

White Paper

Shaping ASEAN's Future Readiness

Collaborations to Advance Manufacturing and Production

In collaboration with A.T. Kearney

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Foreword



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The Fourth Industrial Revolution will have a tremendous impact on the Association of Southeast Asian Nations' (ASEAN) sizeable manufacturing industry of close to \$600 billion in value added, offering opportunities for growth but also challenging its current competitive position.

First, global value chains are continuing to shift, especially from East Asia, but are also increasing reshoring, creating both new production opportunities and challenges for ASEAN. Second, the quality of labour and higher productivity will be the new source of production advantages, putting pressure on the region's young and vibrant workforce. And finally, new technologies are disrupting and fostering a technology-based model of production, challenging especially the region's small to medium-sized enterprises (SMEs) that account for an estimated 70-90% of manufacturing companies in ASEAN.

The World Economic Forum's previous work on the readiness of countries for advanced manufacturing (*Readiness for the Future of Production Report 2018*), conducted together with A.T. Kearney, revealed very different levels of preparedness across ASEAN, reflecting also the different stages of economic development of its member states. The ASEAN region is aware of the opportunities and challenges presented by the Fourth Industrial Revolution, and several countries have already embarked on concerted programmes to accelerate their shift to higher manufacturing value-adding activities.

This White Paper examines the question of whether and what type of multilateral collaboration can help advance manufacturing and production in ASEAN. Although improving manufacturing initially appears to be more of a country-specific issue, our work reveals that multilateral collaboration is indeed not just helpful but also imperative to capture the opportunities presented by the future of production.

The findings surfaced six concrete opportunities that can be made into initial showcases of collaboration: (1) *Prototyping*: setting up 3D printing and prototyping centres of excellence; (2) *Smart packaging*: jumpstarting the development of smart packaging capabilities; (3) *Digital logistics*: supporting the development of digital logistics providers and solutions; (4) *Academy*: establishing a learning and competence academy for SMEs; (5) *Circular economy*: launching an education and adoption platform for sustainable manufacturing; and (6) *Seamless data*: creating seamless data exchanges for faster flow of goods. In addition, a series of other initiatives has been identified that sets the stage for the next wave of collaboration.

With these initiatives, ASEAN now has an opportunity to collectively start shaping the future of advanced manufacturing in the region.

We invite ASEAN's leaders to study the proposed action agenda and are looking forward to reactions and actions.

Executive summary

Manufacturing is at the centre of the Association of Southeast Asian Nations' (ASEAN) economy, accounting for more than 20% of the region's gross domestic product¹ and driving its continued growth and competitiveness. The Fourth Industrial Revolution is now bringing unprecedented changes to the region, putting it at risk of falling behind and allowing other regions to close their manufacturing competitiveness gap with ASEAN.

The World Economic Forum's previous work on the readiness of countries for the future of production showed that ASEAN member states have a very different level of preparedness and action orientation. While some countries in the region will certainly benefit from the opportunities brought by the future of production, others stand to lose if they are not able to accelerate the shift to more advanced manufacturing and production capabilities and technologies.

Multilateral collaboration has often been highlighted as a way to strengthen a region's economic resilience. Moreover, hyperconnected organizations and countries that can collaborate tend to fare best in rapidly changing environments.

The aim of this work was to understand what opportunities in ASEAN will drive the development of advanced manufacturing and production, and whether and what type of collaborations will increase the chances of success.

The work revealed the following:

- **ASEAN has tremendous opportunities to further improve its competitiveness.** A systematic approach helped pinpoint opportunities and pain points across both the production value chain (design, supply chain, manufacturing, distribution, reuse) and enabling actions (building new capabilities, improving production networks, strengthening ecosystems).
- **Over 30 collaboration opportunities were identified.** They can help address these opportunities and pain points across multiple industries and countries.
- **Five industries emerged as ideal test beds for industry-specific collaborations.** They have fair distribution of activity across countries and economic significance to the region, accounting for close to 30% of the region's manufacturing value added.
- **Six concrete opportunities were identified that can be enacted now.** They provide a model for ASEAN to start shaping the future of advanced manufacturing and production: (1) 3D prototyping centres, (2) smart packaging solutions, (3) digital logistics, (4) Fourth Industrial Revolution academy, (5) circular economy platform and (6) seamless data flows.
- **Multilateral and new collaboration models are imperative to realizing these opportunities.** These collaborations should be multilateral, leverage new platform-based production networks and foster more direct, proactive interventions to advance capabilities.

ASEAN has a tremendous opportunity in leveraging collaboration to strengthen its collective readiness and competitiveness for the future of production. While the region has a history of collaboration, deploying structured approaches to launch and scale up several of the identified priority ideas will be critical to building collaborative role models. This will also help to generate momentum that makes collaboration the way forward for advancing manufacturing and production in ASEAN.

1. The imperative to advance the future of production in ASEAN

The Fourth Industrial Revolution is bringing significant changes to the world's fifth-largest manufacturing economy and has been a key driver of ASEAN's growth. Member states have pursued different paths to remain competitive in the production landscape – some countries enacted strategic blueprints to deal with the disruption, while others are still building awareness across the production ecosystem.

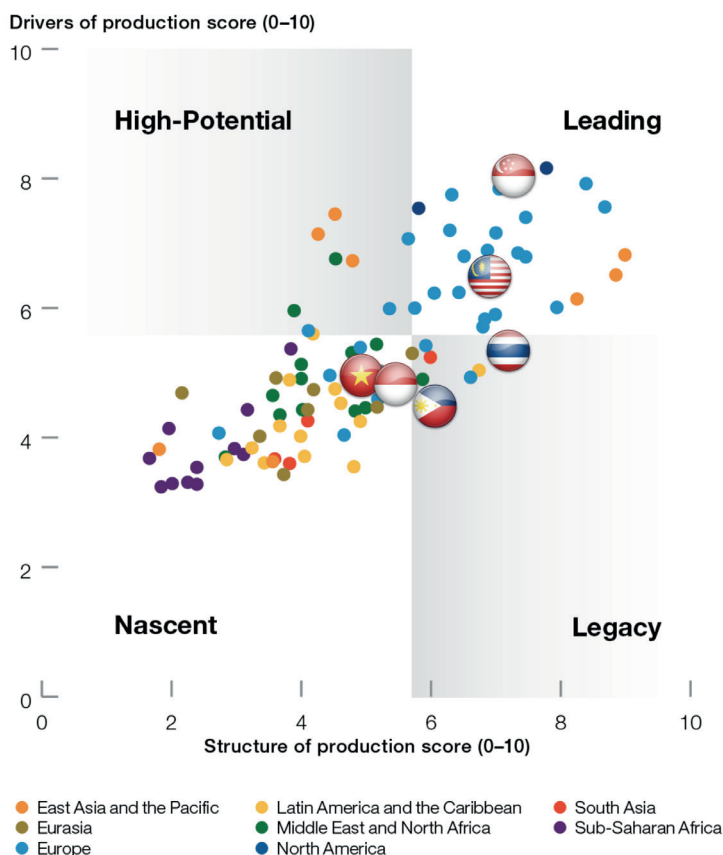
Based on the World Economic Forum Country Readiness Index for the future of production, a diagnostic tool developed in collaboration with A.T. Kearney, three country archetypes emerge in ASEAN (Figure 1): *Leading* (Singapore and Malaysia), *Legacy* (Thailand and the Philippines) and *Nascent* (Indonesia, Viet Nam and Cambodia).²

These three archetypes reflect the reality of ASEAN's situation, with member states in different stages of

economic development. This results in varying degrees of preparedness and action orientation to strengthen the drivers that define the readiness for the future of production.

ASEAN is at a crossroads. Two scenarios of manufacturing competitiveness can be envisaged based on how the region addresses the various drivers of production (Figure 2). The first, **multi-speed ASEAN**, is a less favourable scenario, where the region remains at the status quo and sees the differences in manufacturing competitiveness widen both within ASEAN and compared to other regions. The second, **ASEAN as a leading production hub**, is where the region collectively adapts its manufacturing and production capabilities to technological disruptions and capitalizes on its inherent strengths, further reinforcing its position as a globally leading production and technology development hub.

Figure 1: Global map of Readiness Assessment results 2018



Source: World Economic Forum in collaboration with A.T. Kearney.
Readiness for the Future of Production Report 2018

What is it?

