11-2018

# Disruptive technologies and sustainable development: Implications for Southeast Asia

Ching-Fu LIN

Han-wei LIU
*Singapore Management University*, hanweiliu@smu.edu.sg

# Disruptive Technologies and Sustainable Development:

## Implications for Southeast Asia

**Ching-Fu Lin**
**Han-Wei Liu**

ICTSD

International Centre for Trade
and Sustainable Development

# Disruptive Technologies and Sustainable Development:

## Implications for Southeast Asia

**Ching-Fu Lin**
National Tsing Hua University

**Han-Wei Liu**
Monash University

Issue Paper

## CONTENTS

## ABBREVIATIONS

| | |
|---|---|
| AGI | artificial general intelligence |
| AI | artificial intelligence |
| ASEAN | Association of Southeast Asian Nations |
| CLMV | Cambodia, Lao PDR, Myanmar, and Vietnam |
| DAI | Digital Adoption Index |
| DLTs | distributed ledger technologies |
| GATS | General Agreement on Trade in Services |
| GDP | gross domestic product |
| IAI | Initiative for ASEAN Integration |
| ILO | International Labour Organization |
| IoT | Internet of Things |
| MNEs | multinational enterprises |
| R&D | research and development |
| SMEs | small and medium-sized enterprises |
| UNHCR | United Nations High Commissioner for Refugees |
| WFP | World Food Programme |
| WTO | World Trade Organization |

# FOREWORD

Disruptive technologies, including artificial intelligence (AI), distributed ledger technologies (DLTs), and the internet of things (IoT), are driving a transformative reorganisation of economic structures. If correctly harnessed, these emerging technologies have the potential to assist economies in creating new efficiencies, boosting productivity, and enhancing international trade.

ICTSD's Inclusive Economic Transformation Programme aims to empower least developed countries (LDCs) across the Indo-Pacific region to take advantage of the opportunities and mitigate the risks posed by disruptive technologies. This paper falls within that project and is part of a series of publications that examine the potential of e-commerce and disruptive technologies to advance sustainable development objectives.

This paper by Ching-Fu Lin of National Tsing Hua University, Taiwan, and Han-Wei Liu of Monash University, Australia, explores the scope for disruptive technologies to contribute to sustainable development. Though the term was coined years ago, today technologies such as blockchain and artificial intelligence are growing rapidly and promising to transform international trade in a way that will truly disrupt conventional understandings of the trade and development relationship. The authors focus in on implications for Cambodia, Lao PDR, Myanmar, and Vietnam, highlighting several ways in which these technologies could be deployed. From protecting property rights, facilitating access to credit, to fostering innovative food supply chain management, the applications are clear.

From a policy perspective, the pervasiveness of the digital divide — in which many of their citizens struggle to get electricity and internet access — is a stubborn obstacle to overcome before disruptive technologies can be put to use in lower-income countries. The authors propose investments in related infrastructure to foster the inclusive use of disruptive technologies. Interestingly, they shed light on a whole set of adaptable policy frameworks that can be used to support fast-moving technological areas such as these. Finally, the paper briefly explores the new moral and legal questions posed by these technologies.

We hope this research paper will help inform the decisions of policymakers, businesses, and relevant stakeholders engaged in international trade as they work to advance the United Nations Sustainable Development Goals.

**Ricardo Meléndez-Ortiz**
Chief Executive, ICTSD

# EXECUTIVE SUMMARY

Closing the development gap among the Member States of the Association of Southeast Asian Nations (ASEAN), in particular that between Cambodia, Lao PDR, Myanmar, and Vietnam (CLMV) and the others, has been one of the top agenda items for deeper integration and sustainable development in the region. The CLMV countries have gradually lifted millions of people out of poverty and reduced the poverty rate from 66 percent of the population in 1990 to 18 percent in 2015, thanks to decades of regional efforts like the Initiative for ASEAN Integration (IAI). Nevertheless, various challenges have persisted despite this remarkable progress towards the Millennium Development Goals set forth by the United Nations Development Programme. Among others, one of the most critical tasks facing CLMV is how to effectively leverage and move themselves a long way down the road to harness the rise of "disruptive technologies" and advance towards sustainable development amid the trend of the "Fourth Industrial Revolution".

Southeast Asia, as much as the rest of the world, is witnessing a historical moment of the "Fourth Industrial Revolution" — a collective term that describes how a diverse but interrelated array of "disruptive technologies" is fundamentally transforming how we live, work, and connect to one another with a speed, breadth, degree, and complexity unprecedented in human history. "Disruptive technologies" — a term popularized by Clayton Christensen and Joseph Bower in the 1990s — promise to offer innovative sources of value and opportunities not available previously. While disruptive technologies may outperform earlier ones by providing products and services that are cheaper, simpler, or more convenient than their conventional counterparts, they also pose governance challenges to existing legal and policy frameworks. Among others, blockchain and artificial intelligence (AI) have been highlighted by the World Economic Forum as key enablers that will reconfigure the existing models of social, economic, and political dimensions of our time. As analyzed in detail by this paper, blockchain- and AI-based tools and innovations have been increasingly implemented in developing and developed worlds and will soon penetrate the global market. The underlying benefits and risks of various applications of the above-mentioned two types of disruptive technologies are further assessed, specifically through case studies like the use of blockchain to address the traceability problems for food and agricultural products, micro-finance and fintech to support SMEs, and AI in transforming the provision of goods and services. For instance, AI and blockchain technologies, when exploited appropriately, have strong potentials to reinvent services and manufacturing sectors, innovate food safety and supply chain management, facilitate trade through banking innovation, improve participation and access of disadvantaged groups, and fostering business development through protecting property rights.

As technologies continue to mature, the interplay of blockchain and AI has been expanding and mutually reinforcing in wide practical operations and pose crucial questions to policymakers. For instance, how can CLMV strategize and unfold the potential of these disruptive technologies to bring their economic growth and social welfare to the next level? What types of regulatory or policy actions are available, and how can one identify optimal institutional designs for different contexts? How can CLMV countries align their sustainable development plans with disruptive technologies?

In the age of AI and blockchain, it is imperative to assist the ASEAN Member States, in particular CLMV countries, in closing the development gap among themselves and with the others. One critical task, as pointed out by this paper, is to explore optimal policy strategies to efficiently and effectively harness the rise of disruptive technologies, leverage technological advances to improve their existing positions in the global value chain, and move a long way down the road to sustainable development. By consolidating the critical observations of benefits and

risks of various disruptive technology applications, this paper offers possible policy strategies in the context of the emerging mega-regionalism — such as ensuring adequate accountability, transparency, and fairness, engaging technologically informed and adaptive regulatory reforms, and improving infrastructure and human capital to capture data-driven opportunities — that may help achieve the aim of optimizing economic growth and sustainable development for the people of Cambodia, Lao PDR, Myanmar, and Vietnam.

# 1. INTRODUCTION

Closing the development gap among the member states of the Association of Southeast Asian Nations (ASEAN), in particular that between Cambodia, Lao PDR, Myanmar, and Vietnam (CLMV) and the others, has been one of the top agenda items for deeper integration and sustainable development in the region. The CLMV countries have gradually lifted millions of people out of poverty and reduced the poverty rate from 66 percent of the population in 1990 to 18 percent in 2015, thanks to decades of regional efforts such as the Initiative for ASEAN Integration (IAI) (ASEAN 2017). Nevertheless, various challenges have persisted despite this remarkable progress towards sustainable development. Among such challenges, one of the most critical tasks facing CLMV is how to effectively harness the rise of "disruptive technologies" and move themselves a long way down the road to sustainable development amid the trend of the "Fourth Industrial Revolution" (Schwab 2015).

