

# Chapter 4 | Industrialization

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The date is July 30, 2040 and Mr Khemara, a farmer from Takeo province, has just finished planting his rice crop. Leaving his family to tend to the crop before the harvest period, he departs for seasonal work across the border in Thailand. As he waits in the airport for his flight to depart he thinks back to his first cross-border excursion as a young man of 16. At that time, he would cram himself into the back of an unsafe minivan heading across the border with the hope of being picked up by a generous employer. Thankfully those days are well behind him, and indeed the population in general. Migratory work patterns are now supported by an e-allocation platform "JobHelp." He has registered his intention to work outside the country through the government endorsed app and it has matched him with suitable employment. By creating a profile of his qualities and qualifications Mr Khemara is matched by a mentor to the type of employment that he is seeking.

Prior to boarding the flight Khemara consults his "FarmHelp" mobile application to ensure that the rice crop he has recently planted has enough water and the soil content is appropriate for the young seedlings. In the event of detection of an unsuitable environment, the application sends a notification to alert the farmer suggesting corrective actions. Since its launch in 2035 the application has helped Khemara secure several quality harvests. It also has the additional benefit of ensuring that his brother is undertaking the promised work while Khemara is away.

Sitting in the plane prior to take off, he realizes that the jacket he had purchased for taking the chill out of the cabin is rather tight and

uncomfortable. Fortunately, under the 'custom fit policy' of his garment manufacturer, he can request another one be made to accommodate any unexpected size fluctuation. With the "GarmentsHelp" app he scans the barcode on the jacket to bring up his profile. He can then send the correct size information to the factory and request that the new one be delivered to him in Thailand.

## I. Industrialization: The Ideal Scenario

In 2040, Cambodia's adoption of Industry 4.0 technology has yielded tremendous gains for the kingdom's production, GDP, and development. The timely adoption, utilization, and development of technological industrialization methods has resulted in Cambodia comfortably achieving its goal of reaching high-middle-income status.

Application of such technology in the agricultural sector has had a particularly positive effect. By connecting the farm to the farmer through technological innovation, farmers are able to access up-to-date, real-time information on land features, including soil & moisture content, crop planting recommendations relative to the soil conditions, and appropriate fertilizers for germination. Access to this information provided the base for an increase in crop production yields that positively impacted the life of Cambodians and provided a strong footing for trade with neighboring countries.

In addition, Industry 4.0 has supported the development of platforms to connect the country's large youth population with existing workers abroad and the relevant authorities, in order to avoid rampant human trafficking problems, and help to contribute to a vibrant productive workforce in the society. In this way, Cambodian young people are able to know about employment opportunities through Cambodian workers abroad and the proper authorities to contact to legally secure such employment. The system can intelligently report suspicious activities or potential human trafficking activities to the responsible authorities for immediate action.

Cambodia has benefitted from the repatriation of migrant labor workers who bring back experience and skills from their time away from Cambodia. The

knowledge exchange facilitated by migration has supported the development of integrated connectivity platforms for domestic and international citizen support.

In addition, the development of quality Industry 4.0 degrees in the Cambodian university system has begun to consistently provide workers who are trained in the requirements of an Industry 4.0 economy. Coding, engineering, and communications comprise the three bachelor's degree programs that have most benefited the Cambodian economy in its industrialization.

Combined with the expertise garnered from Industry 3.0, in 2040 the skilled Cambodian workforce develops an exchange of training and experiences in connectivity, intelligence, and automation. In particular, training has focused on the skills required for the implementation and suitability of Industry 4.0., specifically: the internet of things, mobile computing, big data analytics and advanced algorithms, authentication and fraud detection, pattern recognition, artificial intelligence, cloud computing, and cybersecurity.

These successful developments have been driven in part by the willingness of the private sector to adopt Industry 4.0 technology to stay ahead in their own industry. Firms engaged in assembly work now take advantage of lower labor cost requirements as well as automated and integrated technologies in order to maximize their output and economic success.

Regionally, Cambodia has utilized the further integration of the ASEAN economic community in order to expand its market growth and diversification during its domestic transition to a knowledge economy. Regional university exchanges have supported the training of young ASEAN academics within specialty fields contingent on national locational advantage. With Cambodia's unique ecological blueprint, it has become the regional environmental specialist for Industry 4.0 adaptation and mitigation technologies.

