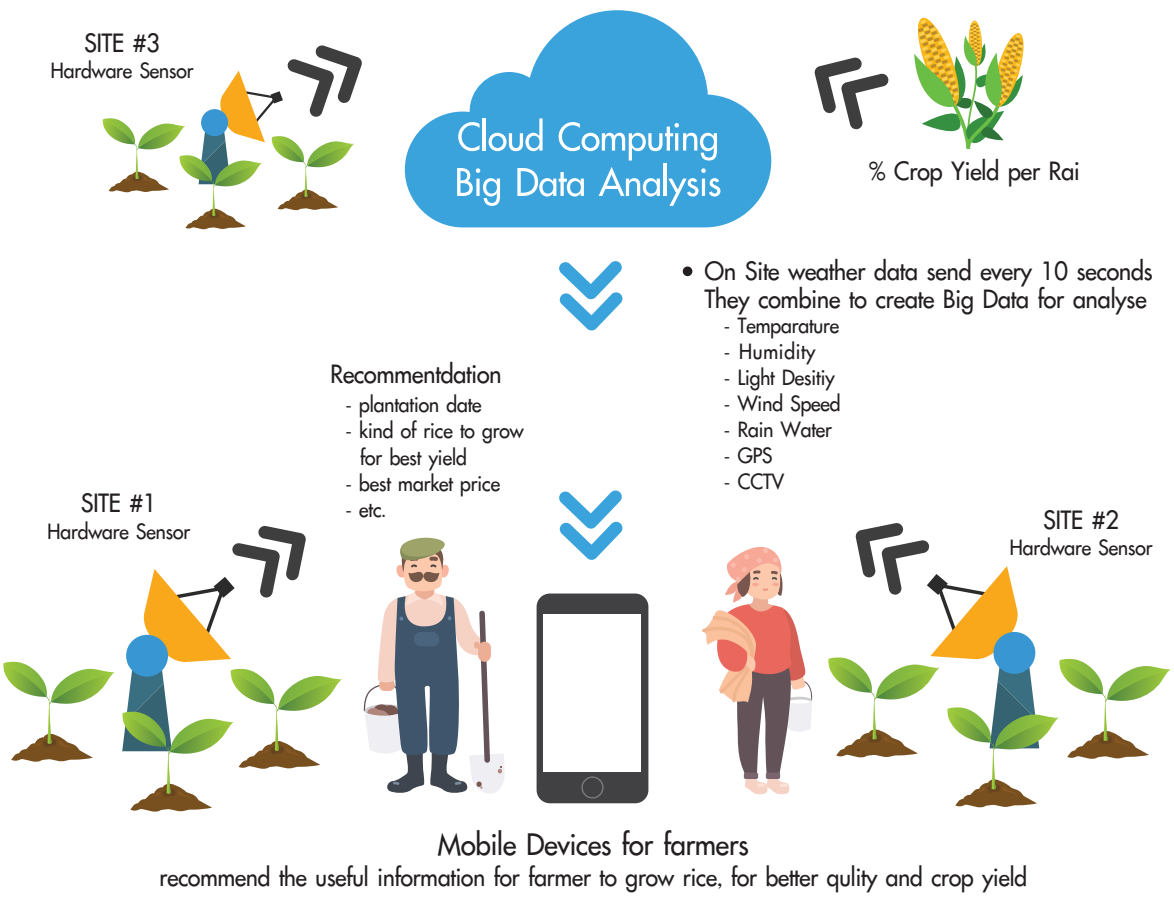
Unlike in Thailand, digital technology in the United States and Japan has been used extensively in agriculture. Today, over 70% of the world's applications of digital technology in agriculture are concentrated in the United States, where farmers have introduced IoT, robots, and GPS to increase efficiency and cut costs. The result is greater productivity. For instance, American farmers produce 7.34 thousand kilograms of cereals per hectare, twice the global average. In Japan, farm labor is scarce and a growing amount of farm land is being abandoned, as young people are disinterested in farming and the population is aging. To overcome these limitations, Japanese farmers use digital technology to practice precise agriculture, allowing them to produce up to 792 kilograms of rice per rai, the highest yield in the world.

Thai farmers have been stuck with low productivity, while production cost is growing steadily. Between 2012-2016, production per rai of agricultural produce has contracted by around 1-6% per year, particularly for palm oil, which saw the worst decline. Similarly, production per rai of rice in Thailand is 35% lower than the global average. Factors depressing productivity are the conditions of soil, water, climate, and pests, while the costs for fertilizers, pesticides, seeds, and maintenance are rising persistently. As a result, farmers who produce major crops, such as tapioca, sugarcane, rice, and rubber, made losses of between 75-14,750 baht per ton in 2016.

Precise agriculture based on IoT offers the right solution for Thai farmers. Precise agriculture is a form of farming that carefully controls all factors of production to maximize efficiency by using IoT technology. IoT devices collect real-time data, such as soil moisture, air temperature, and amount of sunlight, which are analyzed and displayed on smart device applications in order for the farmers to react promptly. For example, if the moisture level is too low, more water will be provided or the sprinklers will be turned on. Data from Atilze reveals that applications of IoT in agriculture can raise production per rai by as much as 30-50%. Thus, IoT should be introduced to crops that face production problems. For instance, if IoT is used in rice farms, production per rai would increase from 317 kilograms to 475 kilograms per rai, which would be close to the global average of 478 kilograms. Note also that IoT should be used in farms with greater than 4 rai of rice production, which is the breakeven point for the required investment in equipment.[1]

Figure 20 : IoT should be introduced to crops that face production problems, such as rice. With IoT, yield per rai can be increased.

IoT solution in rice farming



Source: EIC analysis based on data from Good Chin Group

Three IoT solutions that should be adopted first are water controlling, pest and disease control system, and soil monitoring, which prove to be key success factors.

1) Water controlling tackles the problems of droughts and wasteful water usage. The agricultural sector in Thailand is responsible for around 70%of the total water usage in the country. Plus, water usage in Thailand is among the most wasteful in the world, due to the lack of real-time monitoring in farming. An IoT solution that connects moisture sensors to smart sprinklers can reduce water usage by up to 10-15%, by calculating the right timing and amount of water to provide. Improvements in water management will benefit all kinds of production including Field crop, horticulture, vegetables and Angiosperms.