The *Readiness for the Future of Production Report 2018*, developed by the World Economic Forum in collaboration with A.T. Kearney, measures how well positioned 100 countries are to shape and benefit from the changing nature of production.

Structure of production

Measures a country's existing production base:

- Complexity
- Scale

Drivers of production

Measures the factors and conditions necessary to capitalize on emerging production opportunities in the Fourth Industrial Revolution:

- Technology and innovation
- Skills and human capital
- Global trade and investment
- Institutional framework
- Sustainable resources
- Demand environment

Figure 2: Scenarios of shaping the future of production in ASEAN

	Multi-speed ASEAN	ASEAN as a leading production hub
Technology and innovation	Continuing to progress in a multi-speed manner, with only few members able to help its manufacturing companies adopt advanced manufacturing technologies	Collective and concerted efforts to develop localized and scalable technologies that advance ASEAN's common priority industries, the capabilities of small to medium-sized enterprises (SMEs) and overall competitiveness
Skills and human capital	Continuing reliance on low labour cost as a primary competitive advantage by most members	Leveraging ASEAN's demographic advantage to create a large-scale, highly skilled workforce that sees manufacturing as their future
Global trade and investment	Fragmented regional trade connectivity, reducing ASEAN's attractiveness as an integrated regional market	Well-integrated supply chains and trade networks that create a regional supply base and integrated market for local and global companies
Institutional framework	Legacy policies and digital infrastructure not updated and integrated, affecting the flow of data and goods	Standardized and harmonized approaches to enable the seamless flow of data and goods across the region
Sustainable resources	Resources still exploited and strained, negatively affecting ASEAN's reputation as a manufacturing location	Concerted shift to sustainable practices across production value chains, creating new market opportunities
Demand environment	Goods produced are basic and not tailored to local and regional opportunities, stemming growth of local manufacturers	Rapid prototyping and customization emerging as a core manufacturing skill to capture and retain regional value pools

Note. Scenarios were developed with a regional lens and exclude Singapore's outlook (i.e. Singapore is ahead of its regional peers, ranked 2nd for Drivers of Production based on the *Readiness for the Future of Production Report 2018*).
Source: A.T. Kearney analysis

The second scenario highlights not only that the future of manufacturing provides more opportunities for connectedness, but also that it will require greater connectedness to truly succeed, and for four reasons: (1) pooled resources will help scale up the building of new production capabilities, (2) shared knowledge will shorten learning and adaptation curves, (3) integrated ecosystems will create better visibility across increasingly interconnected production networks, and (4) connected and open platforms will foster co-creation of new solutions and products.

Hence, ASEAN must apply a new strategy and work closer together to shape its collective manufacturing and production capabilities and future competitiveness.

Multilateral collaboration is not new to ASEAN, but efforts now need to shift from being primarily focused on building political and security resilience to strengthening the region's knowledge and innovation as well as its economic and socio-environmental resilience.

However, collaboration between ASEAN countries and across industries is not straightforward. The disjointed structure between countries creates a disequilibrium in investment outcomes. Moreover, member states prioritize similar industries in their respective national economic strategies, possibly constraining collaborative opportunities

due to underlying competitiveness. Finally, an estimated 70-90% of manufacturing companies are SMEs,³ requiring focused and proactive interventions to strengthen their capabilities.

These factors need to be considered when identifying models for collaboration that advance the region's collective prospects and standing. The three collaborative thrusts that will be increasingly important for ASEAN are:

- **More multilateral initiatives:** a collective approach to align and harmonize the manufacturing and production capabilities, ecosystems and flows across the region
- **More platform models:** the creation of collaboration networks that minimize structural differences across countries and harness the strengths of different stakeholders
- **More direct, proactive interventions:** direct, focused interventions to develop more localized technologies and boost production capabilities, especially those of SMEs.

2. A new approach to uncover opportunities for collaboration in manufacturing

Given the inherent challenges, a systematic approach is needed to uncover collaboration opportunities that help ASEAN advance its manufacturing and production capabilities. The approach needs to be based on the opportunities and pain points existing in ASEAN's production value chain and to highlight whether and what type of collaboration will increase the chances of successfully addressing them.

With this mindset, the World Economic Forum, together with A.T. Kearney, developed a framework that applied two lenses – **production value chain activities** and supporting **enabling actions** (Figure 3).

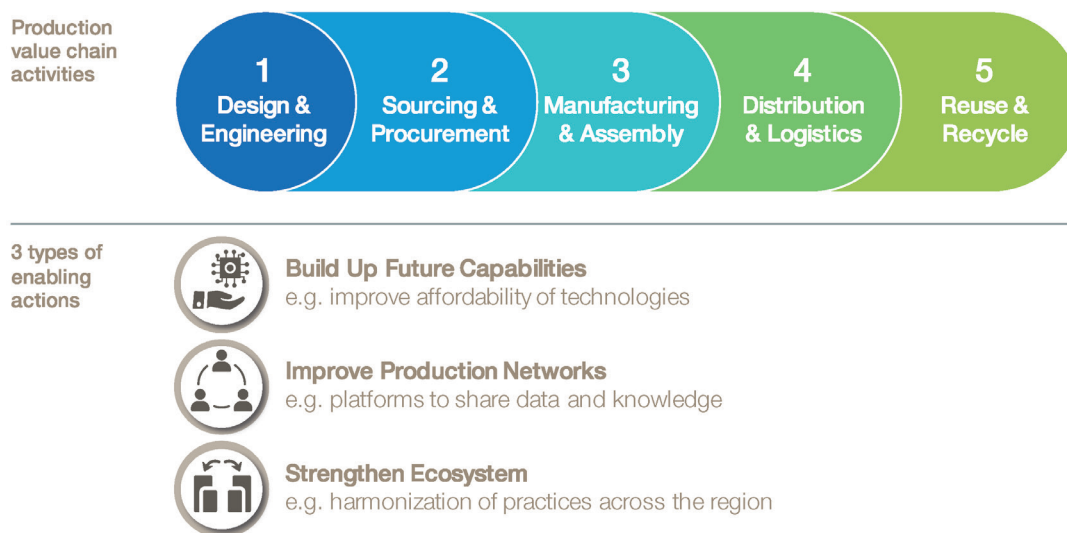
Within each cross section of these two lenses, common opportunities and pain points faced by ASEAN manufacturers were identified and assessed.

For most cross sections, the themes are broad-based, allowing ideas for collaboration to be applied across multiple industries.

Conversely, solutions uncovered in the *design and engineering and manufacturing and assembly* phases of the value chain tend to be industry-specific, as the constraints commonly faced by companies are dependent on the industry's specific materials and manufacturing processes.

To prioritize industry-specific, multilateral collaboration opportunities, 70 ASEAN industries were filtered, based on their economic significance to the region and level of distribution across multiple countries. Five strategic industries emerged as common regional priorities – electronic components, packaged foods, motor vehicles, pharmaceuticals, and auto parts and accessories (Figure 4).

Figure 3: Framework to identify manufacturing pain points and collaboration opportunities



Source: A.T. Kearney analysis

What are enabling actions?

Build up future capabilities: Collaborate in building up future production or technical capabilities (e.g. processes, skills, technologies) that individual firms struggle to build on their own

Improve production networks: Collaborate in areas that directly improve the scale at which capabilities are being deployed and create better visibility, linkages and knowledge sharing among players (e.g. through shared resources, access to platforms or testbeds)

Strengthen the ecosystem: Collaborate to strengthen enablers (e.g. standards, digital infrastructure, regulation, funding mechanisms) that will create a “future-ready” ecosystem across the regional production network.

Moreover, industry-specific collaborations are more likely to occur if the countries do not compete for a share of global exports, as with electronic components (Figure 5). Nevertheless, the opportunities in the remaining four industries were surprising. Although it is a static assessment of current capabilities and focus, the framework reflects a possible strong alignment of interests for the foreseeable future.