## II. Scenario Space and Key Factors for Industrialization

This chapter concerns the Cambodian potential for industrialization and economic growth set within the contexts of Industrial Revolution 4.0

A look into the history of mankind, and of previous industrial revolutions, shows that continued population growth in the face of scarce and limited resources has placed pressures on society to find productive means to better utilize resources and engineer new forms of production for enhanced capacity (Brown and Wolk, 2000). For example, in the 17<sup>th</sup> century, water was used in the form of steam to power mechanized production; in the 19<sup>th</sup> century electricity drove mass production and to light the world (Rudolph and Ridley, 1986; Brower, 1994; Smil, 1994). These periods have been termed Industrial Revolution 1.0 and 2.0, respectively. In the 20<sup>th</sup> century, electricity, electronics, and information technology were employed to automate industrial production. This was the third industrial revolution or Industry 3.0 (Schwab, 2016).

Today, in a convergence of technology, energy, and information, set against a rapidly growing population, Industry 4.0 is born (Marr, 2018). The major difference between Industry 3.0 and Industry 4.0 is the fusion of connectivity, intelligence and flexible automation. It is this fusion of Industry 3.0 with breakthrough technologies and the ability to interact across the physical, digital and biological domains that make the fourth industrial revolution a fundamentally different challenge for the industrialization of developing nations such as Cambodia (Leurent, 2019).

Mr. Klaus Schwab Founder and Executive Chairman of the World Economic Forum, on January 14, 2016, effectively summarized the history of the Industrial revolution as follows:

“The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres.”

Two key trends frame the importance of, and potential trajectories for Cambodia Industry 4.0. The first of these is the proliferation of communication and technology platforms that can help Cambodia more easily transition

towards a knowledge economy. This argument is supported by the insight that currently two-thirds of the population are under 30 and have grown up with significantly more exposure to technology than previous generations. Second, the ability to properly harness the potential of technology is crucial for the growth, development and diversification of the Cambodian economy.

The strength of Cambodian industrialization and its potential trajectories, set against the global backdrop of Industry 4.0, is predicated on key factors that are long standing in the literature on the topic. These are discussed in turn below.

### Technological adoption and adaptation

The key factor most crucial for the transition towards Industry 4.0 is technology. With regard to industrialization, technology concerns the application of science to industrial or commercial processes (Schwab, 2016). At the heart of the entire process, technology represents the factor through which the key processes that demarcate an industrial revolution take place. First, technology provides the ability to make use of new basic materials to drive new forms of development. In the second industrial revolution the development of crucible steel methods fueled the mass production of steel to support industrialization. The Industry 4.0 equivalent would likely be the technological development of lithium for batteries. Technology additionally facilitates the use of new forms of energy sources to power industrialization; such as the steam engine, electricity, and petroleum. In the Cambodian Industry 4.0 context, the discussion of energy will be best framed around the national development of a sustainable long-term supply to fuel industry.

### Regionalism

For Cambodia, as a low-middle-income nation in 2020, the development of Industry 4.0 is likely contingent on the ability to work within its regional framework for economic collaboration, growth, and diversification. The justification for this is best supported historically.

On April 30, 1999 Cambodia was admitted into the Association of South-East Asian Nations (ASEAN). Membership in ASEAN has subsequently supported Cambodian development through its ability to support the domestic

institutional reforms required for regional development, as well as removing a large number of trade barriers to support economic growth. Far from being one-sided, ASEAN recognizes Cambodia for her abundance of domestic resources and strategic geographical location in the region. As Cambodia was among the more recent members admitted into ASEAN in 1999, older members of the bloc viewed the admission of the kingdom as a burden to the groups planned success (Bowring, 1997). During the ASEAN Summit in November 2000 in Singapore, ASEAN adopted a program to narrow the development gap, known as the *Initiative for ASEAN Integration* or IAI (ASEAN, 2000). Under the IAI, Cambodians were able to receive practical training and institutional support within the ASEAN members' support structure. Now, 20 years after joining ASEAN, technical support and collaboration has grown into economic prosperity, with average annual GDP growing by over 7 percent per year, and Foreign Direct Investment (FDI) increasing annually: at less than \$100 million in 2000, ASEAN member countries invested \$603 million in 2017 alone. With a combined population of 640 million, the world's third largest consumer market, and an aggregate GDP surpassing \$2.7 trillion, the ASEAN-Cambodian relationship will matter a great deal for Industry 4.0.