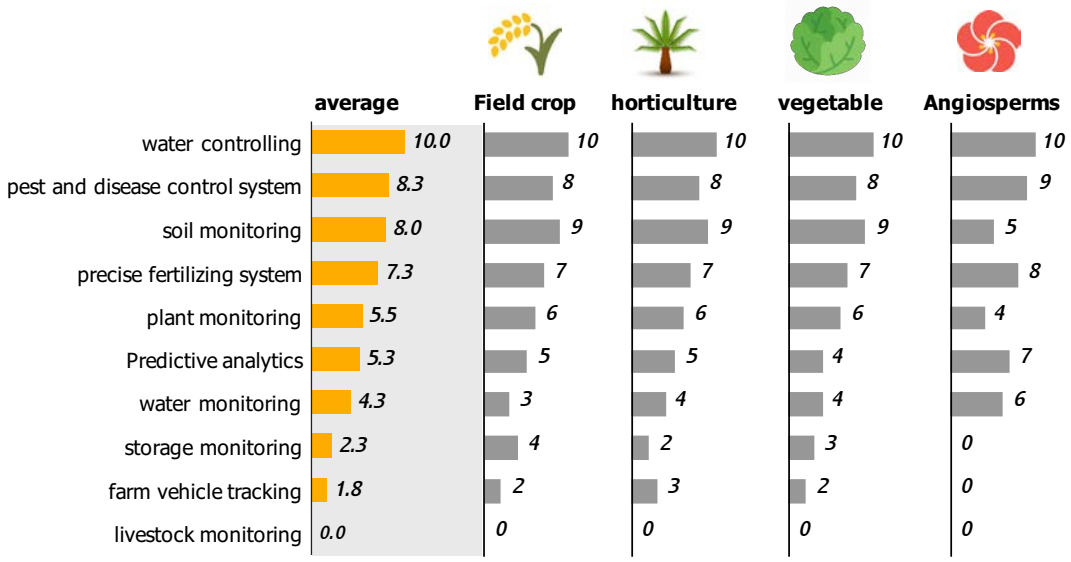
2) Pest and disease control systems can cut the costs of pesticides by 25% and reduce the need for imported farming chemicals. IoT solutions can boost efficiency in pest and disease controls. For example, they can make sure that pesticides are applied only when needed, by analyzing data from temperature sensors. If the temperature rises, pests will become more abundant, and pesticides will be needed. If adopted in Thailand, the solution will help reduce imports of pesticides, insecticides, and chemical treatments for plant diseases, which have been rising at 5% for the past 7 years, costing Thailand over 20 billion baht a year. Pest and disease control systems will be particularly useful for flowering plants, such as orchids, which often face problems like shellfish, orchid midge, or anthracnose.

3) Soil monitoring will reduce the amount of imports needed as it helps determine the suitable amount of fertilizers to be applied. Through monitoring the soil conditions, including moisture, temperature, and nutrients, farmers can determine what kinds of plants are suitable for the soil, as well as how soil conditions can be improved. The information from soil monitoring is also helpful for the planning and maintenance of the crops. This could help reduce fertilizer imports, which currently total 5 trillion tons, costing over 50 billion baht. At the same time, wasteful water usage will decrease, as the right amount of water can be determined, cutting the cost of water by 25%.

Figure 21 : IoT solutions for water control, pest and disease control systems, and soil monitoring are highly beneficial for farming

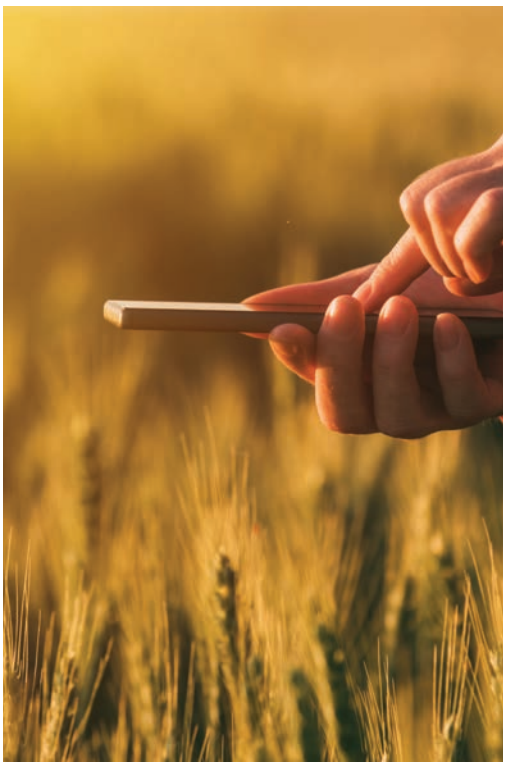
Priorities of IoT solutions by types of plants

Unit: score



Source: EIC analysis based on data from interview industry expert

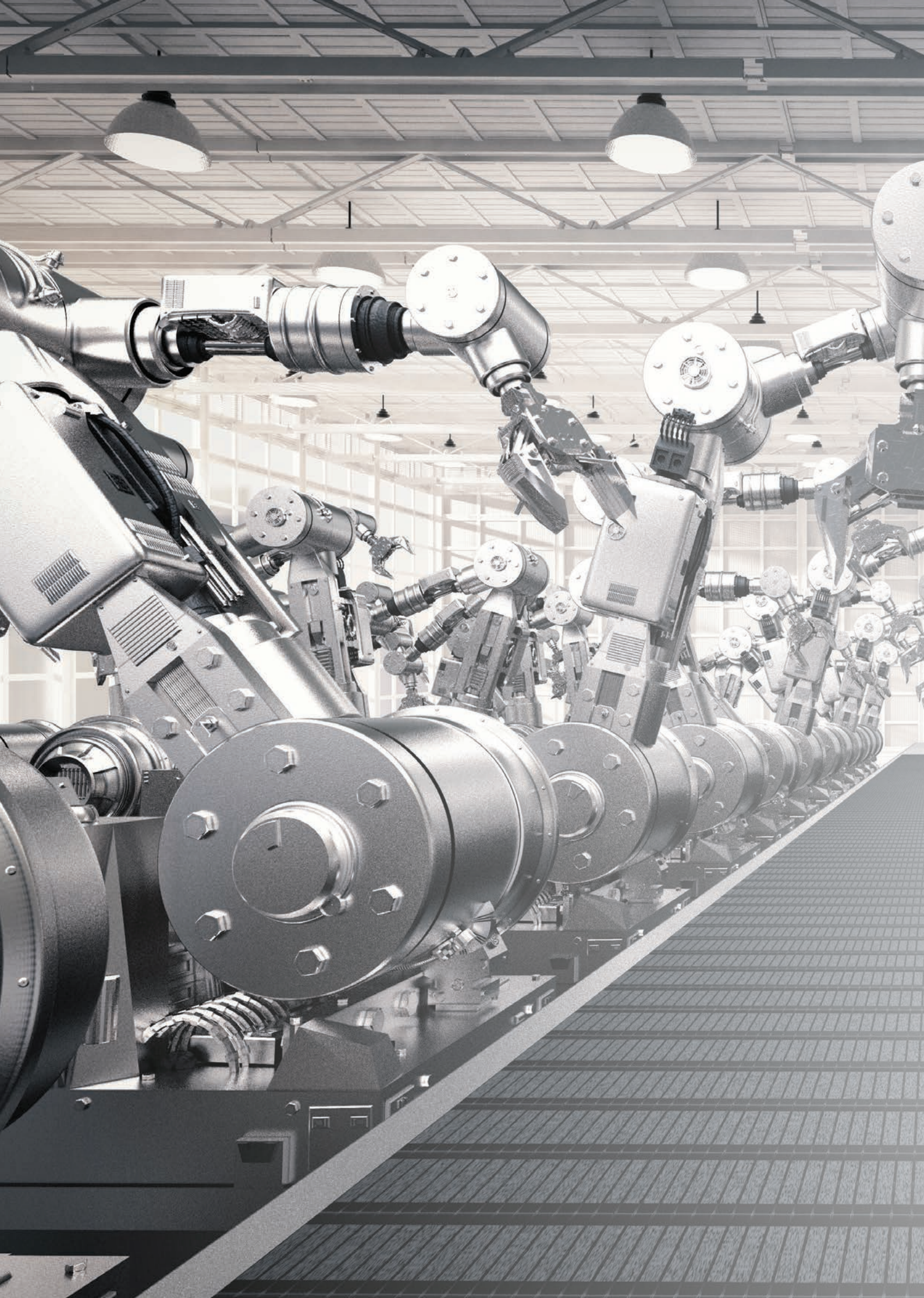
Farmers, IoT businesses, and the government are the main stakeholders in the development of IoT technology. For this reason, they will play an important role in driving investment and development in IoT for farming in Thailand.