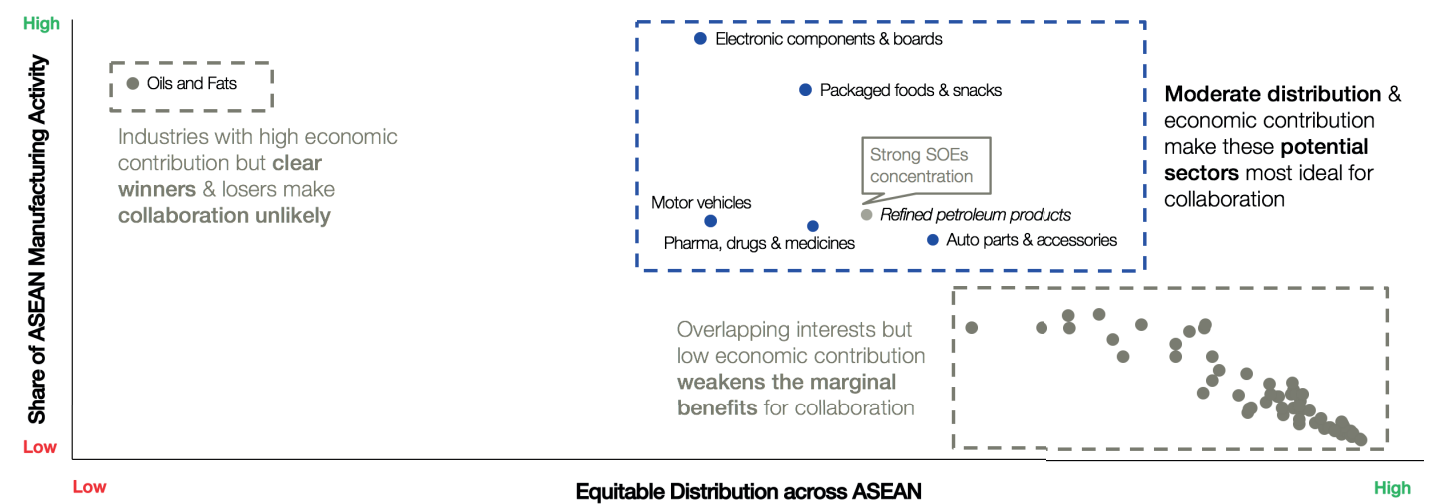
For these industries, the value chain/enabling action framework (Figure 3) was used to identify key pain points and opportunities that revealed several ideas for joint development of technology. More technology-focused collaboration opportunities exist and can be uncovered through further exploration into industry-specific manufacturing capabilities and processes.

For example, launching the joint development of autonomous and secure robotic metal fabrication will increase the outputs and safety of production lines. Such an improvement would benefit a range of industries that make up more than 30% of ASEAN's manufacturing activity.⁴ Certainly, this impact can only be realized in a safe and secure data environment.

From pain points to collaboration opportunities







Using the framework, several underlying themes emerged which then helped to identify and shape specific collaboration opportunities (see Annex 1 for details).

Figure 4: How the 70 ASEAN industries compare to each other
Share of activity in % of total MVA, distribution of intra-industry S.D. of each country



Notes: MVA = manufacturing value added; S.D. = standard deviation; SOE = state-owned enterprise
Sources: IHS Markit, Comparative Industry Service; A.T. Kearney analysis

Figure 5: The nature of the five industries with potential for collaboration
Based on patterns in gross output, exports and apparent consumption

	 SG	 MY	 TH	 PH	 ID	 VN	Likelihood for collaboration
Electronic components & boards	Export	Export	Domestic	Export	Domestic	Export	Low
Packaged food & snacks	Import	Domestic	Domestic	Domestic	Domestic	Import	High
Motor vehicles	Import	Domestic	Export	Domestic	Domestic	Import	Medium
Auto parts & accessories	Import	Domestic	Domestic	Domestic	Domestic	Import	High
Pharmaceuticals, drugs & medicine	Export	Domestic	Domestic	Import	Domestic	Import	Medium

Note: Presence is representative of the top three to five companies within each industry and product category.
Sources: IHS Markit, Comparative Industry Service; UN Comtrade; S&P Capital IQ Platform, using filters for industry classification, geographic locations, revenue (FY 2017) and headquarters of ultimate parent (<https://www.capitaliq.com/ciqdotnet/Screening/ScreenBuilderViper.aspx?UniqueScreenId=285935331&screenypeid=1&clear=all>); A.T. Kearney analysis

Build up future capabilities: Opportunities to upgrade resources, improve affordability and make facilities available for capability and technology development

An examination of ASEAN's production capabilities showed that many companies do not have access to or cannot afford to invest in the required new facilities, capabilities or technologies across many elements of the production value chain. Pooling resources, making advanced facilities and service capabilities available, and charting the development of localized and cost-effective technological solutions are key to strengthening manufacturing advantages and helping ASEAN companies compete at a global level.

For example, jumpstarting the development of smart packaging capabilities drives product safety and quality assurance for the food and pharmaceutical industries, which make up more than a fifth of ASEAN's MVA.⁵ Supporting the development of digital logistics providers allows ASEAN to capture emerging value pools, with the fleet and logistics internet-of-things (IoT) market forecasted to be \$20 billion by 2022.

Improve production networks: Opportunities to connect different players to scale up capabilities, foster knowledge sharing and increase visibility of technologies, suppliers and services

Limited understanding of required capabilities, technologies and local solutions commonly plague the region's manufacturing SMEs. Moreover, manufacturers (ASEAN and global) are unable to fully leverage the ASEAN business-to-business (B2B) market because of the limited visibility of available suppliers and supporting service providers. Pooling and connecting players will provide manufacturers with more efficient and wider supply chain and market access. It will also encourage sharing of learnings across all stakeholders. With less than 15% of ASEAN's manufacturing companies using advanced manufacturing practices,⁶ knowledge sharing is critical to boosting adoption and confidence.

Strengthen the ecosystem: Opportunities to harmonize standards, integrate digital infrastructures and advance skill levels to create a future-ready ecosystem

ASEAN's production ecosystem currently consists of varying country-specific data standards and disjointed cross-border processes, limiting not only market access but also a fast and seamless flow of goods in increasingly interconnected supply chains. Moreover, ensuring cross-border data security is critical, as cyberattacks can erode up to \$750 billion in market capitalization of ASEAN's companies.⁷ Aligning and harmonizing efforts across regional ecosystems will be important to get ASEAN prepared for the future.

This structured framework of themes and areas of opportunity, supported by interviews with experts and key stakeholders, resulted in a hotlist of about 30 initiatives for collaboration across the ASEAN production value chain (Figure 6; see also Annex 2 for details on each initiative).

A further prioritization was conducted based on three criteria: (i) *reach of impact* (to affect multiple industries or value chain activities), (ii) *ease of mobilizing a solid base of sponsors* (to leverage inherent interests), and (iii) *time horizon to achieve outcomes* (to get fast traction) (see Annex 3 for full details).

Six initiatives emerged as priorities and initial role models for collaboration: (1) **Prototyping**: set up 3D printing and prototyping centres of excellence (CoEs), (2) **Smart packaging**: jumpstart the development of smart packaging capabilities, (3) **Digital logistics**: support the development of digital logistics providers and solutions, (4) **Academy**: establish a learning and competence academy for SMEs, (5) **Circular economy**: launch an education and adoption platform for sustainable manufacturing, and (6) **Seamless data**: create seamless data exchanges for faster flow of goods.

In addition, five other initiatives have tremendous potential and should be considered by ASEAN as the next wave: (i) creating an *open consumer platform for analytics*, (ii) launching the *development of autonomous robots*, (iii) establishing a *crowdsourcing platform for design*, (iv) rolling out more *Digital Free Trade Zones*, and (v) establishing a common *cybersecurity action framework*.