## Infrastructure

Infrastructure is the foundation and framework for industrial development. Transportation routes provide the necessary links for raw materials, producers, and consumers, both domestically and with foreign trading partners. The transport network features include railways, roads, seaports, airports, utilities (electricity grids, drinking water, and sewage), and communications networks. Communication provides the system that carries the messages among suppliers of raw materials, producers, and consumers. Under Industry 4.0, internet connectivity is perhaps the most important communication channel as it represents a channel for instantaneously connecting all of the planets' inhabitants.

## Labor

Labor is the human element of industrialization. It represents the allocation of skills and training in the economy towards the employment opportunities

available. Industry 4.0 is expected to automate a large number of currently labor-intensive positions. In the Cambodian context this would threaten thousands of jobs in the garment and tourism sectors. Accordingly, the allocation of labor is predicated on the development of the economy and its diversification into new Industry 4.0 spheres of employment (MLVT, 2014). The discussion on this key factor is less concerned about the number of workers available, and more about the inherent capacity to meet the needs of Industry 4.0

### III. Policy Initiatives to Achieve the Ideal Scenario

In order to deliver Cambodia to the ideal scenario described in section one, based in the key factors above, there are a number of policy initiatives that will need to be undertaken. These initiatives will be framed in line with the identified key factors (technology adoption and adaptation, regionalism, infrastructure, and labor) as well as cross-cutting measures such as political and institutional will, technical capability, and financial commitment.

#### The Development of Governance Structures

For any industries to operate successfully and prosper there must be rules and regulations to protect industry and incentives to promote innovation and technological upgrading. There also must be public and private sector partnerships to ensure that these incentives are aligned with regulatory requirements. For the private sector, company executives must take the lead in efforts to adopt Industry 4.0; while for the public sector, the government must show the will to lead by creating a focal point in the form of the appointment of a high level official/office responsible for national adoption of new technologies. This entity must be able to form a country vision and strategy for Industry 4.0 to thrive and succeed (Rethy et al., 2019).

The Ministry of Labor and Vocational Training (MLVT) is well placed to take a lead on this front. Working alongside the National Employment Agency, the MLVT can undertake a national technology audit that highlights the kingdom's current rate of technology utilization within service and industry. Having identified the status quo circumstance, both agencies will be able to identify where there is potential

for investment and growth within Cambodian business. Without a national view of the technology picture the rate of adoption could be inconsistent and ad hoc. Having identified the opportunities, it will be necessary to establish a set of established rules and procedures that focus on incentivizing technological upgrade, whilst minimizing any adverse risks.

Outside of industry it will be important to understand how technology is used by the public in their everyday lives. The past twenty years has seen an increasing uptake of technologies from smart phones to assisted driving vehicles to voice controlled intelligent personal assistants. In the next twenty years we can expect Cambodia to continue its uptake of technologies to include the widespread use of online banking, e-citizen platforms, and renewable energy systems (to name but a few). Accordingly, it will be prudent to adopt a set of governing principles regarding the use of these technologies. For example, with a potential for the increasing use of drones in consumer product delivery there is a space to establish rules on safe drone routes to ensure that privacy is not infringed upon and there is no risk of collision resulting in injury.

Beyond the rules and regulations surrounding adoption, there will be a need to educate citizens appropriately for a changing workplace and evolving social dynamics. Industry 4.0 will usher in new skills requirements across industry that will require workers to be trained in accordance.

## Ensuring Domestic Technical Capability

Owing to the fact that Industry 4.0 is the fusion of cutting edge, smart, and connected machines, and their interactions across the physical, digital and biological domains Cambodia must be willing to invest in the latest technology and bring in all stakeholders, from the legislator to the regulator and to the people at the factory floor.

To ensure connectivity, intelligence and flexible automation, Cambodia must mobilize technical teams at all levels to actively participate in the development of Industry 4.0. There are two core components to the development of domestic technical capabilities, as set out below.