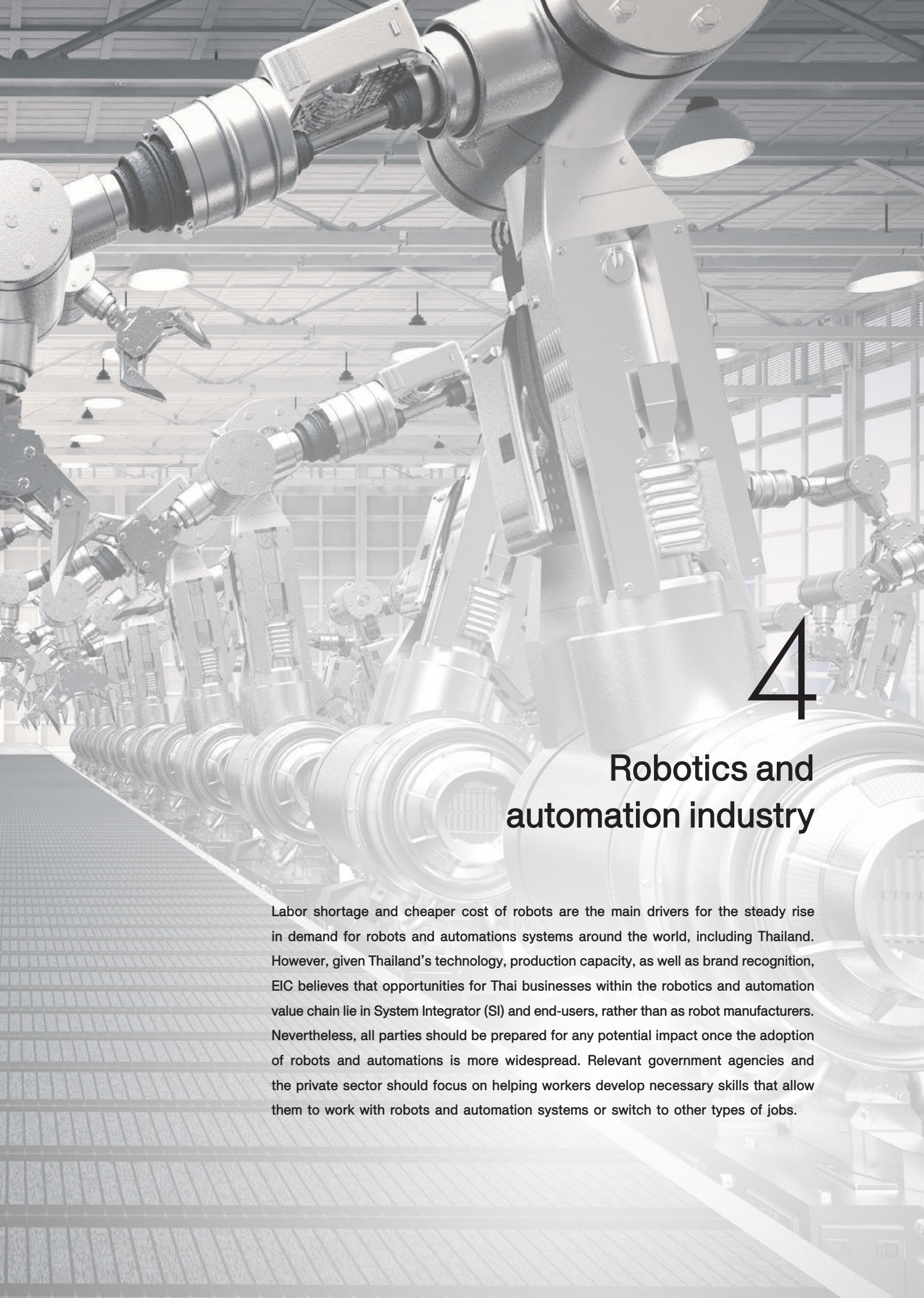


IoT should be applied to farming of plants or animals that requires special care and are high in economic value. Because IoT systems are costly to install, they should be used for plants or animals that can be sold for high prices or that require special care, such as organic vegetables or shrimps. In the case of shrimps, farmers have to regularly monitor water quality, including temperature, acidity, and cleanliness, all of which are key to survival, growth, and reproduction of the shrimps. Currently, this is done by testing water samples, which takes a long time for the results. Moreover, shrimps can be sold for high prices of around 190 baht per kilogram in 2017, which is around 4, 2, and 1 times greater than the price of chicken, pork, and beef, respectively. For this reason, it is advisable to use IoT in shrimp farms.