Southeast Asia, as much as the rest of the world, is witnessing the historical moment of the "Fourth Industrial Revolution" — a collective term that describes how "the way we live, work, and relate to one another" is being transformed fundamentally with enormous "scale, scope, and complexity" unprecedented in human history (Schwab 2015). Central to this Revolution is the emergence and rapid evolution of "disruptive technologies" — a term popularized by Clayton Christensen and Joseph Bower in the 1990s — which promise to offer innovative sources of value and opportunities not available previously (Christensen and Bower 1996). While disruptive technologies may outperform earlier ones by providing products and services that are cheaper, simpler, or more convenient than their conventional counterparts (Christensen 1997), they also pose governance challenges to existing legal and policy frameworks. Among recent

scientific and technological megatrends, blockchain and artificial intelligence (AI) have been identified by the World Economic Forum as key enablers that will reconfigure the social, economic, and political dimensions of our time (WEF 2015). From the view of sustainable development, AI may help achieve economic growth and reduce inequalities.

Distributed ledger technologies (DLTs, colloquially known as blockchain), as the name suggests, are built upon an interdependent chain of secured blocks that brings together existing technologies like cryptography, peer-to-peer networks, and consensus protocols (De Filippi and Wright 2018: 2). Depending on the level of openness and decentralization, blockchains can be broken down into two types: "permissioned" and "permissionless".[1] The former involves a central authority and are not open for everyone. Permissionless blockchains, by contrast, have no central authority and are collectively managed by various nodes spread across the globe, with each node having the same copy of the data based on prescribed software protocols. The decentralized feature makes blockchains tamper-proof so that people can interact in a transparent and non-repudiable manner. As blockchains can be deployed by public, private, or hybrid actors, an increasing number of corporations and governments have applied different types of blockchains to serve various functions. Cryptocurrency, digital identity, real property registration, the Internet-of-Things (IoT), smart contracts, traceability mechanisms, and supply chain management are just a few notable blockchain-based applications.

AI, on the other hand, is an umbrella term that blends a range of techniques such as data analysis, machine learning, and deep learning, and can be roughly divided into two types: "strong AI" and "weak AI". The former, also known as "artificial general intelligence"

---

1  There are two other types: hybrid blockchains and distributed ledgers, which are based on directed acyclic graphs (DAGs) (Ferrarini et al. 2017: 4-5).

(AGI), refers to systems capable of virtually every intelligent action, while the latter is often crafted for a specific task and is thus referred to as "narrow AI" (Copeland 2000). AI has been applied across many novel contexts like transportation (e.g., Google self-driving cars), banking (e.g., Merrill Edge Guided Investing, a robo-adviser), law enforcement (e.g., Traffic Jam, a tool combating human trafficking), legal practice (e.g., LawGeex, a contract review and management system), and healthcare (e.g., IBM Watson), though most of these remain weak AI.

Blockchain- and AI-based tools and innovations have been increasingly implemented in developing and developed worlds and will soon penetrate the global market. Furthermore, as technologies continue to mature, the interplay of blockchains and AI has been expanding and mutually reinforcing in wide practical operations. In light of such developments, how can CLMV strategize and unfold the potential of these disruptive technologies to bring their economic growth and social welfare to the next level? What types of regulatory or policy actions are available, and how can one identify optimal institutional designs for different contexts? How can CLMV countries align their sustainable development plans with disruptive technologies? To address these issues, the rest of this paper proceeds as follows. Section 2 begins by identifying some salient contributions of disruptive technologies to economic growth and sustainable development in the developing world. We further point out important ramifications that not only highlight how certain institutions or governments have reinvented their governance mode as public and private institutions, but also shed light on potentially bigger roles disruptive technologies can play for most of the developing world – including CLMV countries. On this basis, we will then address CLMV-specific implications by contextualizing their political, social, and economic underpinnings and examining the opportunities and challenges in three areas: financing, food safety and supply chain control, and the manufacturing sector. Our observations in section 2 lead us to take one step further to map the possible policy strategies that CLMV countries may leverage in section 3 along four dimensions: legal, technical, human, and institutional. Section 4 concludes.

# 2. PUTTING DISRUPTIVE TECHNOLOGIES INTO PRACTICE: LAYERS OF IMPLICATIONS FOR SOUTHEAST ASIA

The far-reaching ramifications of blockchains and AI have been documented in media, literature, and political arenas in recent years. While much of the focus is centered on the implications for the developed economies, blockchains and AI will similarly reshape the landscape of the developing world. Due to space constraints, we more closely examine the role of disruptive technologies for five issues: land registry, identity, trade finance, food safety and supply chain management, and manufacturing. These areas are of clear relevance to the sustainable development of the Global South. As discussed below, each case demonstrates the potential benefits to the developing world and at the same time underscores the challenges facing policymakers.

## 2.1 Fostering Business Development by Protecting Property Rights

A nation's economic prosperity is often premised on a modest legal infrastructure protecting property and contract rights (Posner 1998). Valid property rights are the building blocks for investment, productivity, and economic growth. Studies indicate that a clear and effective delineation of property rights can not only put owners in a better position of getting credit from banks but also offers incentives for foreign investors. More broadly, a credible and up-to-date land administration system can help all parties involved — governments, financial institutions, buyers, and sellers — to track the deal, correctly appraise the value of property for various purposes (e.g., taxation), and reduce transaction costs (World Bank 2018a). While this looks rather promising, not every developing country maintains an adequate land registry, which makes secured transactions more pricey and problematic (Mendes 2018). Rampant bribery and corruption add further complexity to this context. In Ghana, for instance, land-related matters remain the major source of disputes, accounting for some 70 percent of Ghanaian court cases (Berryhill

et al. 2018). This is in large part due to the lack of effective land registry. Studies show that traditionally the average time to confirm land ownership and real-time land information from the government was about one year and one month, respectively. To resolve this problem, the Ghana government relied on Bitland, the Ethereum-based digital registry invented by BenBen, to overhaul the system. Bitland was able to reduce the above-mentioned processing time to three months and three days, respectively, and enhanced transparency can mitigate concerns about property fraud and corruption, thereby increasing efficiency gains (Kshetri and Voas 2018).

Similar initiatives can be found in the rest of the developing world, like Honduras, India, and Georgia (Oprunenco and Akmeemana 2018; Shin 2017). Honduras, for instance, teamed up with a Texas-based start-up, Factom, to move its land registry onto blockchain. The underlying purpose is to rebuild people's trust in the land administration scheme. For decades, Honduras has struggled with land conflicts: a majority of its lands are unregistered, and the expansion of mining and energy projects fueled land-related violence (Chandran 2017). Plus, it is common to see government officials alter the titles for their own interests or in exchange for bribes (Maxim 2015).