Figure 6: Hotlist of action items

■ Prioritized for the short-term ■ Medium-term considerations
 Note. Value chain activities impacted by each action item are highlighted

 BUILD UP FUTURE CAPABILITIES	 IMPROVE PRODUCTION NETWORKS	 STRENGTHEN ECOSYSTEM
Prototyping Set up 3D printing & prototyping Centres of Excellence	Design Crowdsourcing Establish crowdsourcing platform for design	3D Printing Standards Harmonize standards for additive manufacturing
Advanced Materials R&D Create regional R&D centre(s) for advanced materials	B2B Marketplace Create ASEAN-wide digital marketplace for suppliers	Seamless Data Create seamless data flows for faster goods flows
Product Analytics Establish open consumer platforms for product life-cycle analytics	Catalogue Curate regional catalogue of Fourth Industrial Revolution technologies & lighthouses	Cybersecurity Align and enhance cybersecurity framework
Robotic Metal Fabrication Launch development of autonomous robots for metal fabrication processes	Showcases Set up regional Fourth Industrial Revolution showcase centres and testbeds	Skills Rubrics Jointly develop future skills rubrics and training programs
Smart Packaging Jumpstart development of smart packaging capabilities	Logistics Marketplace Create ASEAN-wide online logistics & distribution marketplace	Funding Programs Launch pan-regional funding programs for Fourth Industrial Revolution solutions
3D Printing Launch development of low-cost 3D printers for priority industries	DFTZs Roll out Digital Free Trade Zones across ASEAN	Tax Policies Align such policies for adoption of Fourth Industrial Revolution technologies
Quality Control Devices Launch development of intelligent quality control devices for priority industries	Autonomous Freight Control Set up regional control tower for future autonomous freight	Recycling Incentives Promote incentives for recycling biological material
Digital Twins Promote deployment of digital twins for heavy equipment	Academy Establish the Fourth Industrial Revolution Learning & Competence Academy for SMEs	
IoT Champion Advocate creation of regional IoT champion for logistics & fleet management	Circular Economy Launch education and adoption platform for sustainable manufacturing	
Digital Logistics Support the development of digital logistics providers & solutions	Used Materials Marketplace Set up digital marketplace for used materials	
Biodegradable R&D Create regional R&D centre(s) for bio-degradable, non-toxic plastics		

Note: Lighthouse = a leading organization or example in the field.
 Source: A.T. Kearney analysis

3. From opportunities to action

Prototyping: Set up 3D printing and prototyping centres of excellence

3D printing and rapid prototyping technology are on the verge of disrupting traditional manufacturing. These technologies will push production of goods closer to consumers and allow products to be cost-effectively customized to consumer needs. This presents a huge emerging value pool; for example, the automotive 3D printing materials market is estimated to be valued at \$570 million by 2024.⁸

Despite the large market opportunity, ASEAN companies cannot meet the needs of the materials prototyping market. Based on A.T. Kearney's global 3D Printing Index, most of the region's countries are behind in the 3D printing adoption curve. Singapore was the first to launch initiatives as part of its Smart Nation ambition and is now seen as one of the leaders globally. Malaysia, Indonesia and Viet Nam are following Singapore's footsteps, but are still lacking the technology infrastructure, capabilities and innovation to fully capitalize on this technology. Most importantly, most manufacturing companies in ASEAN lack the capital and knowledge to set up their own 3D printing and prototyping facilities.

When examining successful 3D printing ecosystems, three building blocks emerged: (1) *commitment from the country's government*, typically funding for the build-up of capabilities and facilities; (2) *extensive public-private partnerships (PPPs)* of government, manufacturers and 3D printer makers teaming up to develop solutions; and (3) *industry-specific solutions* with clear focus on developing solutions

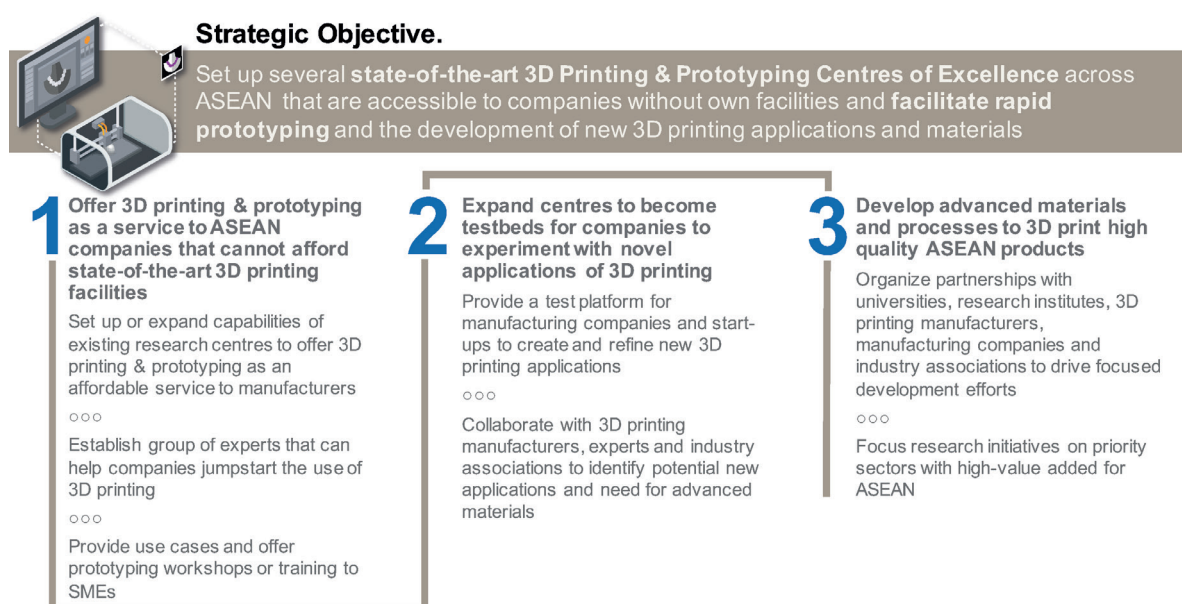
to address the industry's needs (e.g. rapid prototyping for high-precision plastic manufacturing).

In ASEAN, Singapore has already developed a lighthouse for 3D printing – the National Additive Manufacturing Innovation Cluster (NAMIC). The institution has over 850 companies involved and has set up shared 3D printing centres across the country.

This provides an opportunity for ASEAN to collaboratively scale up and expand successful models like NAMIC into a multi-country initiative. Therefore, ASEAN should create a series of **3D printing and prototyping CoEs** that allow companies to understand 3D printing and provide access to rapid prototyping facilities (Figure 7).

In the near term, ASEAN should set up a network of CoEs across the region. These centres will focus on facilitating access to prototyping and bridging the connection between 3D printing players and users to create a powerful panel of experts that can help provide solutions to the evolving industry needs. Over time, these CoEs should build up capabilities to develop new 3D printing materials and processes, putting the region at the frontier of advances in technology. Given the right conditions, they can eventually scale up and steer the technology towards the next generation of more distributed and localized production and consumption.

Figure 7: Overview of prototyping – strategic objective and key initiatives



Source: A.T. Kearney analysis

Smart packaging: Jumpstart the development of smart packaging capabilities

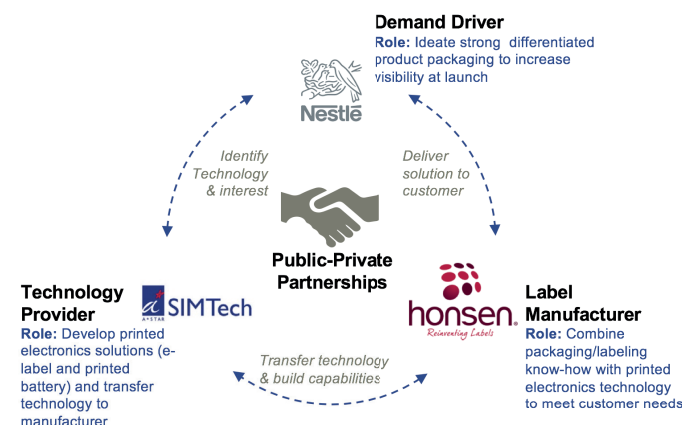
In recent years, an increase in major food-related crises in ASEAN countries has led to outbreaks of food contamination, food product recalls and suspended exports. For example, food loss arising from damage and/or spoilage ranges from 30-70% in developing ASEAN countries, an alarming figure compared to the 1.5% to 5% rates in developed countries. Although safe food handling practices and more stringent food screening is in place, concerns about food quality and safety standards for ASEAN products still exist, especially as products are increasingly being consumed further away from production sources.

A key solution is **smart packaging**, or packaging material that contains an intelligent component to detect changes in freshness or safety, keep live records and ensure traceability. Smart packaging is already gaining ground in developed countries such as the United States (Identiv), Canada (Bizerba), Sweden (Vitsab) and the United Kingdom (Timestrip).

In ASEAN, a PPP between Nestlé, Honsen and SIMTech is developing the first e-label solution (Figure 8) and is compelling in two aspects: (1) *Nestlé's involvement in the co-creation of solutions*, which helps increase awareness among food companies; and (2) the *collaboration between packaging and technology providers*, which allows the transfer of capabilities to better serve the food and beverage (F&B) market.