IoT businesses should offer practical IoT solutions through hardware together with application software, and make prices affordable. Since the major problems users have with IoT applications are the high prices and their complex use, businesses should focus on developing products that address these pain points. One successful case is Cropx, a startup that develops hardware and software systems for soil monitoring. Cropx devices can be easily installed by the users themselves, and the minimum cost is only 275 dollars per year. Founded only in 2013, Cropx has been vastly successful with this strategy, having made 1.5 trillion dollars in revenue and raised 10 million dollars of funds from investors.

The government should provide support and trainings for farmers, and partner with businesses in research and development of agricultural innovations. Thailand has seen a decline in the number of farmers, most of whom still have difficulty to accessnew technology and still relied on theknowledge passing through generations. As a result, they still lack the knowhows of new tools and technology. The government should therefore provide support for the new generations of farmers to learn and apply new technology that would help them achieve better results. In addition, the government should partner up with IoT businesses in experimenting, conducting research, and developing innovations and technology that will benefit farming in Thailand. All these would lead to productivity enhancement, quality control, and cost reduction for Thai farmers.





4

Robotics and automation industry

Labor shortage and cheaper cost of robots are the main drivers for the steady rise in demand for robots and automations systems around the world, including Thailand. However, given Thailand's technology, production capacity, as well as brand recognition, EIC believes that opportunities for Thai businesses within the robotics and automation value chain lie in System Integrator (SI) and end-users, rather than as robot manufacturers. Nevertheless, all parties should be prepared for any potential impact once the adoption of robots and automations is more widespread. Relevant government agencies and the private sector should focus on helping workers develop necessary skills that allow them to work with robots and automation systems or switch to other types of jobs.

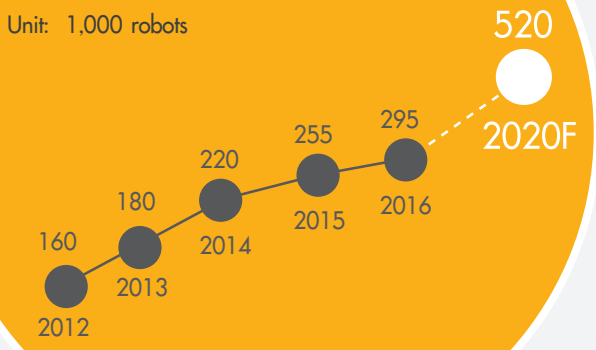
Industrial robots ...
The near future awaits

Factors for robots to thrive

1 **Aging society**
Falling fraction of working population in the future

2 **Decline in robot prices**
A continued trend of price decrease

Global adoption of industrial robots



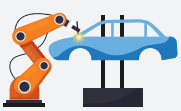
With such concerns, the Thai government released ...

1.Tax reduction measures

2. Expenditure deduction measures

3.Investment support

Investment on robots and automations began to break-even as a substitute for labor

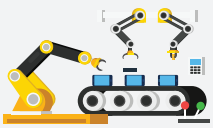


Automobile

Labor replaced = 5 people

Cost of labor 400-480 baht/person/day

Break-even in 8~10 years



Other industries

Labor replaced = 2 people

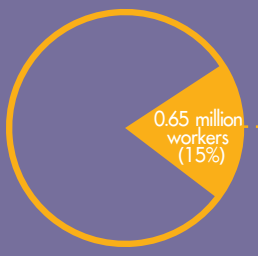
Cost of labor 300-450 baht/person/day

Break-even in 6~10 years

Maximum life cycle of existing industrial robots is **12 years**

Over 0.65 million of workers in manufacturing could be replaced by robots

Industries which are likely to be most affected



Jobs that risk being replaced

Labor-intensive tasks

Routine tasks

Precision tasks

Source: EIC analysis based on data from the International Federation of Robotics (IFR), J.P. Morgan, the UN and Ministry of Labor (MOL)

Automation is a system that combines machines and controlling software, allowing production or service to operate according to a pre-set program. Most automation systems have been adopted in the production of automotive, electronic parts, and food and beverage, with the System Integrators (SI) providing consultation, design, and system installation for end-users.

An adoption of automation technology, particularly robots, will improve both the quantity and quality of the products. For example, it will increase the production capacity of the business as robots can work faster than humans, and they do so without a break. This raises productivity of the firm, which in turn leads to a larger degree of economics of scale. Moreover, the quality of the products is improved. Robots are more precise than humans, so their works tend to have lower defect rates. This helps reduce production cost, as well as operating costs.

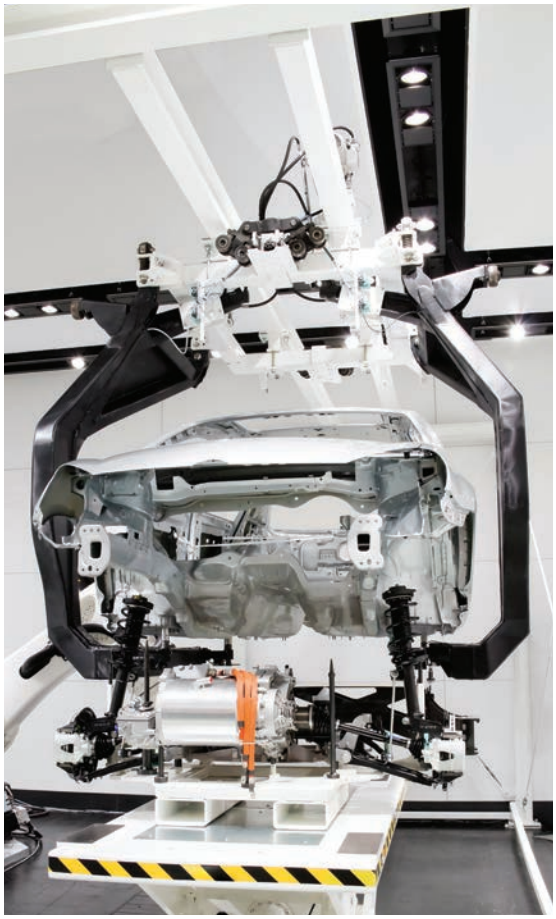
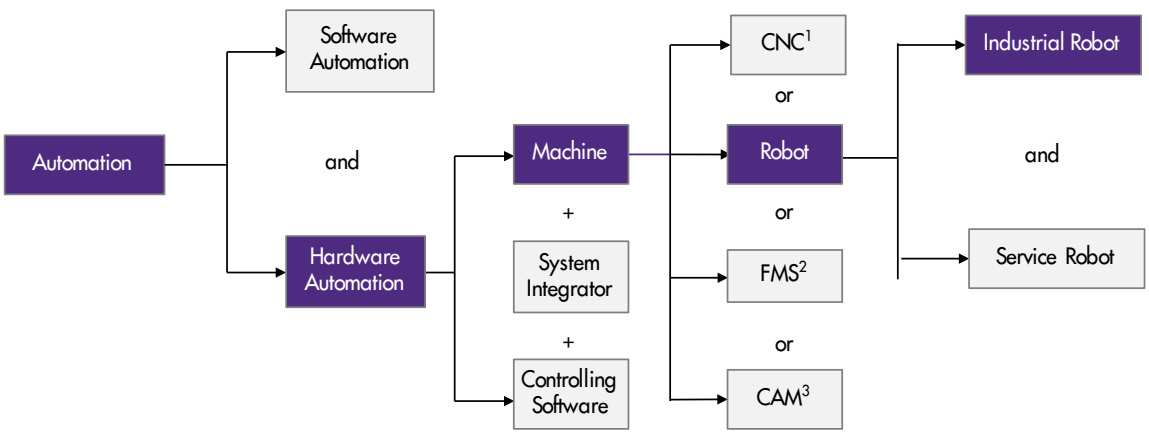