The above cases have lessons for Southeast Asia, including CLMV countries. As per the most recent Doing Business Report issued by the World Bank, for instance, Cambodia, Laos, and Myanmar still use paper-based systems to keep the majority of title or deed records in their largest business cities, and lack electronic means to record boundaries, check plans or provide cadastral information (World Bank 2018a). While Vietnam and Laos have begun to use electronic databases to check the rights attached to properties, neither Cambodia nor Myanmar offers such provisions. Moreover, transfer of titles can also involve extra paperwork for the purpose

of publicity. In Myanmar, for instance, parties to the transactions are required to, as part of the registration process, announce their agreement in one of the state newspapers to allow those with claims to the property at least two weeks (though typically one month) to come forward before the registration can be finalized. Overall, the index score of CLMV countries in terms of quality of property registration are: Cambodia (7.5); Laos (10.5); Myanmar (5.5); and Vietnam (14.0), which are all below the average score of East Asia and the Pacific Area (15.8). This suggests that CLMV countries can tap into the potential of disruptive technologies by upgrading the traditional paper-based land administration systems to blockchain-based ones. Some industry stakeholders in Vietnam, for instance, have suggested blockchain as an innovative way to boost the real property market (Viet Nam News 2018). However, much remains to be done before these reforms can take place, with the political climate and special interests as important hurdles.

## 2.2 Improving Participation and Access of Disadvantaged Groups

Another major impediment to sustainable development is the lack of identity documents. An "inclusive, secure, and trustworthy identification system" that ensures individuals' access to "rights, services, and the formal economy" is identified as a key component of the Sustainable Development Goals (World Bank 2018b). Yet evidence reveals that as of 2017 there were still around 1.1 billion people lacking official identity documents, and more than half of them lived in lower-middle-income economies (Desai et al. 2017). People without appropriate documents may be denied access to a range of rights and services, such as finance, education, health, legal redress, and social benefits. Such an "identification gap" can inhibit disadvantaged groups from participating in social, economic, and political life. This problem can be exacerbated in the context of asylum-seekers and refugees, where most of them are forced to leave their homes without verifiable documents. While there

are efforts to moderate these concerns, some of the approaches that are implemented in a more formalized manner may instead restrict certain individuals from obtaining legal documents. Disruptive technologies appear to be a promising alternative to fix this problem. Beginning in 2017, for instance, the World Food Programme (WFP) of the UN launched the "Building Block" program. Using iris-scanning technologies and blockchains, this program helped Syrian refugees verify their identities and directly deduct what they spent from the amount of aid they received from the WFP (Bacchi 2017). The benefit of this program is salient: transforming paper-based documents into blockchain-enabled identity can, on one hand, better protect refugees, because their identities remain immutable and cannot be lost or destroyed, and on the other, enable the WFP to make cash transfers in an efficient, secure, and cost-effective way by undercutting the role of middlemen while tracking the fund flow (WFP 2018; Jafrey 2018).

Noting that blockchains can promote transparency and reduce fraud and corruption, charity organizations have also applied this disruptive technology to their donation platforms. The "Ant Love", launched by Ant Financial, an affiliate of China's Alibaba, is one prime example that empowers people to track their donations with a view to improving the accountability of Chinese philanthropic organizations (Chen 2016). Using blockchain technologies in solving identity issues matters to Southeast Asia, a region hosting more than a million refugees and stateless people and some 51,000 asylum-seekers in 2017 (UNHCR 2017). Its significance can be best illustrated by the Rohingya crisis, in which a large number of Rohingya refugees fled from Myanmar to Bangladesh and Malaysia. According to one source, 94 percent of Rohingya refugees are not in possession of documentation of any kind, while another 5 percent hold the so-called "White Cards" — a temporary non-citizenship document — deemed invalid by the Myanmar government in 2015 (Rohingya Survey 2017). With the aid of UNHCR, the Bangladesh government set up biometric registration

to help identify the refugees properly. Considering the ramifications of their data being controlled by a centralized authority and the long-term development of the Rohingya community, there has been a call for the creation of a "Rohingya Project" to empower the stateless and financially excluded Rohingya people through a more secure and transparent blockchain system (Rohingya Survey 2017).

## 2.3 Facilitating Trade through Banking Innovation

Sustainable development rests on a robust global trading system. International trade in turn is underpinned by adequate financing, credit, and credit insurance provisions to help exporters and importers in different jurisdictions to receive payments, mitigate risks, and expand operations. Despite its significance, however, trade finance has remained a major impediment for small and medium enterprises (SMEs) to engage in global trade. Unlike larger firms, SMEs typically lack a financial track record, sufficient skills and knowledge, and collateral to secure credit facilities from financial institutions. Such concerns are particularly true for SMEs in lower-income economies who have relatively small banking industries that are not of interest to global financial institutions (WTO 2016). Another issue, related to SMEs access to trade finance, is asymmetry of information in cross-border transactions. It is not necessarily the case that financial institutions will have information on whether the applicant has already received financing based on the same invoice; besides double financing, it is not uncommon to see fake invoices. These issues have been pervasive in parts of Asia, adding further complexity to trade finance.

A recent survey by the Asian Development Bank (ADB) suggests that 74 percent of SMEs' requests for trade financing were rejected, while the rejection rate was only 26 percent for multinational enterprises (MNEs) and large companies (Di Caprio et al 2017: 3). There is no exception for ASEAN: another report reveals that for SMEs in the five original members of

ASEAN – Indonesia, Malaysia, the Philippines, Singapore, and Thailand – it is personal funds rather than bank loans which serve as a primary source of financing (Tan and Ng 2015: 11). Although there are no relevant data about the CLMV in this regard, all but Vietnam are underperforming as compared to the other ASEAN counterparts in terms of getting credit generally.

Both private and public sectors in Southeast Asia have begun to improve SME's access to bank lending. Some governments like Thailand seek to help SMEs provide adequate collateral as required for their transactions by enacting a Business Collateral Act (Ferrarini et al. 2017). Others such as the Philippines and Malaysia have introduced programs to help SMEs secure credit by setting credit volume targets for SMEs as a mandatory requirement, a credit guarantee program, or comprehensive credit information regarding SMEs (ADB 2014: 6-8). More recently, disruptive technology seems to be another promising solution to streamline finance. In 2017, for instance, HSBC and Bank of America teamed up with Infocomm Development Authority of Singapore to improve the letter of credit transaction processes via blockchain technologies (Suominen 2018: 9). Likewise, in Thailand, a group of banks launched the "Thailand Blockchain Community Initiative" to create a blockchain-based platform to facilitate the use of letters of guarantee (Ono 2018a), which could help banks reduce overhead and infrastructure costs by US$15-20 billion annually through 2022 and reduce errors and inconsistencies (Suonminen 2018: 33).

While the CLMV have not yet rolled out similar initiatives, these countries may follow suit at some point. In Cambodia, for instance, the National Bank of Cambodia is reportedly engaging with a Tokyo-based financial technology startup to create a blockchain-based payment system to offer people a secure, cost-effective method of money transfer (Nikkei 2017). This would help this nation remove the impediments to better banking services – low quality staff, ATM accessibility, and poor digital capacities (Kotoski 2016a). Stakeholders

in Vietnam's banking industry seem keen to tap blockchain technologies to serve its massive underbanked population (Hynes 2018). Blockchain technologies, if adopted in the banking system of CLMV countries, can not only support SMEs but also facilitate labor mobility in this region. According to the International Labour Organization (ILO), for instance, there are around 400,000 Vietnamese workers now present in more than 40 countries worldwide, creating annual inflows of remittances of some US$2 billion in recent years (ILO no date). Rebuilding the payment system through blockchains could enable migrant workers to move their money back home without the middleman. In a way, this may help the Mode 4 trade of CLMV countries under the framework of the General Agreement on Trade in Services (GATS) of the WTO.