First, there is the question of the Khmer language and the challenges that it confronts in the context of machine-readability. The writing system of the Khmer language is complex and difficult for humans to read and impossible at present for a machine to properly parse because there is no Natural Language Processing rules in place yet. In English, a word is separated by a space; but in Khmer there is no space between words. A space can be entered at the end of a sentence. For example, the Khmer sentence: “លាមករាវង្ស” is grammatically correct but ambiguous. By adding a white space between the word, a machine can determine the meaning of the word; but can humans understand the sentence? By adding a space to separate the word, the sentence will have totally different meanings: “លា មករាវង្ស” is different from “លាមក រាវង្ស” which is different from “លាមករា វង្ស” In English, there is only one row or layer of characters allowed; but in Khmer there are five rows or layers of characters allowed. This makes it difficult or impossible for the machine to process the word. For the same reason, Optical Character Recognition cannot be used to process the Khmer language.

These Natural Language Processing and Optical Character Recognition problems are the stumbling blocks for any computing using Khmer language. Attempts have been made by Google to translate Khmer language and Khmer street signs; but results have been generally negative. This is due to the inability to read and processes Khmer language by machine.

Without modification of the Khmer writing system, Cambodia will have no choice but to continue to use the system built for foreign languages, i.e. English, Chinese, French, etc. A simple feature of the “Google Near Me” will allow English language users to effectively employ the system to track and locate devices that have enabled their location to be seen. This feature is part of Google and is stored in SensorVault (Valentine-DeVries, 2019). The content in SensorVault is in English and cannot be translated by Google Translate into Khmer. Even if it tries to translate into Khmer, the result will not be understandable. Thus, in the area of law enforcement for example - a crime happens, and an investigator needs to determine what devices were nearby that particular location at that particular time, in order to establish the closest probability of a crime committed by the owner of one of those devices. This hypothetical Cambodian investigator will

need to gain assistance from overseas in order to help decipher the location information in the Google Sensorvault.

The second aspect relates to the question of security. Currently Cambodia has some capable programmers but lacks the software engineers necessary in order to meet the software development demands that the country requires in order to achieve the ideal 2040 scenario. Cambodian programmers are able to write small programs that are able to do a small task; but are unable to develop the complex software required to handle personal information, finance, and other areas. The Royal Government must provide professional software engineering training for this group in order to ensure a readily available supply of Cambodian software security experts who are able to support the development of Industry 4.0 in the kingdom.

### Building Trust in the System: Cybersecurity

Public confidence in a system is a natural prerequisite to the adoption and widespread utilization of a system. Without public confidence therein, demand and utilization will remain stagnant - a basic ingredient for failure. The current cybersecurity system of Cambodia is not safe for serious applications involving personal privacy or finance. Moreover, it does not have the requisite features to block malicious users or protect from intrusions. Currently, anyone can use Cambodia as a launching pad to attack systems in any country in the world. In line with creating general governance guidelines, as discussed above, there should be a taskforce established in a public-private partnership to develop a suitably safe and secure cyberspace within the kingdom.

### Ensuring Investment

Similar to any project undertaken by Cambodia, financial commitment to the project is one of the critical success factors. Without financial commitment any project is bound to fail. In order to ensure a successful transition, there are three potential routes to be explored.

Firstly, the kingdom could seek foreign investment for technological infrastructure upgrades. Under the current Belt and Road relationship with China, for example, Cambodia could seek additional investment for widespread

5G network infrastructure. In a similar manner, there are opportunities for investment in renewable energy systems and waste management centers from national partners in Europe and Asia.

Secondly, a portion of government spending could be earmarked for technology investments. In addition, public investment would be necessary for managing the necessary governance infrastructure at a ministerial level.

Thirdly, public-private partnerships could be encouraged to ensure that the requisite technological expertise is in place from the private sector to efficiently deliver technological growth and development.

### Technology Adoption and Adaptation

Cambodia must develop inclusive and enhancing technologies to support its transition towards Industry 4.0. As Mr. Christian Patron, Head of Innovations and Digitalization in Production System, and Marcel Figner, Strategy Digitalization and Smart Data Analytics Production System, of the BMW Group put it, *“one of the main tasks in the Fourth Industrial Revolution environment is to identify highly effective applications and to standardize and scale these rapidly within an international production system. Nobody has a better take on a solution’s effectiveness than the people in the process”* (Patrn and Figner, 2019).