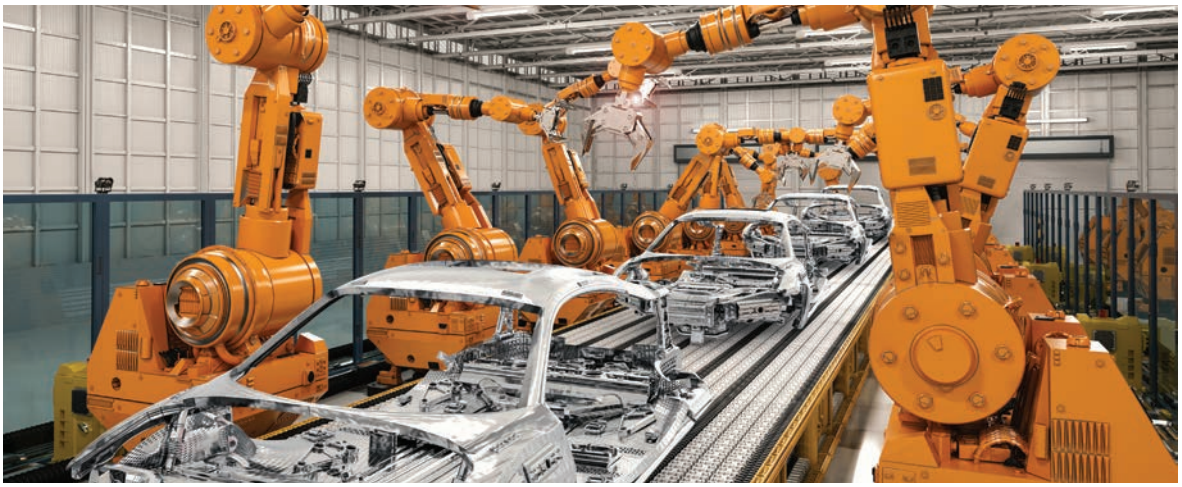
Figure 22 : Automation is a system that combines machines and controlling software with System Integrators (SI) providing consultation, design, and system installation for end-users

Breakdown of robot and automation industries



Noted: 1.Computer Numerically Controlled (CNC) 2.Flexible Manufacturing System (FMS) 3.Computer-Aided Manufacturing

Source: EIC analysis

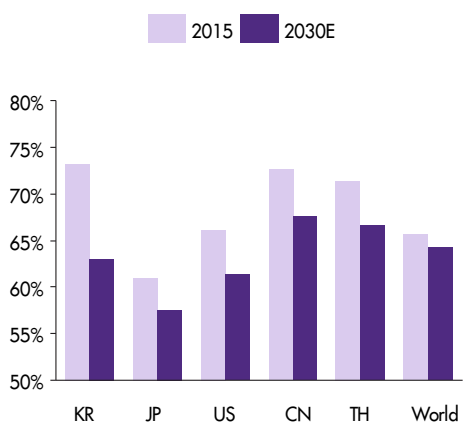


Demand for robots around the world will continue to rise, driven by labor shortage and falling prices of robots. The International Federation Robotics (IFR) projects that demand for Industrial Robot (IR) around the world will expand by approximately 15%CAGR during 2018-2020, bringing the total number of robots to over 500,000 units by 2020. The first factor driving the surge is labor shortage, as the world's population continued to age over the past decade. The global birth rate has been falling, while the average life expectancy is on the rise, resulting in a dwindling labor force. In fact, the share of working-age population (between 15-64 years old) is expected to fall from 67% in 2015 to 63% in 2030. Given this trend, it is more likely that IR will be adopted to replace the missing productivity from human workers. The second factor driving the popularity of robots is the price of the robots themselves. The price of IR have been falling steadily by over 2%YOY, whereas the average global wage has been rising by more than 4%YOY. Thus, IR presents a more cost effective alternative to labor with every passing year.

Figure 23 : The share of working age population (between 15-64 years old) around the world will fall in 2030.

Percent of population, ages 15-64 years

Unit: % of population

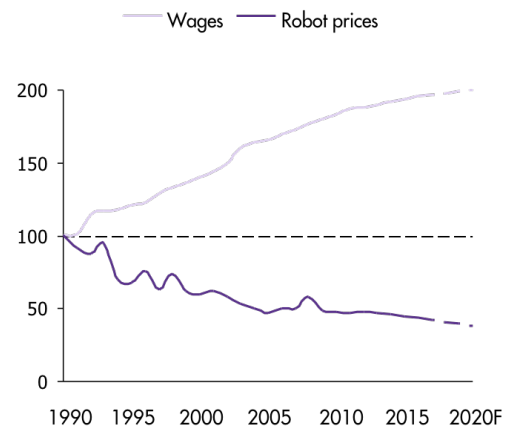


Source: EIC analysis based on data from United Nation

Figure 24 : The price of robots has been falling steadily, unlike wages that have trended upward.

The price index of labor wages and robot

Unit: Index (1990 = 100)



Source: EIC analysis based on data from McKinsey, J.P. Morgan and United Nations (UN)

Labor shortage and rising wages have prompted the Thai government to put forward measures to support the robotics and automations industries, by promoting both demand and supply. Over the past 5 years, Thailand's imports of IR have increased by over 20%CAGR, totaling 13,500 robots in 2016, and causing a trade deficit of 20 baht billion each year. The majority of the imported IR are used in the automotive, electronics, and food and beverages industries, mostly in manufacturing plants within EEC. Against such backdrop, the government has rolled out measures to promote both demand and supply of robotics and automations industries. Supply-side measures include corporate tax exemptions and reductions for manufacturers of machines, equipment and parts related to robotics, as well as the SI business. The goal is to raise the number of SI firms from 200 at present to 1,400 within the next 5 years. On the demand side, in order to encourage more industrial use of robots and automation systems, tax exemptions and deductions, as well as credit lines for the purchase of IR will be offered. It is hoped that the value of applications of IR and automations will grow from 12 billion baht at present to 200 billion baht within the next 5 years.