## 2.4 Innovating Food Safety and Supply Chain Management

The agri-food industry is of paramount importance to the economy in Southeast Asia. For example, in 2014, the agricultural and fisheries sectors accounted for about 51 percent of GDP and 30 percent of employment in in Cambodia, 42 percent of GDP and 10 percent of employment in Thailand, and 47 percent of GDP and 18 percent of employment in Vietnam (OECD-FAO 2017). Among all the business actors in ASEAN, over 95 percent are SMEs, which play a critical role in the region's economic growth and sustainable development (ACCA 2016; Iqbal and Rahman 2015). As the production, distribution, and consumption of food has become globalized against the background of trade liberalization in recent decades, the Southeast Asian countries are not immune from regulatory challenges in relation to domestic and cross-border issues of food safety and quality, trade facilitation and supply chain management, product standard compliance and market access, and food fraud and fair competition. Nevertheless, governments and enterprises, especially those in CLMV countries, may have at their disposal limited infrastructural support, financial resources, or technical capacity to respond

to these complex challenges at the local, regional, and global levels.

Blockchains and AI, among other disruptive technologies, may be able to help CLMV respond to such challenges in various ways. In some cases, AI technologies are being developed and applied in both developed and developing countries to increase farmland management and productivity (e.g. machine learning algorithms combined with drone technology to efficiently plant and cultivate crops) and reduce sanitary and phytosanitary diseases (e.g. machine learning algorithms, image classification, and animal facial recognition to speedily identify unhealthy animals and plants) (Jagannathan 2018). In other cases, blockchains have effectively transformed how we conventionally think about food safety, certification, and traceability. For instance, IBM has been collaborating with certain major retailers (such as Walmart, which has required its upstream suppliers of leafy greens to comply with a new standard by September 2019) to use the cloud-based IBM Food Trust platform to "blockchainize" the food supply chain (Wolfson 2018; Ganne 2018: 79). The day-to-day management of food production and distribution along the global value chain (especially for players in the developing world), is by and large manual and paper-based, and therefore a labor-intense and time-consuming endeavor. The IBM Food Trust platform places a physical supply chain on its virtual blockchain, connecting all participants globally (each represents a node) to upload their data to the system and generate a transparent, traceable, immutable, and shared record of production details, quality specifications and origin facts, sustainability and fair trade certifications, and storage, import/export, and logistics information (IBM Food Trust no date). The use of blockchain cuts off intermediaries and third parties, facilitates real-time transparency and pin-point traceability, and enables much faster reactions in cases of food safety outbreaks – thereby considerably reducing the cost of transactions and recall as well as the likelihood and scale of damage. In addition to the benefits for better food safety governance,

blockchains may also help entities along the supply chain identify inefficiencies, provide verifications and certifications, and maximize shelf life to reduce waste (IBM Food Trust no date). Blockchains can also be combined with smart contract systems or other AI techniques to increase efficiency, simplify transactions, ensure compliance and security, and promote trade facilitation across borders, resulting in more inclusive and sustainable agri-food supply chains (Tripoli and Schmidhuber 2018).

In CLMV, there has been a growing demand for leveraging blockchain and AI technologies to modernize agri-food production and distribution to boost efficiency, transparency, and competitiveness. Cambodia, for example, has worked with Oxfam to use a blockchain system called "BlocRice" that helps small-scale organic rice farmers in Preah Vihear province in traceability, smart contract and cashless payment, and consumer communication (Oxfam Cambodia no date). Such a blockchain-based initiative helps small farmers and exporters use technology to gain negotiating power and to get fair prices. These small players have to sell quickly under pressure to repay high-interest loans (usually provided by traders), oftentimes are neither protected by valid contracts nor paid accordingly, and who generally lack market power and information necessary for negotiating terms and conditions (especially regarding prices) with traders and middlemen (Ono 2018b).

Recent developments in Vietnam also indicate a promising path towards effectively using blockchain and AI technologies to increase market value and competitiveness, livelihood of SMEs in the agri-food sector, and sustainable development in the country. Concerned about lagging behind Thailand in the world agri-food market due to high prices, lower quality, and the lack of information, the Deputy Director of the Vietnam Agriculture Academy has stated that Vietnam's products will encounter difficulty in accessing high value chains and markets if the players do not replace their out-of-date technology with advanced ones (VietNamNet Bridge 2018). In this light, Infinity

Blockchain Labs has launched the blockchain-based "Fruitchain" platform — which provides real-time production, packaging, shipping, and quality information to consumers and trading partners — to strengthen Vietnamese fruit farmers' and suppliers' capacity in terms of supply chain management, traceability and transparency, standard certification and international competition, and sustainable development (Infinity Blockchain Labs no date). Similarly, TE-FOOD, recently recognised by the Food and Agriculture Organisation of the United Nations (FAO) as a partner, has also implemented blockchain-based farm-to-table traceability platforms in the livestock and fresh produce sectors in Vietnam. In 2016, TE-FOOD established a pig tracking system along the entire supply chain to track 10,000 pigs daily, and it also worked with local governments to train over 6,000 companies in South Vietnam; in 2017, TE-FOOD trained twenty-two regions of Vietnam to track 350,000 chickens and 2.5 million eggs daily; and since 2018, the company has engaged in national livestock registration and management as well as tracking mechanisms for fruits and vegetables (TE-FOOD no date).

## 2.5 Reinventing Services and Manufacturing Sectors via AI

While there are now numerous AI applications that have been deployed in developed countries to upgrade manufacturing and services, the use of AI in CLMV countries has remained relatively rare. Nevertheless, AI technologies have equal potential in CLMV countries to help transform services and manufacturing sectors, boost economic growth, and provide critical public services in similar ways. According to the ASEAN Secretariat, the application of disruptive technologies could generate internal growth and external investment and significantly increase productivity by 2030, resulting in an additional US$220 to US$625 billion in terms of annual economic impact in the region (ASEAN 2016).

Optimal use of disruptive technologies such as blockchains and AI systems can empower

business (including SMEs) and citizens in CLMV countries to ensure economic growth and sustainable development. For example, together with robotics, AI systems can be applied in traditional factory sites to modernize the labor- and experience-intensive production process into a smart manufacturing process, increasing productivity, ensuring quality, reducing production cost, and preventing harm from strenuous or dangerous work. While robots have already been used on a large scale in manufacturing since the beginning of industrial automation in the 1970s, the development and application of AI-supported robots is expected to grow significantly in the coming decade (the industrial robot market was estimated to account for US$29 billion in 2014 and around 230,000 industrial robots were sold in 2014 — both numbers are predicted to increase in the near future) (Stankovic et al. 2017: 8). The combination of AI technologies and robots can also be used to upgrade work and service in various settings such as restaurants, waste processing sites, train stations and airports, farms, hospitals, elderly care centers, and government agencies. Providing assistance and care to aging and disabled populations can contribute to the overall quality and accessibility of social welfare system (Stankovic et al. 2017: 9). Automated vehicles and smart transport infrastructure may also increase the potential of production logistics and distribution network, offering more efficient and sustainable options for business to trade and connect. While the empirical employment impact of AI and robotic technologies is yet to be ascertained, various AI and robotic innovations have been diffused to developing countries (including CLMV countries) through global supply chains and multinational businesses to upgrade local manufacturing and increase product quality (Stankovic et al. 2017).