Given the crucial importance of the F&B and pharmaceutical industries (20% of ASEAN's MVA), the region should further emulate this PPP and transform food safety into a large-scale project.

Figure 8: Nestlé-Honsen-SIMTech PPP



Source: A.T. Kearney analysis

There is clear value for the region to **jointly pioneer the development and cost-efficient manufacturing of smart packaging solutions** and foster their rapid integration into the F&B industry (Figure 9).

In the short term, partnerships involving advanced electronics research institutes like SIMTech should be established to co-develop smart packaging solutions. Involvement of F&B companies will be critical as deeper technology understanding increases the likelihood of adoption and the "push" of solutions into the market.

In parallel, regulations should be put in place to encourage innovation in smart packaging as well as increase compliance and adoption by the food industry. This will help smart packaging manufacturers to scale up production and exports of ASEAN-made intelligent food packaging modules, and in turn establish strong credibility of ASEAN food industry standards.

Figure 9: Overview of smart packaging – strategic objective and key initiatives



Source: A.T. Kearney analysis

Digital logistics: Support the development of digital logistics providers and solutions

ASEAN has always been recognized as a cluster of countries strategically positioned astride vital trade routes, as reflected by the strong growth in flow of goods both domestically and across the region. ASEAN exports of manufactured goods have grown from \$660 billion in 2010 to \$900 billion in 2017.⁹ Intra-regional trade accounts for more than 20% for eight out of the 10 ASEAN countries.¹⁰ Intra-ASEAN investment has also been steadily increasing over the years and accounts for a quarter of total foreign direct investment flows,¹¹ with manufacturing a major part. In the backdrop of a greater flow of goods, countries such as Indonesia, the Philippines and Viet Nam are trying to reduce their logistics costs to improve competitiveness. Efficient logistics and connectivity of supply chains reduce trade costs and boost integration of respective economies in regional and global value chains.

Smart logistics in ASEAN has increased in importance thanks to this significant flow of goods. *Optimized operations* (e.g. route optimization), *connected networks* (e.g. resource aggregation platforms) and *improved customer experience* (e.g. parcel locker networks) are just several basic expectations of trade partners. However, the logistics of ASEAN SMEs are not developed enough to capture and capitalize on these growing demands. Moreover, SMEs lack the understanding and access to smart logistic capabilities. In Indonesia, only 25% of SMEs

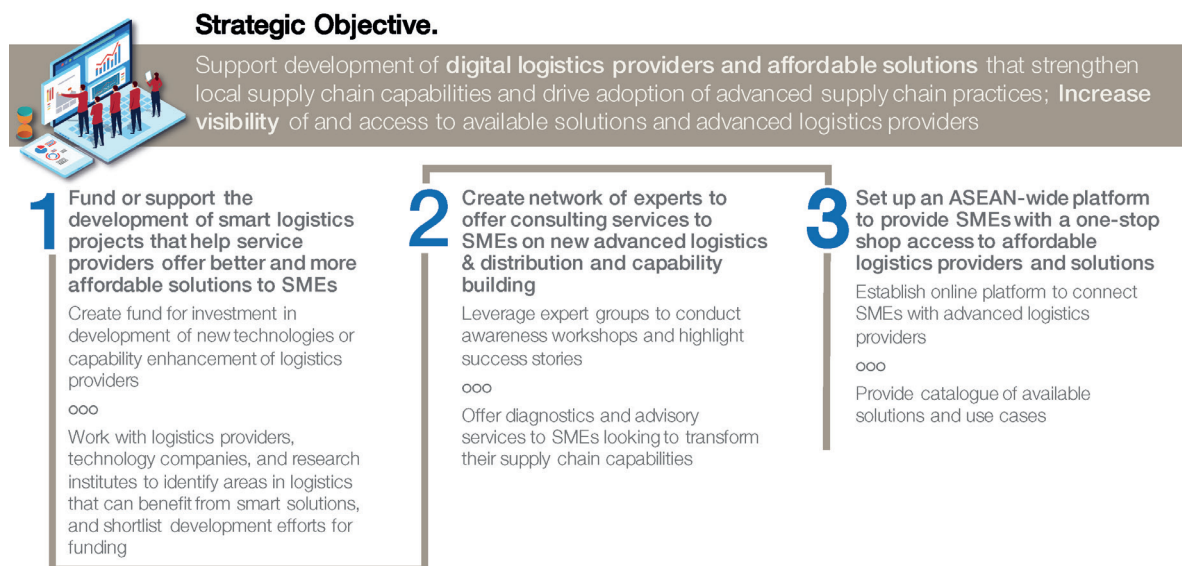
have adopted supply chain management software. In Viet Nam, less than 10% of SMEs use technology to manage logistics and distribution.¹²

Globally, multi-country efforts at collaboration seek to address similar gaps in logistics solutions. The European Union (EU), for example, has set up the Alliance for Logistics Innovation through Collaboration in Europe, an industry-led, EU-funded multistakeholder initiative. This institute focuses on developing technology platforms for research, innovation and market deployment of logistics and supply chain management. Other regions have established logistics portals to connect trade and logistics partners (Panama) or even invested in service providers to enhance their technology capabilities (East Africa).

ASEAN, too, can collaboratively address the current gap by **supporting the development of capable and affordable service providers** that can provide smart logistics solutions (Figure 10).

To initiate this, ASEAN should focus on identifying a list of logistics categories that can benefit from collaborative smart solutions (e.g. warehousing, inventory management, freight shipping). An organized panel of experts and solution providers should then be appointed for developing and executing solutions, advancing the capabilities of ASEAN-based providers and building a catalog of successful case studies of ASEAN SMEs that revamp their logistics operation.

Figure 10: Overview of digital logistics – strategic objective and key initiatives



Source: A.T. Kearney analysis

Academy: Establish the Fourth Industrial Revolution Learning & Competence Academy for SMEs

Since the advent of the Fourth Industrial Revolution, ASEAN and its individual member states have pushed to increase understanding of the technological disruption and to drive adoption of capabilities to make SMEs ready for the future. Thailand launched Thailand 4.0, for example, to connect local SMEs with the global community and encourage technology transfer to local businesses. The initiative also provides financial support to boost production capabilities. Similarly, Indonesia recently launched Making Indonesia 4.0 to improve its labour productivity and drive a shift to higher MVA in priority industries.

Each member state has similar challenges to address, especially as SMEs make up an estimated 70-90% of manufacturing companies in most countries.¹³ ASEAN needs an interactive learning environment that builds on existing initiatives and supports manufacturing SMEs in their transformation journeys to advanced manufacturing.

The IMP³rove Academy is a successful catalyst that helped develop a similar learning environment and ecosystem. Established by the EU in 2006, it builds innovation capabilities among SMEs (Figure 11) and has helped nearly 5,000 of them assess their innovation capabilities and conduct extensive training support to enhance innovation management practices.

ASEAN should **similarly establish an academy to help SMEs understand the requirements of the future of advanced manufacturing and production and how to adapt** (Figure 12). IMP³rove is already expanding its

Figure 11: What does the IMP³rove Academy do for SMEs?

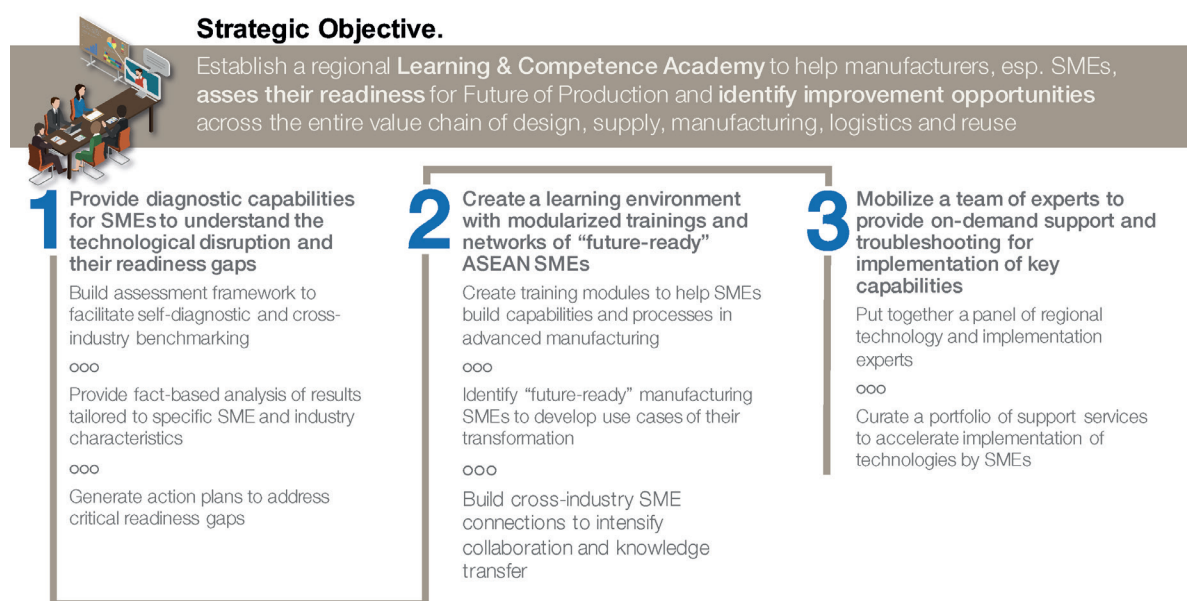


Source: A.T. Kearney analysis

programme to the Fourth Industrial Revolution and could be used as a platform for ASEAN.