Nevertheless, limitations with respect of technology, production capacity, and brand recognition are 3 main obstacles that Thai firms have to overcome in order to become IR manufacturers. This is because IR consists of multiple parts that require highly advanced technology to produce, such as the sensors and servos. Currently, Thai businesses still lack the expertise in this type of production, unlike leading manufacturers of IR in China, the United States, and Japan. Moreover, in terms of production capacity, Thai businesses will struggle to compete with the number 1 producer like China, who can produce 100 thousand units per year, or 30% of the global IR production capacity.

Even if Thai businesses are able to overcome the technology and capacity limitations outlined above, they will still face challenges with regards to brand recognition. Since most industries that use IR, such as automotive and electronics, require a high degree of precision in their production, they are often unwilling to switch to an unfamiliar brand of IR. This issue has been evidenced in China, where the local robot industry has already overcome the technological barrier by acquiring KUKA AG, one of the German largest IR manufacturers, and raising production capacity to become the largest producer in the world. However, despite these accomplishments, most end-users in the automotive and electronics industries remain reluctant to use Chinese robots. Indeed, 70% of total IR sales in China are made up of foreign brands such as Fanuc, ABB and Yaskawa.

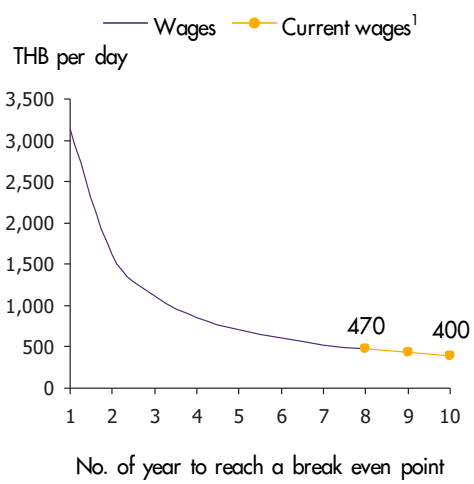
For Thai firms, SI business appears to be an appropriate choice within the robotics and automation value chain. SIs provide consultation, design, and installations of robots and software for the end-users. The income of SIs varies by the size and sophistication of the systems they provide. Usually, Sis charges their clients arounf 50% of total project costs. Taking into account the revenue structure and future trend in demand for IR in Thailand, EIC believes that there is a growth opportunity for SI businesses in the country, where there are currently only 200 SI firms, most of them are SMEs.

From our analysis, 3 key success factors in SI business are as follow: 1) the ability to design automation systems that suit clients' needs, 2) the ability to complete projects within the given timeframe, and 3) the ability to build and maintain trust among clients by getting certified by international organizations such as the Control System Integrator Association (CSIA), or prominent firms in the automotive or electronics industries.

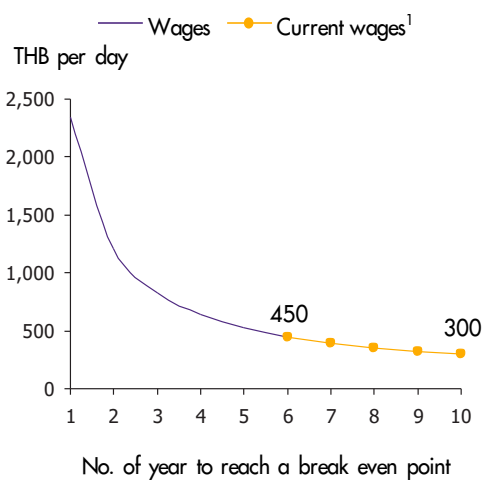
On the demand side, comparing IR prices with the prevailing wages in Thailand, firms will find that IR is the more cost competitive choice. In the automotive industry, an IR for spot welding costing around 3.5-4.5 million baht can replace up to 5 workers. Compared with wages of 400-480 baht per worker per day, investing in IR will reach breakeven in 8-10 years. As for the electronics and the food and beverage industries, the cost of IR is approximately 1.2 million baht per unit, each replacing around 2 workers. With wages of around 300-450 baht per day per worker, the IR investment would breakeven within 6-10 years. Given the IR units lifetime of 8-12 years, it can be suggested that IR is a worthwhile investment nowadays.

Figure 25 : At current wages, an investment in IR to replace workers in the automotive and other industries will reach to breakeven within 6-10 and 8-10 years respectively

No. of years needed for investment in IR in automotive industry to breakeven, given various wage levels



No. of years needed for investment in IR in other industries to breakeven, given various wage levels



Noted: 1.Based on national skill standard

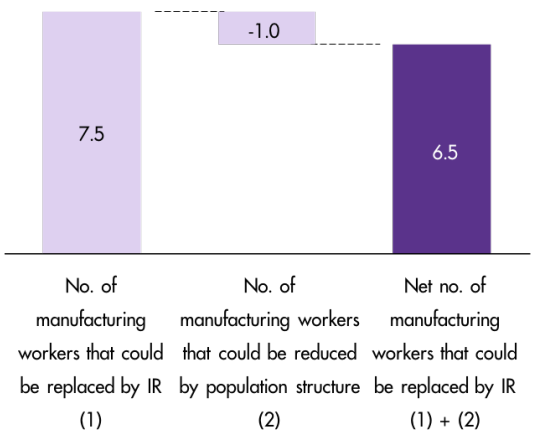
Source: EIC analysis based on data from Ministry of Labour (MOL)

EIC expectes that an increase in IR adoption in Thailand will replace 650,000 workers or 15% of the workforce in the manufacturing sectors within 2030. As IR becomes more costcompettitive, businesses will increasingly turn to IR as an alternative to hiring workers. Considering the Thailand's demographic trend of shrinking labor force, EIC estimates that up to 650,000 workers, or 15% of total manufacturing workers, could be replaced by IR within 2030. First to be replaced are those in labor intensive industries with repetitive tasks, such as automotive, electronic parts, and food and beverage industries, which together hired around 2 million workers at present. Particularly, in the automotive industry, currently only 16 units of IR are used for every 1,000 cars produced, which is markedly lower than the global average of 40 units per 1,000 cars. Such low degree of IR integration suggests that manufacturers have an opportunity to invest much more in IR going forward.