Blockchains may provide innovative and inclusive ways for individuals to access services which were previously unreachable and for businesses to trade with each other across existing barriers – via new sources of market information, new channels of education and employment, and new platforms of financial services (WEF and ADB 2017: 8). In CLMV countries, blockchains and AI systems may offer new opportunities in contexts where many SMEs have limited capacities for obtaining in a fair and efficient manner information, financial services, business networks, and global market access. For instance, while less than a third of the population in Myanmar and Vietnam have a bank account with conventional financial institutions, blockchain is poised to "revolutionize payments and logistics, enabling small firms to interact on a trusted basis despite never having met each other," empowering SMEs to trade in novels ways in global digital marketplaces, and therefore "unleash a world of micro-transactions" (WEF and ADB 2017).

In addition, blockchains and AI systems are able to bring innovative models for delivering various business and public services, most notably health services in less advanced countries such as CLMV. The development and application of telemedicine (such as online or portable medical expert systems, mobile health advisors, or unmanned drone delivery of medical products) for rural areas is an adequate example. Commentators have affirmed that while many countries have integrated AI technologies into their healthcare systems to generate benefits like cost reduction, increased access, and distributional justice, there is tremendous potential for AI systems to facilitate and revolutionize healthcare provision in resource-lacking countries (Wahl et al. 2018). For instance, while the Internet penetration rate in CLMV is not as high as that in most developed countries, the rapidly growing number of smartphones (i.e. the necessary basics for AI applications) is increasing the supply of quality data in a network of electronic devices, which can support the provision of health services in resource-poor scenarios. With adequate investment in cloud computing infrastructure and in digitizing health information, AI-supported expert systems may be deployed in CLMV and other less developed countries in many ways. In some circumstances, expert systems can help communicate health information to patients

when personal interactions are infeasible; in other cases, expert systems can be used to assist physicians (or, in some rural areas, community health workers) in diagnosing and making treatment decisions; and in even more exceptional conditions (usually in poor communities), expert systems may be used to act in lieu of human doctors when they are nonexistent (Wahl et al. 2018). In a broader setting, AI technologies are being exploited to "predict, model and slow the spread of disease in epidemic situations around the world" (Wahl et al. 2018). In Manila, for example, researchers who have studied epidemic patterns of dengue fever recently leveraged a machine-learning-based system to identify weather and land-use factors pertinent to the transmission of this disease (Wahl et al. 2018). With no doubt, such AI technologies can be equally beneficial to CLMV countries.

# 3. ALIGNING DISRUPTIVE TECHNOLOGIES WITH SUSTAINABLE DEVELOPMENT: POLICY STRATEGIES IN THE AGE OF MEGA–REGIONALISM

Thus far this paper has discussed the development and deployment of DLTs and AI technologies for the provision of public and private goods and services. This section takes one step further to discuss possible policy strategies along the regulatory, institutional, technical, and human dimensions. To elucidate the potential of disruptive technologies to bridge the development gap vis-à-vis industrialized nations amid the trend of mega-regionalism, there are hurdles facing policymakers in CLMV countries. As explained below, some of these challenges, such as the lack of adequate physical infrastructure and human capital, are not new. Yet CLMV can face even heavier stress to catch up with the developed world because of the fast-growing disruptive technologies. Other emerging issues, like mapping out an adaptive and anticipatory regulatory approach in response to the dynamics of the digital world, and taming AI and blockchains through transparency, accountability, and fairness have become even more challenging tasks facing CLMV. We identify major challenges and potential policy options below.

## 3.1 Improving Infrastructure and Human Capital to Capture Data-Driven Opportunities

As explained, disruptive technologies can cause fundamental changes throughout the world, including developing countries. But how developing countries can benefit from these new changes to bridge the development gap between haves and have nots within and between countries is in large part premised on infrastructure. As demonstrated by the Digital Adoption Index (DAI) issued by the World Bank, CLMV countries lag way behind their ASEAN counterpart Singapore in terms of digitalization. While Singapore sits at the top of the rankings, Vietnam, Cambodia, Laos, and Myanmar rank 91st, 101st, 109th, and 160th, respectively. This reflects in part the shortfall of Internet access and electricity in these countries. Despite

years of efforts via initiatives like "e-ASEAN", for instance, a large number of inhabitants in Myanmar, Laos, and Cambodia remain offline. The number of internet users per 100 of the population was about 84 for the developed world at the end of 2017; by contrast, these three countries had user density of somewhere between 33-49 (ITU no date). Shortfall of electricity is another critical issue. Studies show that in 2014 only half of the inhabitants in Cambodia and Myanmar had access to electricity (WEF and ADB 2017).

It seems unlikely that populations without access to the Internet and electricity would readily take to using blockchain, let alone relevant applications, in meaningful ways. As an example in point, Myanmar, Laos, and Cambodia have not joined the ASEAN Single Window, a platform to facilitate trade and expedite electronic exchange of customs data that may harness the potential of blockchain. Adding more complexity is the operational costs for storage, bandwidth, computing powers, and encryption technologies involved as blockchain and AI mature overtime (Kasireddy 2017). CLMV should hence continue to work on the improvement of infrastructure by offering a stable and quality supply of connectivity and electricity at affordable costs, which would of course require substantial fiscal resources. This would help mitigate the digital divide – a major challenge to further economic integration in the digital realm in the age of disruptive technology (WTO 2018).

Another related hurdle for CLMV to grasp the opportunities presented by disruptive technologies is the lack of skilled manpower to catch up with the shifting data-driven economy. In Vietnam, for instance, the shortage of information technology (IT) personnel for the year 2017-2018 alone is projected to be some 70,000 staff, and the number will increase by 500,000 employees by 2020 (Tuan 2017). The quality of manpower is yet another problem, as

evidenced by the average productivity lagging behind many of its ASEAN counterparts like Singapore and Malaysia (VietNamNet Bridge 2017). Emerging AI, big data, and blockchain, as well as their cross-sectoral implications, put great pressure on CLMV to improve computer science education and training to close a critical gap in skill sets for jobs in high-tech industries and encourage interdisciplinary collaboration. From a trade law perspective, this may also call upon CLMV to revisit their existing commitments, mutual recognition agreements, and visa and work permit processes to effectively facilitate cross-border labor mobility within or outside the multilateral, regional, or bilateral economic arrangements in response to market demands.[2]

## 3.2 Engaging Technologically Informed and Adaptive Regulatory Reforms

Diffusion of disruptive technologies depends on not only physical infrastructure and human capital, but also an adequate regulatory framework. Yet it has been a daunting task for governments to craft an optimal regulatory framework when it comes to technological innovation. While protecting public interests and preventing market failures is certainly imperative, how to achieve this without deterring innovation is by no means easy. For one, the questions of when and how to regulate can be problematic, because they turn on the underlying risks, public perceptions, legal tradition (i.e. common law or civil law), and various economic, social, and political underpinnings (Black and Baldwin 2010). For another, the "pacing problem" – a situation where technological progress always outpaces legal development – makes innovations a moving target to catch up with (Marchant and Wallach 2013). A heavy-handed regulatory approach adopted too soon could reduce investments in research and development (R&D) activities below some optimal level, thereby stifling

innovation. Costs of government failures – mismatches between adequate regulation and the corresponding problems – can be significant and sometimes more expensive than other policy options (Breyer 1984).