To begin realizing this opportunity, workshops between member states, ASEAN agencies and IMP³rove Academy representatives should be held to gather insights on the IMP³rove collaboration success story and develop an ASEAN-specific academy. A list of key manufacturing technologies should be established together with a think tank of experts that will steer the diagnostics framework, implementation of technologies, training curricula and consultation support. Ultimately, the Fourth Industrial Revolution Learning & Competence Academy should grow to become a vital platform for manufacturing SMEs to leverage as they adapt to advanced manufacturing.

Figure 12: Overview of the Fourth Industrial Revolution academy – strategic objective and key initiatives



Source: A.T. Kearney analysis

Circular economy: Launch an education and adoption platform for sustainable manufacturing

It is no surprise that the increase in domestic consumption in all ASEAN countries has led to an influx of waste. In electronics (15-20% of ASEAN MVA¹⁴), 3 million tons of e-waste were accumulated in ASEAN in 2017,¹⁵ but with a limited core return (i.e. retained product or components) of e-waste. For example, Singapore only registered 8% of core return, far lower than the EU's requirement of 45%.

Waste also presents a sizeable market opportunity, with the global e-waste management market expected to grow at a compound annual growth rate of 21% to \$5 billion by 2020.¹⁶ For ASEAN to capture a share of this market, significant efforts are needed to change the behaviour of manufacturing companies.

Currently there is a lack of interest in environmental issues and of understanding e-waste as a commercial opportunity. The majority (89%) of chief executive officers in ASEAN believe that the foundation of change must come from government efforts on sustainability measures, incentives, regulations, standards and taxation.¹⁷

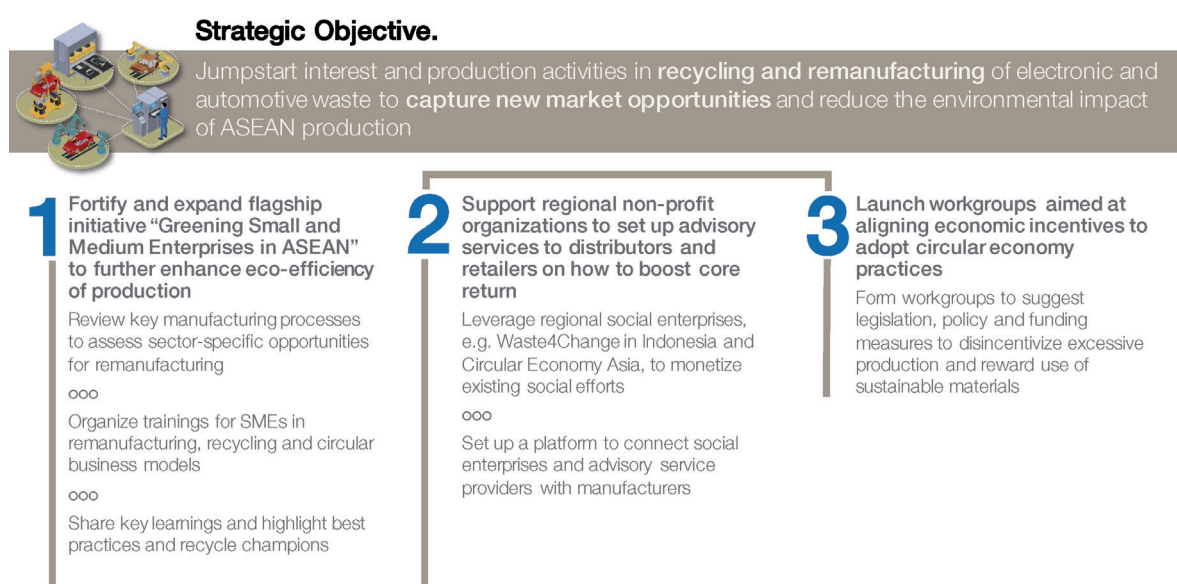
For ASEAN, evolving consumption patterns that lead to an increase in e-waste are requiring the move to a circular economy. To drive the needed shift in behaviour, efforts must focus on creating a stronger awareness of benefits and practices, as well as a rebalancing of incentives to improve convenience, cost and rewards for companies engaged in the circular economy.

ASEAN is already actively trying to accelerate the development of a more sustainable manufacturing ecosystem. Greening Small and Medium Enterprises in ASEAN is an aspirational initiative to boost the capacity for innovation and of greening businesses using technology. It aims to involve over 80% of businesses and could cover 60% to 90% of total ASEAN employment. Given the increasingly pressing issue of waste, this programme now needs to focus on producing impact and tangibly improving the visibility of circular economy projects.

The initiative is a good start but needs to be substantially enhanced. Further collaboration efforts are needed to **jumpstart interest and production activities in recycling and remanufacturing of waste** (Figure 13) and to create a step change in awareness, mindsets and behaviours.

To accelerate this effort, ASEAN should collaboratively review manufacturing processes to identify quick wins and easy adaptations that translate into less waste and lower production costs. Expert and knowledge-exchange networks, advisory services, training in remanufacturing, recycling and circular business models should be established to increase understanding and boost core returns. In the longer run, ASEAN-wide regulations and incentives for recycling and remanufacturing, especially in the region's core industries of auto parts and electronic components, should be enacted to change to more sustainable manufacturing practices.

Figure 13: Overview of the circular economy – strategic objective and key initiatives

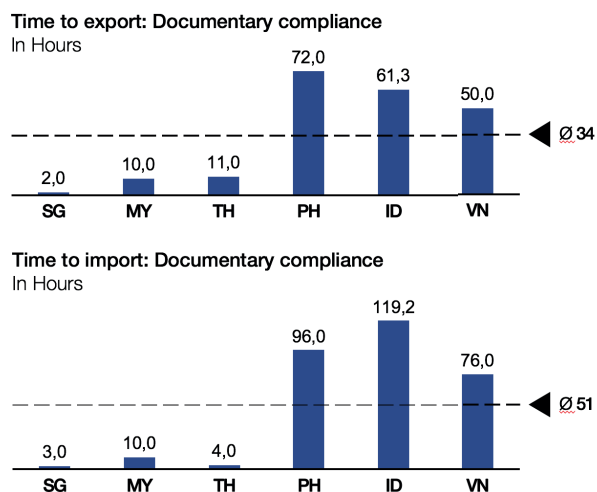


Source: A.T. Kearney analysis

Seamless data: Create seamless data exchanges for faster flow of goods

As trade flows increase in ASEAN countries, especially intra-regionally, the demand for a more seamless and quicker flow of data is expected to cater to expedited clearance of goods. However, standards and the level of sophistication of digital infrastructures vary between member states, leading to large differences in cargo processing time (Figure 14) and resulting trade inefficiencies.

Figure 14: Time taken to complete documentary compliance



Source: World Bank, 2018. Doing Business Database, "Trading across borders/Data" (<http://www.doingbusiness.org/data/exploretopics/trading-across-borders>), extracted January 2018

ASEAN has taken a positive step to resolve this by establishing the ASEAN Single Window (ASW), a regional initiative that connects and integrates the National Single

Windows (NSWs) of member states. The objective is to securely connect all NSWs and integrate the electronic exchange of shipment information, reducing cost and time of doing business and enhancing trade competitiveness.