Figure 26 : EIC predicts that an increase in IR adoption will replace 0.65 million works or 15% of the manufacturing workforce within 2030, especially in automotive industry

Estimated no. of manufacturing workers at risk of replacement by IR within 2030

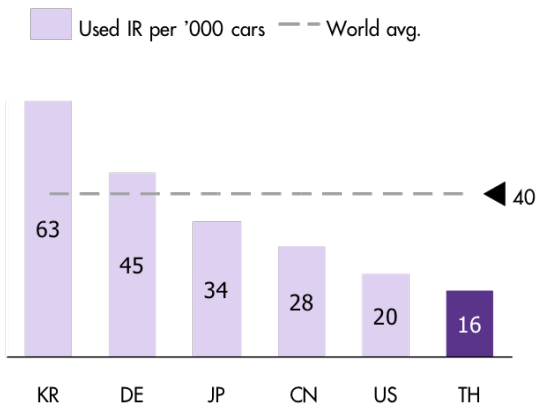
Unit: '00 thousand



Source: EIC analysis based on data from BCG and UN

Comparing the no. of IR units used in automotive production across countries

Unit: robot per 1,000 vehicles

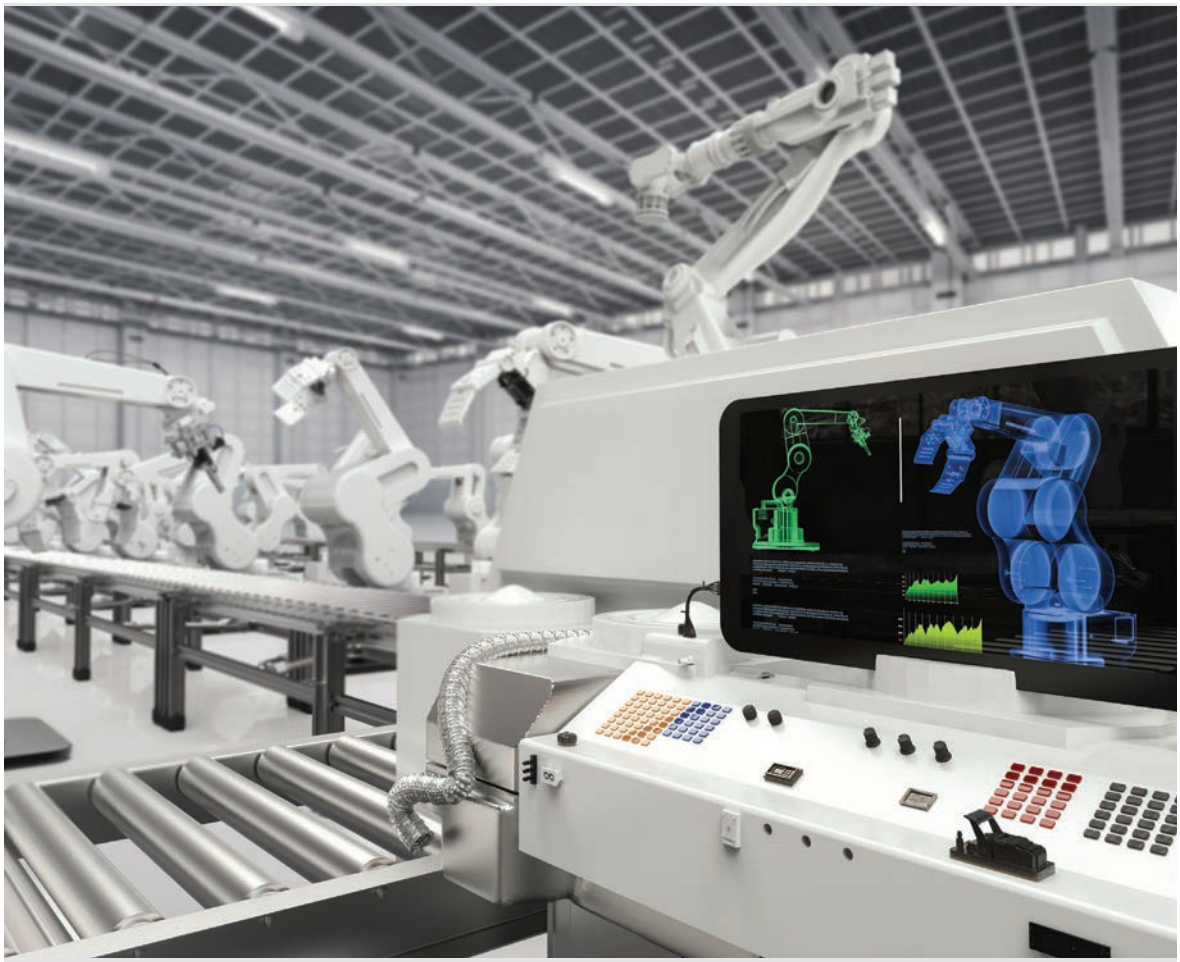


Source: EIC analysis based on data from IRF and WTO

Although the use of IR will have a negative impact on workers in the manufacturing sector, but it will also promote new types of jobs, such as automation system design, machine control programing, and robot maintenance. In the past, the introduction of new technology on the one hand may have rendered some obsolete jobs, but on the other hand also created new jobs. A study by McKinsey on the impact of new technology on employment in the US found that the rise of automotive production during 1900-1950 led to a destruction of 0.6 million jobs in public transportation. At the same time, however, 7.5 million new jobs were created in multipleindustries such as auto parts manufacturing or car maintenance services.In sum, the employment was scalted by more than 12.5 times dur to this automotive disruption. Another example is the introduction of personal computers (PC) during 1970-2015. Although this technology eliminated up to 3.5 millions clerks, typists, secretaries, and accountants, however, it has created around 19.5 new Information Technology (IT) positions such as software developers and computer scientists.

In order to mitigate the negative impact on the labor market, the government and private sector should work together in training new skillset for workers, to help them cope with the changing demand. The government and educational institutions in Thailand have together established the Center of Robotic Excellence (CoRE), which will help promote the robotics and automation industries in the areas of 1) development of robot prototypes, 2) accreditation of SIs, 3) technology transfers and, 4) human resources developments, including building experts in the fields and reskilling workers vulnerable to the introduction of IR. In addition to this effort, the private sector should also take part in equipping workers with the skills needed to work alongside robots and automated systems, encouraging them to switch to other types of jobs, and supporting the training to raise productivity and efficiency of labor.

With the advantages of robots and automated systems couple with labor shortage and price declination, EIC believes that investment in robotics and automation will sufficiently pay off. As a result, the demand for this robot and automation industry will be on the rise, giving SIs an opportunity to provide advisory, design and installation services to end-users. Meanwhile, the government, private sector and other related parties should focus on developing labor skills in order to mitigate the impact of being replaced by robots in the production line.