All these problems become particularly prominent in the context of disruptive technologies that evolve and revolutionize rapidly and exponentially, high uncertainties about their risks, benefits, and future direction, and a wide range of applications across sectors and national borders. Challenges can be even more acute for developing countries – including CLMV – due to their relative low regulatory and policy capacities as compared to their developed counterparts. To unfold the potential of disruptive technologies and avoid the immense costs of government failures by picking the wrong side while the world is resetting itself, CLMV need to rethink the traditional, linear approach by taking into account the unique nature of disruptive technologies – fast-moving, cross-sector, and cross-border. A flexible, experimental regulatory model based on the notion of inclusiveness and multi-stakeholderism would seem a promising option (WEF and ADB 2017). This would call for a principle-based approach to ensure regulatory decisions can be more open-ended, subject to new knowledge and input from stakeholders in both public and private sectors. To this end, CLMV policymakers should tap into big data to map out whether, when, and how to govern new challenges. The emergence of the so-called "sandbox" approach in the banking and financial sector is a prime example of an alternative governance mode. The rationale underlying the sandbox approach is to facilitate innovation by creating a "safe space" for businesses to test new products and services without immediately fulfilling the licensing requirements under the existing framework (FCA 2015). In ASEAN, countries like Singapore, Malaysia, Indonesia, and Thailand have set up sandbox schemes for fintech.

---

2   In the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) to which Vietnam is a party, for instance, Annex 10-A sets forth provisions to facilitate the recognition of professional qualifications, licensing or registration. Also, Vietnam has undertaken under the CPTPP to allow the entry of "Contractual Service Suppliers" in sectors like "Computer and related services," "Engineering services," and "Integrated engineering services."

While this sandbox approach seems promising, there are hurdles facing CLMV too. Although the requirements of the sandbox approach can vary in different nations, "innovativeness" is often a prerequisite for a firm to benefit from the licensing exemption (Bromberg et al. 2017). Determining whether a proposed service or product is innovative enough often involves certain judgment calls that require relevant expertise and skill sets. To facilitate diffusion of disruptive technologies and their applications without creating unnecessary obstacles to international trade and investment, it is crucial for CLMV to draw lessons from other nations not only in crafting new legal frameworks, but also the way of implementation in practice. Regulatory cooperation, be it bilateral, regional, or multilateral, is much warranted to avoid negative ramifications of arbitrary exercise of discretionary powers. ASEAN's Financial Innovation Network is such an example that promotes collaboration and facilitates development of and experimentation with innovative financial products and services in the region (MAS 2017). Nevertheless, as promising as a sandbox framework at the ASEAN level may be, challenges may arise from the diverse regulatory landscapes in different member states, and thus well-informed evaluation is required. For example, some countries in the region have well-designed property law and contract law systems, while others have serious problems in law enforcement and independent judicial review; some have stringent privacy protection regimes, while others are underdeveloped in this regard.

International cooperation also plays a role in at least two other aspects. First, it could help to establish common standards and to moderate ramifications of the lack of interoperability across systems and countries. Existing blockchain platforms, for instance, do not speak to one another, which poses challenges for wide-scale deployment of blockchains (WTO 2018: 7; Ganne 2018: 94). The second aspect goes beyond the purely technical aspect of interoperability by bringing together policymakers in shaping mutual understandings of various values attached to these disruptive technologies in different jurisdictions. This has broader implications from the perspective of international economic law. It has been debated, for instance, whether and to what extent robots should gain legal personhood. If so, will robots still be considered products or services for the purpose of the WTO? Could we consider them to be "service providers" that are subject to certain educational and professional qualification requirements, and thus, to trade negotiations – even though they may not neatly square into the existing framework of Mode 4, a notion based on a "natural person"? Other issues, such as "likeness" can be equally, or even more, problematic when it comes to evaluating different treatments given to robot and human service providers. Addressing all these questions would require policymakers — including those from CLMV — to work together and explore the common values shared by diverse groups of stakeholders with different cultural backgrounds. Considering the vast diversity in the region in terms of technological development, economic structure, legal systems, and positions in the global value chain, different nuanced patterns of disruptive technology application may call for different policy responses. Having said that, any unilateral regulatory intervention without regard to the cross-border nature of disruptive technologies and their spillovers can create more problems than they solve.

For CLMV to reap the benefits of disruptive technologies, there are many other hurdles lying ahead. For instance, cryptocurrencies may undermine already fragile anti-money laundering and terrorism financing schemes in this region (Kotoski 2016b). Market concentration and anti-competitive conduct due to the nature of the digital markets require CLMV governments to reconfigure their competition laws and policies (WTO 2018). Transparency brought by blockchain can influence the political will to engage in deeper reform. This is what happened with Honduras's land registration reform — Fatcom's blockchain project was so-called "stalled" because of political issues (Kirby 2015). Moreover, the dearth of adequate privacy and

data protection laws to meet requirements set out by the APEC Privacy Framework, ASEAN Framework on Personal Data Protection, or the General Data Protection Regulation, for instance, can not only raise human right concerns, but also inhibit cross-border data flows in these countries, thereby reducing incentives for foreign investments in high-tech industry (Greenleaf 2014). These and many other factors are all important underpinnings of the diffusion of disruptive technologies in the long run.

### 3.3 Ensuring Adequate Accountability, Transparency, and Fairness

Like other developing countries, CLMV are most likely to be recipients that borrow disruptive technologies from the more technologically advanced world. As promising as these innovations may be, there are challenges ahead in the process of transplanting new business models or systems into CLMV. These challenges are, by and large, centered on the notions of transparency, accountability, and fairness. While disruptive technologies reinvent business models by making conventional machines and processes even smarter, the costs of potential misuse or abuse of such technologies can sometimes outweigh the potential gains. Hidden bias, for instance, has been a recurring theme that engenders enormous legal, policy, and ethical debates. Built on data and algorithms, AI systems are designed to spot patterns, map out real-world problems, and propose solutions. This entails a complex process of data collection, feeding massive amount of data, and training. As humans are involved in all these processes, there are evident risks of subjectivity. If there is any sort of bias in the training dataset, that would be translated into the recommendations or decisions of the AI systems. Unwanted ramifications can also emerge due to an incomplete dataset or the design of algorithms. As seen in *State v. Loomis* in Wisconsin USA, for instance, the risks of racial discrimination are already present in the U.S. criminal justice system, where the data-driven approach has become popular in assisting law enforcement authorities and

courts in various settings (State v. Loomis 2016). It can be problematic to detect and address the bias effectively because of legal and technical constraints. These AI systems can operate as a "legal black box", as they are often treated as proprietary technologies and are thus protected by trade secrets or otherwise. Even more problematic is the "technical black box"; the outcomes produced by certain sophisticated AI based on artificial neural networks are barely explainable, even by their creators (Liu et al. unpublished).

Admittedly, to address these black box problems and validate datasets that are suitable for the local contexts and to ensure bias-free AI-based applications can be extremely challenging for developing countries without sufficient technical or institutional capacities. Nevertheless, CLMV should weigh in on these factors when importing AI systems from the West. In ASEAN, Singapore has taken the lead to explore the framework to foster responsible development and adoption of AI (PDPC 2018). In addition, government procurement could serve as useful leverage for CLMV governments, as a user of AI systems in the provisions of public services, to negotiate better terms and scale down the scope of nondisclosure, thereby moderating the legal black box problem. To unfold the technical black box of AI and build trust in the ecosystem calls for sustainable development of technological capacity and ethically informed R&D in AI and other new areas of endeavors. In doing so, CLMV can also moderate the concerns of vendor lock-in by reducing their reliance on foreign technologies and creating their home-grown AIs or blockchains – although this is unlikely to occur soon, as most useful data are still controlled and utilized by select firms in the developed world. There is a long way to go to achieve data fairness for the Global South (Cordova 2018).