There are several means of encouraging rapid adoption of technologies in the current Cambodian economy, both at personal and industry level, with a view to promoting national growth and development. Three features of the economy provide illustrations as to how this initial phasing can work in practice. These are the garment sector, agricultural practice, and migration. All three are expected to undergo major transition as Cambodia meets middle-income status, however, the role of technology is to ensure the most effective utilization of available resources at a moment in time. As we cannot be certain as to the precise nature of future technologies it is a valuable exercise to consider the immediate opportunities presented for economic prosperity under the adoption of more advanced technological practices.

- **Connecting Garment Workers.** Everyone at the garment factory floor is connected through an app to provide reports on his or her activities.

When a problem occurs for one employee and negatively affect costs and productivities, a flag is set and alert everyone on the factory floor. When an effective solution is found for a problem, it is highlighted and report to everyone in the factory floor. Everyone on the factory floor is encouraged to actively participate in the cost cutting and productivity increases in the production process and that all app built for this process should be democratized.

- **Connecting Cambodian Youth.** Every youth and every worker abroad are connected through a government-endorsed app with location data embedded. All workers abroad, with government endorsement, can register with the app about their employment, industry and location to serve as a mentor. Any young person with proper government identification (ID) can register with this app to receive mentoring services. Mentors can provide information about their employment, industry, location and availability of the job to their mentees. Outsiders without government endorsement, or potential traffickers cannot access this app.
- **Connecting Agricultural Workers.** A special sensor, installed in the farm, can be made to detect the soil chemistry and soil moisture and transmit that information to the receiver; which then transmit to the farmer's mobile phone and upload to the central server for analysis. Based on the information sent from the mobile device, with location data, the central server can analyze the received information, match with the central soil content database, pinpoint the location of the farm and make recommendations accordingly. The same sensor can be made to transmit the soil moisture content, query the Water Resource and Meteorology server, and intelligently recommend as to when the farmer should add water or should just wait for the rain. These processes can be automated and spare the farmer from the guessing works as to what fertilizers to use and when to add water to the farm.

## IV. Industrialization Under the Baseline Scenario: Business as Usual 2040

What is the price for Cambodia of not embracing Industry 4.0?

Cambodia could choose not to do anything with Industry 4.0, but such a decision could entail serious risks for the country's economic growth and development. As the production and manufacturing industries upgrade around the globe under the presence of new technologies and processes, Cambodia's failure to adapt will see its strategic investment advantage eroded. Where a competitive labor market had previously sustained the kingdom's economic development, Industry 4.0 will place even greater importance on effective, efficient, and systematic production processes that minimize unit cost and maximize gains. This reduction in comparative productivity will see investment flow away from the kingdom and towards more tech-ready destinations such as Nigeria.

From a labor force perspective, the lack of 4.0 readiness has the potential to cause two distinct issues. First, for those who wish to excel in industry, foreign employment destinations will be sought after, causing a brain drain within the kingdom. Second, wages could remain suppressed as the workforce is deemed unproductive. It is unlikely, in the face of being ill prepared for industry 4.0, that the labor market employment opportunities will have changed considerably from the options available today. Agriculture will continue to underpin the economy, while garment manufacturing will migrate elsewhere as firms see Cambodia as a sub-optimal market.

From a tourism perspective, if Cambodia is unable to provide a suitable level of technology infrastructure for tourists then there will be a concomitant decline in visitors and, accordingly, national revenue. This is of particular concern when we consider who the tourists of 2040 will likely be. By 2040, the Chinese and Indian markets will stand as two of the largest inbound tourism markets as a result of a middle-class explosion. With a great emphasis placed on the technologies that make travel less cumbersome, such as cashless payment and booking platforms, the absence of suitable infrastructure will encourage potential visitors to take their business elsewhere.

In the absence of suitable governance structures, investment in new technology will remain ad hoc and minimal. There will remain some moderate uptake of systems that seek to meet consumer demands such as online banking and movie streaming. Investment in new technology will, in the absence of a limited governance structure, primarily come from the private sector and remain limited.

Perhaps worryingly, should the benefits of industrialization be poorly understood or communicated, Cambodia may find itself retroactively enacting laws and legislation that damage the opportunity for economic growth and development. For example, if a new technology governing the productive processes of garment manufacturing is seen as a threat by workers in that industry, it may be outlawed in the country. While the short-term outcome would see workers retain their jobs, the long-term reality is that the factories would relocate to a more suitable production base.

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