BOX

Return on robotic investment

The are multiple reasons why more than 85% of Thai businesses have not yet adopted in robots and automations which are the lingering questions of whether robots can be applied their businesses, which process robots can benefit, and most importantly how muchreturn on investment (ROI) that they will get. Below are case studies of various industries that have adopted robots and automations. All have enjoyed positive outcomes, but in different forms and varying degrees.

1. Bricklaying robots in U.S. construction industry The Semi-Automated Mason (SAM) is a robot developed by a company called Construction Robotics. The technology is used in construction businesses in the U.S. and has helped alleviated the problem of rising labor costs, which accounted for 1.1-1.2 million baht per worker per year. Although SAM still requires 2 workers to control and reload concrete and bricks, it can erect a wall of up to 3,200 bricks per day, which is 6 times faster than workers's capability on average. As a consequence, oneSAM unit allows construction businesses to hire 4 fewer workers and save significantlabor costs. SAM's investment cost is roughly 3.5 million baht per year, while savings on wages total around 4.5 million baht per year, resulting in an ROI of 30%.

2. Pretzels picking robots in the food and beverage industry in Switzerland. During the beginning of 2000, Roland Murten AG, producer of pretzels, crackers and cereal biscuits, faced a problem with its packaging process. Every year, over 120 tons or 10% of total production wasbroken in the process, costing the company over 80 million bahtannaully. To resolve this issue, in 2007-2008 the company decided to improve the packaging process by introducing an automated system that made up of an automated conveyor belt and 6 pretzel packing robot. The system only costed 12 million baht. The precision of the pretzel picking robots brought the rate of broken pretzels down to a mere 4%. As a result, the cost of defects went down by 50 million baht per year which equivalents to 60-70% ROI.

3. Label tagging robot in the U.S. steel industry. During 2012-2013, Nurcor steel, the top American producer of long steel products, invested in an automated system called BilletID. Combining label tagging robots, 3D scanners and other equipment, the system helped reduce human errors in the process of tagging billet steel, of which 2,400 pieces are produced everyday, based on quality, size, and weight. The BilletID system would transfer data real time from a database using Structural Query Language (SQL) to the label printer. Then, the robot would put the printed labels where the 3D scanner identifies, yielding greater accurately than using human workers. Given BilletID's benefits, such as lower labeling errors, enhanced tracking ability, and lower use of labor, its cost of 25-30 million baht suggests an ROI of up to 80-100%.

Epilogue

The EEC is the government's initiative aiming for a long-term growth engine of the Thai economy. In this light, the government attempted to increase connectivity through transport infrastructure development as well as to enhance fundamental business need through public utilities provision. The government also offered tax privileges including exemptions of import duties on imported machinery and raw materials used for production of export products, funding and facilitation for businesses investing in the area. However, EIC views that there remain 3 issues that stakeholders including public, private and other related agencies should be prepared and consider on pre-emptive measures in order to push forward the EEC initiative effectively. These 3 issues are as follow.

1) Building confidence and ensuring continuation of investment support measures. In order to build private sector confidence, the government needs to communicate clearly with the public regarding the overall processes, from permit request, investment approval, to operations. Relevant economic data and information about social and physical contexts, that are beneficial for business operation, should also be provided. Proactive marketing will also allow the government to reach more foreign investors.

2) Increase readiness and develop skilled workers for the 10 targeted industries. In order to do so, the public and private sectors as well as related agencies should cooperate as growth of these targeted industries will lead to greater demand for labor, both in terms of quantity and quality. For example, an MRO business will result in greater demand for aviation professions such as engineers, maintenance workers, and skilled technicians. A widespread use of IoT will also lead to more demand for software developers, data scientists, and computer and computer network technicians. In terms of worker quality, less sophisticated tasks requiring less advanced skills will increasingly be replaced by robotics and automation. Workers should thus develop their technical know-how and language skills for everyday communication and professional standards certification. For the EEC initiative to succeed, the government, the private sector, and related agencies, will have to cooperate in establishing plans for creating and developing skills for workers.

3) Measures to prevent social and environmental impact. Industrial development not only brings about economic growth, but also environmental and social degradation. With the EEC Act in effect, more factories will be opened, affecting the lives of communities in the surrounding areas in terms of water, air, and noise pollution, resulting in lower quality of life for residents. The cost of living may also rise in line with economic growth. The government should carefully assess social and environmental impact in the EEC and develop prevention and remediation measures. Although there are plans to establish a fund for EEC community development and environment with an aim of supporting communities and people affected by industrial development, more environmental and social preventive measures are needed. Examples include regulations on emission of factory's pollution and measures to ensure that communities in the area can actually benefit from the development. These efforts will help guarantee that the project benefits all stakeholders and provide sustainable growth.

As for the private sector, businesses should keep up to date with investments rules, regulations, and benefits from EEC investments. They should also pay close attention to the business environment of their industries and related businesses. Careful study and planning to ensure the most efficient use of transport infrastructure for shipping of both raw materials and finished products could also guide business strategies going forward.

Contributors

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Sutapa Amornvivat is Chief Economist and First Executive Vice President at Siam Commercial Bank (SCB), where she leads the Economic Intelligence Center. She previously set up and led Risk Analytics Division under Risk Management Group. Sutapa currently sits on Subcommittee on Finance, Banking, Financial Institutions and Capital Markets, The National Legislative Assembly. Before SCB, Sutapa founded Risk Analytics and Research Group at TMB Bank during her secondment from ING Group, where she worked in various departments in risk management. Prior to joining the banking industry, Sutapa was Economist at the International Monetary Fund (IMF) in Washington, DC. She had also served as Director of Macroeconomic Analysis Section at the Thai Ministry of Finance.

Sutapa's academic contribution includes lecturing at various universities in Asia including Hitotsubashi University, the Indian Institute of Technology, Chulalongkorn University, and National University of Singapore.

Sutapa holds an undergraduate degree in Applied Mathematics from Harvard University and a doctorate degree in Economics, Management, and Policy from Massachusetts Institute of Technology (M.I.T.) She was a recipient of Thailand's most prestigious King's Scholarship, awarded to five scholars in an annual nationwide competition.

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Head of Service Cluster

Vithan has previously held positions at the Fiscal Policy Research Institute, Ministry of Finance, working on the development of the medium-term government expenditure framework and the budget allocation model as well as conducting studies on fiscal policies. He also worked in the Research and Information Department and the Strategy Development Department at the Stock Exchange of Thailand.

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