There are also issues in relation to blockchains. As much as blockchains can provide innovative upgrades and solutions to existing challenges in the developing country settings, worries may be surfacing from the proprietary blockchain-enabled solutions themselves.

While blockchains can help empower SMEs and individuals to take part in innovative trading networks, full access to benefits of blockchains innovations may be strategically (or inadvertently) limited to certain businesses or groups in an advantaged position in the market or society, thus excluding many from superior tools or information and undermining equitable participation in the long run (Schia 2018). In this regard, CLMV may likewise leverage their government procurement policy tools to mitigate potential problems of technological monopoly or unfair business practices. To ensure fairness and alleviate inequality when importing blockchain-based innovations from the developed world and applying them to their societies, CLMV should not only ensure regulatory, infrastructural, technical, and institutional readiness in the process as mentioned above, but also provide tailored assistance to local businesses and individuals to allow them to meaningfully participate in the ecosystem. A plausible policy option is to build public-private partnerships under a governance structure that facilitates access rights, fair use, and inclusiveness, promotes interoperability and standardization for easy integration, and brings values to all parties.

# 4. CONCLUSION

In the age of AI and blockchain, it is imperative to assist the ASEAN Member States, and in particular CLMV countries, in closing the development gap among themselves and with others. This article has pointed out that one critical task is to explore optimal policy strategies to efficiently and effectively harness the rise of "disruptive technologies," leverage technological advances to improve their existing positions in the global value chain, and move a long way down the road to sustainable development. This article draws on the existing scholarship and empirical evidence to investigate two major types of disruptive technologies that can serve as a cross-cutting infrastructure or platform for broad applications — blockchain and AI technologies — and to assess their potential impacts on CLMV countries. The underlying benefits and risks of various applications of the above-mentioned two types of disruptive technologies are further assessed, specifically through case studies such as the use of blockchain to address the traceability problems for food and agricultural products, micro-finance and fintech to support SMEs, and AI in transforming the provision of goods and services. By consolidating the critical observations of benefits and risks of various disruptive technology applications, this article offers possible policy strategies that aim at optimizing economic growth and sustainable development for the people of Cambodia, Lao PDR, Myanmar, and Vietnam.

# REFERENCES

ACCA - Association of Chartered Certified Accountants. 2016. *SME development in ASEAN*. London: ACCA.

ADB-Asian Development Bank. 2014. *ADB-OECD Study on Enhancing Financial Accessibility for SMEs: Lessons from Recent Crises*. Asian Development Bank.

ASEAN Secretariat. 2016. *Master Plan on ASEAN Connectivity 2025*. Jakarta: ASEAN Secretariat.

ASEAN Secretariat. 2017. *ASEAN Statistical Report on Millennium Development Goals 2017*. Jakarta: ASEAN Secretariat.

Bacchi, Umberto. 2017. "U.N. Glimpses into Blockchain Future with Eye Scan Payments for Refugees." *Thomson Reuters Group*, 21 June.

Berryhill, Jamie, Theo Bourgery and Angela Hanson. 2018. "Blockchains Unchained: Blockchain Technology and its Use in the Public Sector." *OECD Working Papers on Public Governance* 28. Paris: OECD Publishing.

Black, Julia, and Baldwin, Robert. 2010. "Really responsive risk-based regulation." *Law and Policy* 32 (2): 181-213.

Breyer, Stephen. 1984. *Regulation and Its Reform*. Boston, MA: Harvard University.

Bromberg, Lev, Andrew Godwin, and Ian Ramsay. 2017. "Fintech Sandboxes: Achieving a Balance between Regulation and Innovation." *Journal of Banking and Finance Law and Practice* 28(4): 314-336.

Chandran, Rina. 2017. "Modernizing Land Records in Honduras Can Help Stem Violence, Says Analyst." *Thomson Reuters Foundation*, 11 August.

Chen, Lulu Yilun. 2016. "Jack Ma Takes on Murky Chinese Charities in Blockchain Foray." *Bloomberg*, 21 July.

Christensen, Clayton M. 1997. *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston, MA: Harvard Business School.

Christensen, Clayton M., and Joseph L. Bower. 1996. "Customer Power, Strategic Investment, and the Failure of Leading Firms." *Strategic Management Journal* 17(3): 197-218.

Copeland, Jack. 2000. "What is Artificial Intelligence?" *AlanTuring.Net*.

Cordova, Yasodara. 2018. "Artificial Intelligence and the Need for Data Fairness in the Global South." *Medium* Website, 22 March.

De Filippi, Primavera, and Aaron Wright. 2018. *Blockchain and the Law: the Rule of Code*. Boston, MA: Harvard Business School.

Desai, Vyjayanti T., Matthias Witt, Kamya Chandra, and Jonathan Marskell. 2017. "Counting the Uncounted: 1.1 Billion People without IDs." *World Bank Group* Information and Communications for Development (IC4D) Blog.

Di Caprio, Alisa, Kijin Kim, and Steven Beck. 2017. 2017 Trade Finance Gaps, Growth, and Jobs Survey. *Asian Development Bank* Brief 83.

Ferrarini, Benno, Julie Maupin, and Marthe Hinojales. 2017. "Distributed Ledger Technologies for Developing Asia." *ADB Economic Working Paper Series* No. 533.

FCA -- Financial Conduct Authority UK. 2015. *Regulatory Sandbox*. London: FCA.

Ganne, Emmanuelle. 2018. *Can Blockchain revolutionize international trade?* Geneva: World Trade Organization.

Greenleaf, Graham. 2014. *Asian Data Privacy Laws*. Oxford: Oxford University.

Hynes, Casey. 2018. "Vietnam May Soon Emerge As One Of Southeast Asia's Blockchain Innovation Hubs." *Forbes*, 27 May.

IBM Food Trust. No Date. *An IBM Blockchain solution for the complete food system*. IBM Food Trust Solution Brief 2.0.

Iqbal, Badar Alam, and Mohd Nayyer Rahman. 2015. "Contribution of ASEAN-6 SMEs to Economic Growth of ASEAN." *Economics World* 3(11-12): 258-269.

ILO - International Labour Organization (ILO). No date. Labour Migration in Vietnam. *ILO Vietnam* Website.

Infinity Blockchain Labs. No date. "IBL Ready to Revitalize Vietnamese Agriculture with Fruitchain!" *Medium* Website.

ITU -- International Telecommunication Union. No Date. "ICT Facts and Figures." *ITU* Website.

Jafrey, Irfan. 2018. "Blockchain Could Help Achieve The UN's Sustainable Development Plan." *Forbes*, 4 September.

Jagannathan, Sheila. 2018. "In Africa, Technology and Human Capital Go Hand in Hand?" *World Bank* Blog, 16 October.

Jones, Maria Nakhayenze, and Mark Szekely Weegmann. 2017. *The Rohingya Survey*. XChange.

Kasireddy, Preethi. 2017. "Fundamental Challenges with Public Blockchains." *Medium* website.

Kirby, Peter. 2015. "A Humble Update on the Honduras Title Project." *FACTOM*, 25 December.

Kotoski, Kali. 2016a. "Banking Service Deemed Poor." *Phnom Penh Post*, 27 June.

Kotoski, Kali. 2016b. "Cambodia Stuck on Money Laundering Blacklist." *Phnom Penh Post*, 10 August.

Kshetri, Nir, and Jeffrey Voas. 2018. "Blockchain in Developing Countries." *IT Professional* 20(2):11-14.