However, several challenges could impede its success. The ASW, for instance, only acts as a gateway to integrate NSWs. Each country still requires its own NSW (based on national requirements) before developing an interface with the ASW. Additionally, no regional mandate exists to standardize exchange protocols. As a result, manual clearance processes that interrupt the flow of goods are expected to continue.

Without the standardized, seamless and secure flow of data, ASEAN is at risk of falling behind in developing a "digital single market", an aspiration the EU is already working towards. The EU is using key enablers of production (e.g. cloud computing, the IoT) to increase interoperability and enable the seamless flow of goods.

To achieve similar results, ASEAN should **improve its data infrastructure and establish common standards for formats, quality, usage, rights and exchange protocols** to achieve a better regional flow of production goods (Figure 15).

Key pain points in intra-ASEAN trade related to data flow must be identified to prioritize problem-solving efforts. The relevant agencies should then launch joint projects to fully digitize cross-border documents. This should be supported by state-of-the-art systems enabled by blockchain, IoT and other relevant technologies. Efforts should focus on having different data formats "speak to one another" on a common platform, leveraging ongoing public and private initiatives. In the longer run, this will encourage international alliances with other regions and further boost ASEAN's competitiveness in the trade of production goods.

Figure 15: Overview of seamless data – strategic objective and key initiatives



Source: A.T. Kearney analysis

4. Conclusion – A call for action

ASEAN is at a crossroads as the Fourth Industrial Revolution drives fundamental changes to the region's manufacturing ecosystem. This will especially affect SMEs, the vital backbone of ASEAN's manufacturing competitiveness, increasing the need for new capabilities to be built and scaled up, and at an accelerated pace.

Multilateral and public-private collaboration across ASEAN can capitalize on the strengths of each country to address critical pain points and propel the region and its production networks to be ready for the future.

While collaboration might seem obvious (and ASEAN has a history of collaboration), a shift in thinking and approach is nevertheless needed. The focus on individual competitive advantages must be rethought; this work highlighted important opportunities even in common strategic priority sectors. Launching and expanding several initiatives will be crucial, as will generating the momentum that makes collaboration the way forward for ASEAN.

The six priority initiatives identified provide this new platform and allow ASEAN to start collectively shaping a stronger future for advanced manufacturing and production in the region. To get started, a series of actions are suggested:

- **Focus on a few specific opportunities** first and make them successful role models for collaboration.
- **Build on existing initiatives and take inspiration** from similar initiatives in other countries or regions. NAMIC as a platform for prototyping centres, or IMP3rove Academy as a model for the academy, are examples that can be leveraged effectively.
- **Create a strong set of sponsors** and supporting stakeholders. Expansive public-private partnerships are most effective in creating both government and business support, and are already being pursued in ASEAN.

- **Establish a clear governance structure** that ensures multi-country participation and drives progress. Steering committees are needed to create a common action framework, monitor progress regularly and drive regulatory changes where required. This is particularly important for initiatives such as seamless data that require major changes across countries.
- **Figure out the funding**, especially for developing technology in common priority industries. ASEAN will benefit from the development of new, localized and cost-effective technologies that overcome current pain points. While many of the region's countries have sufficient technology funds, these might need to be redirected toward manufacturing and aligned across countries.

Government and business leaders need to equally contribute to this new paradigm of collective problem-solving across regional production value chains and ecosystems. As a next step, ASEAN leaders are invited to champion the suggested priority initiatives and refine the action agendas to enact them as impactful role models for collaboration.

Annex 1: Analysis framework for identifying opportunities

Design & Engineering	Sourcing & Procurement	Manufacturing & Assembly	Distribution & Logistics	Reuse & Recycle
<p>Build up production capabilities</p> <p>Which capabilities to bolster through collaboration – processes, skills or technologies</p>	<p>Managing supply chains across a large network of suppliers is crucial to achieving competitive advantages.</p> <p>Many ASEAN companies lack advanced and digital supply chain capabilities.</p>	<p>Advancing production capabilities and moving to higher-value activities are critical for ASEAN companies to maintain manufacturing advantages.</p> <p>Adoption and development of new capabilities and technologies are constrained by lack of awareness and high set-up costs. Solutions need to be industry-specific as they are shaped by the materials and processes involved throughout specific production lines.</p>	<p>Managing logistics and warehousing, and tracking the movement of goods across large distribution networks, are key to market success.</p> <p>Many ASEAN companies lack advanced and digital logistics and distribution capabilities.</p>	<p>Integrating recycled or highly biodegradable materials into products and adopting circular business models help companies reduce waste, minimize impact on the environment and reposition with customers.</p> <p>Manufacturing companies currently focus on cost-effectiveness before considering the impact on the environment.</p>
<p>Pooling resources, capabilities and information helps companies produce better outcomes; through co-design, for example, companies can enhance existing offerings and create new ones.</p> <p>ASEAN SMEs have limited understanding of required capabilities and lack the ability to scale up.</p>	<p>Connecting to a large network of suppliers and manufacturers provides local companies with more options across their supply chains.</p> <p>Manufacturers do not fully benefit from the ASEAN B2B market due to limited visibility and lack of unified sourcing platforms across the region's diverse and fragmented SME supplier base.</p>	<p>Connecting manufacturers with technology and service providers and sharing learnings are critical to boost understanding of the need for adoption and confidence in available market offerings.</p> <p>Manufacturers in the region need guidance on which technologies to watch, which local solutions are available and how to prioritize investment decisions.</p>	<p>Connecting to advanced logistics and warehousing providers, as well as linking to regional/global distribution and e-commerce platforms, provides local manufacturers with more efficient and wider market access.</p> <p>Manufacturers have limited digital marketing capabilities and lack visibility on solutions that enable more efficient distribution networks.</p>	<p>Raising awareness on sustainable manufacturing practices and pooling resources to maximize the use of assets and reuse of materials foster an overall reduction in carbon footprints of ASEAN's manufacturers.</p> <p>Manufacturing companies lack a clear understanding of carbon footprint measures and do not actively pursue asset optimization beyond their own local operations.</p>
<p>Strengthen the ecosystem</p> <p>How to ensure a pan-ASEAN ecosystem with standards, digital infrastructure, regulation and funding mechanisms</p>	<p>Harmonizing standards, job certifications and policies fosters consistent quality in design and engineering across the region.</p> <p>To date, SMEs follow varying country-specific standards (pertaining to design and quality), which limit the extent of their design and engineering capabilities that can be scaled across ASEAN.</p>	<p>National talent development and funding mechanisms help build future-ready skills and support accelerated adoption of technologies.</p> <p>Only a few ASEAN countries have policies and initiatives that properly incentivize companies to adopt new technologies and prepare the workforce for the transition and emerging specialized jobs.</p>	<p>Harmonizing data standards and building a secure data exchange ecosystem are critical to ensuring a fast and seamless flow of goods across regional distribution networks.</p> <p>Cross-border processes within ASEAN can be lengthy and costly to businesses, preventing them from growing outside local markets.</p>	<p>Creating and aligning environmental policies help incentivize companies to minimize their carbon footprint and waste production, and to reduce soil and water pollution.</p> <p>Most national manufacturing programmes do not integrate environmentally friendly initiatives into their operations beyond activities related to corporate social responsibility.</p>

Source: A.T. Kearney analysis





Annex 2: Action agenda for ASEAN

Nearly 30 ideas were identified for collaboration across the ASEAN production value chain.