Liu, Han-Wei, Ching-Fu Lin, and Yu-Jie Chen. Unpublished. "Beyond State v. Loomis: Artificial Intelligence, Accountability and Justice."

Marchant, Gary E., and Wendell Wallach. 2013. "Governing the Governance of Emerging Technologies', in *Innovative Governance Models for Emerging Technologies*, edited by Gary E. Marchant, Kenneth Abbott, and Braden Allenby, 136-154. Cheltenham UK: Edward Elgar.

MAS -- Monetary Authority of Singapore. 2017. "ASEAN Financial Innovation Network to Support Financial Services Innovation and Inclusion." *MAS* Website.

Maxim, Jeffrey. 2015. "Fatcom Partners with Honduras Government to Build Blockchain-backed Land Registry." *Bitcoin*, 19 May.

Mendes, Karla. 2018. "Can Blockchain save Amazon in Corruption-mired Brazil." *Thomson Reuters Foundation*, 25 January.

Nikkei. 2017. "Cambodia Taps Japanese Blockchain Tech for Payment System." *Nikkei Asian Review*, 21 April.

OECD-FAO. 2017. OECD-FAO *Agricultural Outlook 2017-2026*. Paris: OECD Publishing.

Ono, Yukako. 2018a. "Thailand's Leading Banks to Share Blockchain Platform." *Nikkei Asian Review*, 20 May.

Ono, Yukako. 2018b. "Cambodian Rice Farmers Turn to Blockchain to Gain Pricing Power." *Nikkei Asian Review*, 27 August.

Oprunenco, Alexandru, and Chami Akmeemana. 2018. "Using blockchain to make land registry more reliable in India." *LSE Business Review* 13 April. Blog Entry.

Oxfam Cambodia. No Date. "BlockChain For Livelihoods From Organic Cambodian Rice (BlocRice) Project." *Oxfam Cambodia* Website.

PDPC - Personal Data Protection Commission Singapore. 2018. "Artificial Intelligence (AI) and Personal Data Fostering Responsible Development and Adoption of AI." *PDPC* Discussion Paper.

Posner, Richard A. 1998. "Creating a Legal Framework for Economic Development." *World Bank Research Observer* 13 (1): 1-11.

Rohingya Project. 2017. The Rohingya Survey 2017. *Rohingya Project* website.

Schia, Niels Nagelhus. 2018. "The Cyber Frontier and Digital Pitfalls in the Global South." *Third World Quarterly* 39(5): 821-837.

Schwab, Klaus. 2015. "The Fourth Industrial Revolution." *Foreign Affairs* 12 December.

Shin, Laura. 2017. "The First Government To Secure Land Titles On The Bitcoin Blockchain Expands Project." *Forbes*, 2 February.

Stankovic, Mirjana, Ravi Gupta, Bertrand A. Rossert, Gordon I. Myers, and Marco Nicoli. 2017. *Exploring Legal, Ethical and Policy Implications of Artificial Intelligence*. Washington, DC: Global Forum on Law, Justice and Development at the World Bank.

STATE v. LOOMIS (2016), 881 N.W.2d 749 (Wis. 2016) 754 (US).

Suominen, Kati. 2018. *Closing in on the Holy Grail on World Trade: Blockchain to Boost in Southeast Asia*. Geneva: International Centre for Trade and Sustainable Development (ICTSD).

Tan, Ashley and Jieqi Ng. 2015. *Digital Banking for Small and Medium-Sized Enterprises Improving Access to Finance for the Underserved*. Deloitte.

TE-FOOD. No date. "Livestock and Fresh Produce Traceability Platform." *TE-FOOD* on the Hungarian Ministry of Foreign Affairs and Trade Website.

Tripoli, Mischa, and Josef Schmidhuber. 2018. *Emerging Opportunities for the Application of Blockchain in the Agri-food Industry*. Rome and Geneva: Food and Agriculture Organization of the United Nations (FAO) and International Centre for Trade and Sustainable Development (ICTSD).

Tuan, Huu. 2017. "IT Manpower Facing Serious Shortfall in Quantity and Quality." *Vietnam Investment Review*, 26 April.

UNHCR - United Nations High Commissioner for Refugees. 2017. Operations: South East Asia 2017. *UNHCR* website.

Viet Nam News. 2018. "Blockchain to change world real estate market." *Viet Nam News*, February.

VietNamNet Bridge. 2017. "Vietnam Urged to Reform IT Training amid Demand for Workers." *VietnamNet Bridge*, 7 August.

VietNamNet Bridge. 2018. "Vietnam Lags behind Thailand in Use of Blockchain in Agriculture." *VietNamNet Bridge*, 14 May.

Wahl, Brian, Aline Cossy-Gantner, Stefan Germann, Nina R Schwalbe. 2018. "Artificial Intelligence (AI) and Global Health: How Can AI Contribute to Health in Resource-poor Settings?" *BMJ Global Health* 3(4).

WEF -- World Economic Forum and ADB -- Asian Development Bank. 2017. *ASEAN 4.0: What Does the Fourth Industrial Revolution Mean for Regional Economic Integration?* WEF and ADB White Paper.

WFP - The World Food Programme. 2018. "Building Blocks: Project overview." *World Food Programme* Website.

Wolfson, Rachel. 2018. "Understanding How IBM and Others Use Blockchain Technology to Track Global Food Supply Chain." *Forbes*, 11 July 2018.

World Bank. 2018a. *Doing Business 2018: Reforming to Create Jobs*. World Bank Group.

World Bank. 2018b. *Principles on Identification for Sustainable Development: Toward the Digital Age*. Washington, D.C.: World Bank Group.

World Economic Forum. 2015. *Deep Shift: Technology Tipping Points and Societal Impact*. Geneva: World Economic Forum.

WTO – World Trade Organization Secretariat. 2016. *Trade Finance and SMEs: Bridging the Gaps in Provisions*. Geneva: World Trade Organization.

WTO – World Trade Organization Secretariat. 2018. *World Trade Report 2018: the Future of World Trade: How Digital Technologies are Transforming Global Commerce*. Geneva: World Trade Organization.

www.ictsd.org

Other recent publications from ICTSD's Programme on Inclusive Economic Transformation include:

- Gender and Sanitary and Phytosanitary Measures in the Context of Trade: A Review of Issues and Policy Recommendations
  Spencer Henson, 2018

- Financial Services: The Trade and Gender Nexus.
  Ben Shepherd, 2018.

- Women-led Firms on the Web: Challenges and Solutions.
  Kati Suominen, 2018.

- Closing in on the Holy Grail of World Trade: Using Blockchain to Expand Southeast Asia's Trade.
  Kati Suominen, 2018.

- Voluntary Sustainability Standards and Gender Equality in Global Value Chains.
  Sally Smith, Federica Busiello, Georgia Taylor, and Elaine Jones, 2018.

- Gender and Sanitary and Phytosanitary Measures in the Context of Trade: a Review of Issues and Policy Recommendations.
  Spencer Henson, 2018.

**About ICTSD**
The International Centre for Trade and Sustainable Development (ICTSD) is an independent think and-do-tank, engaged in the provision of information, research and analysis, and policy and multistakeholder dialogue, as a not-for-profit organisation based in Geneva, Switzerland; with offices in Beijing and Brussels, and global operations. Established in 1996, ICTSD's mission is to ensure that trade and investment policy and frameworks advance sustainable development in the global economy.