Build up future capabilities

Action item	What is it?	Activity
Prototyping: Set up 3D printing and prototyping centres of excellence	<ul style="list-style-type: none"> Set up several state-of-the-art 3D printing and prototyping centres of excellence that can be used by companies without own facilities and can provide access to leading experts Facilitate rapid prototyping for companies to meet increasing customer requirements for fast customized design turnarounds 	
Advanced materials research and development (R&D): Create regional R&D centre(s) for advanced materials	<ul style="list-style-type: none"> Launch regional R&D centre(s) to capture growth in the use of advanced materials and strengthen ASEAN's capability in applying smart, lightweight and resistant materials Help companies move up the value chain in industries such as automotive while consistently reducing product costs and improving product characteristics 	
Product analytics: Establish open consumer platforms for product life-cycle analytics	<ul style="list-style-type: none"> Establish open, consumer-based platforms to support easy and affordable ways of consolidating and analysing product life-cycle data and improve future products or designs Enable companies, especially SMEs, to better understand product information (e.g. usage, performance) and improve future designs 	
Robotic metal fabrication: Launch development of autonomous robots for metal fabrication processes	<ul style="list-style-type: none"> Launch regional development effort for autonomous robots applied to metal fabrication processes (impacting 30% of the region's manufacturing activity) to create more efficient and safer manufacturing operations 	
Smart packaging: Jumpstart development of smart packaging capabilities	<ul style="list-style-type: none"> Pioneer development and cost-efficient manufacturing of smart packaging for the food industry (20% of ASEAN's gross domestic product) Improve product quality and safety and meet the growing importance of accurately capturing and sharing information related to traceability and freshness 	
3D printing: Launch development of low-cost 3D printers for priority industries	<ul style="list-style-type: none"> Undertake regional development effort for low-cost 3D printers with initial focus on the automotive industry (11% of ASEAN's manufacturing value added) Lower the financial barrier of using 3D printing at scale, allowing ASEAN players to penetrate and be competitive in producing highly customized products 	
Quality control devices: Launch development of intelligent quality control devices for priority industries	<ul style="list-style-type: none"> Launch regional development effort for intelligent and cost-effective quality control devices (e.g. sensors, artificial intelligence) tailored to ASEAN's priority industries Enable accurate and efficient product quality inspection, improving production outputs and safety for end users 	

Digital twins: Promote deployment of digital twins for heavy equipment	<ul style="list-style-type: none"> Promote and showcase the deployment of digital twins (i.e. virtual replicas of physical devices) for heavy equipment, such as commercial vehicles and agricultural machinery Demonstrate the value of capturing real-time data on usage and performance to improve product design, maintenance and customer experience 	
IoT champion: Advocate creation of regional IoT champion for logistics and fleet management	<ul style="list-style-type: none"> Advocate creation of joint regional IoT champion for logistics and fleet management, e.g. through regional telco consortium (Axiata, Singtel and Telenor cover most ASEAN markets) Pool existing efforts to reduce costs and talent constraints, and eliminate duplicated work in developing a fragmented suite of services with limited scale 	
Digital logistics: Support development of digital logistics providers and solutions	<ul style="list-style-type: none"> Support development of advanced logistics providers and affordable solutions for SMEs that strengthen local supply chain capabilities Increase visibility of available solutions and provide access to a broad suite of logistics providers 	
Biodegradable R&D: Create regional R&D centre(s) for biodegradable, non-toxic plastics	<ul style="list-style-type: none"> Set up or support regional R&D efforts for biodegradable, non-toxic plastics and other unconventional raw materials for use in the production value chain Pool resources to more affordably co-develop new solutions and reposition ASEAN's standing in the circular economy 	

Improve production networks

Action item	What is it?	Activity
Design crowdsourcing: Establish crowdsourcing platform for design)	<ul style="list-style-type: none"> Establish an ASEAN crowdsourcing and collaboration platform for design, based on a network of product developers, designers and end customers Provide SMEs with one-stop access to locally relevant design and testing capabilities 	
B2B marketplace: Create ASEAN-wide digital marketplace for suppliers	<ul style="list-style-type: none"> Create an ASEAN-wide online supplier marketplace to list and connect regional suppliers, especially SMEs, to regional and global buyers 	
Catalogue: Curate regional catalogue of Fourth Industrial Revolution technologies and lighthouses	<ul style="list-style-type: none"> Curate a catalogue of ASEAN-accredited technologies and showcase regional lighthouses in applying these technologies Help ASEAN companies in making informed decisions on investing in technology and implementing decisions 	
Showcases: Set up regional Fourth Industrial Revolution showcase centres and testbeds	<ul style="list-style-type: none"> Set up centres and testbeds to educate SMEs on availability and applicability of advanced manufacturing and logistics technologies and processes (only 10-15% of ASEAN companies currently use these technologies) Leverage competences, experiences and facilities of leading manufacturing and service provider multinational corporations 	
Logistics marketplace: Create ASEAN-wide online logistics and distribution marketplace	<ul style="list-style-type: none"> Create this marketplace to list and connect manufacturing companies to service, logistics, warehousing and distribution providers 	
Digital Free Trade Zones: Roll out DFTZs across ASEAN	<ul style="list-style-type: none"> Roll out additional DFTZs with advanced warehousing facilities, expedited goods clearance processes and a link to regional/global e-commerce/trading platforms Expand on Malaysia's initiative of setting up the world's first DFTZ 	
Autonomous freight control: Set up regional control tower for future autonomous freight	<ul style="list-style-type: none"> Set up a regional control tower for the future operation of autonomous trucks to launch Green Freight Corridors across the ASEAN highway network (long distance freight transport corridors where advanced technology is used to achieve energy efficiency and reduce the environmental impact) 	
Academy: Establish the Fourth Industrial Revolution Learning & Competence Academy for SMEs	<ul style="list-style-type: none"> Establish this regional academy to help manufacturers, especially SMEs, assess their readiness for advanced manufacturing and identify improvement opportunities across the entire value chain of design, supply, manufacturing, logistics and reuse 	
Circular economy: Launch education platform for sustainable manufacturing	<ul style="list-style-type: none"> Launch a regional platform to raise awareness and benefit understanding of recycling, reusing, and reducing costs sustainably in manufacturing Share key learnings and highlight best practices and recycle champions 	
Used materials marketplace: Set up digital marketplace for such materials	<ul style="list-style-type: none"> Set up ASEAN-wide digital marketplace for buying and selling used materials (plastics, rubber, fabric and scrap metal), both vertically and horizontally across industries 	

Strengthen the ecosystem

Action item	What is it?	Activity
3D printing standards: Harmonize standards for additive manufacturing	<ul style="list-style-type: none"> Harmonize process, materials and certification standards for additive manufacturing to ensure design quality considerations are common across ASEAN countries 	
Seamless data: Create seamless data exchanges for faster flow of goods	<ul style="list-style-type: none"> Harmonize data standards by establishing common guidelines on data usage, rights, quality and exchange protocols (e.g. Application Programming Interfaces, blockchain) to achieve interoperability and sustained adoption of big data Focus initially on logistics to support faster and seamless cross-regional flows of goods and clearance 	
Cybersecurity: Align and enhance cybersecurity framework	<ul style="list-style-type: none"> Align and enhance regional cybersecurity framework for identifying security risks, keeping data safe and strengthening ASEAN's cyber-resilience across increasingly interconnected regional supply chains 	
Skills rubrics: Jointly develop future skills rubrics and training programmes	<ul style="list-style-type: none"> Advance a workforce prepared for the future by equipping students and professionals with Fourth Industrial Revolution skills through updated skills rubrics, education programmes and expert certification schemes at all stages of the value chain Share learning and best practices and create a common set of requirements for reskilling the existing workforce and developing the future one 	
Funding programmes: Launch pan-regional funding programmes for Fourth Industrial Revolution solutions	<ul style="list-style-type: none"> Launch pan-regional technology and innovation funding programmes for companies collaborating across ASEAN to develop new solutions for priority industries Align and pool resources and purposefully support cross-regional efforts 	
Tax policies: Align such policies for adoption of Fourth Industrial Revolution technologies	<ul style="list-style-type: none"> Align tax policies, incentivizing companies to adopt technologies in manufacturing to create a joint regional boost to adoption 	
Recycling incentives: Promote incentives for recycling biological material	<ul style="list-style-type: none"> Create dedicated incentives for producers to collect biological materials and recycle them as new products, fertilizers or as a source of biomass power generation Raise interest among manufacturing companies and put ASEAN on the path to more environmental practices 	

Source: A.T. Kearney analysis

Annex 3: Prioritizing the leadership agenda

	Action item	Medium-term considerations			Reach of impact	Availability of sponsors	Timeliness
		High	Medium	Low			
Build up production capabilities	Prototyping: Set up 3D printing and prototyping centres of excellence [#]						
	Advanced materials R&D: Create regional R&D centre(s) for advanced materials						
	Product analytics: Establish open consumer platforms for product life-cycle analytics [†]						
	Robotic metal fabrication: Launch development of autonomous robots for metal fabrication processes [†]						
	Smart packaging: Jumpstart development of smart packaging capabilities [#]						
	3D printing: Launch development of low-cost 3D printers for priority industries						
	Quality control devices: Launch development of intelligent quality control devices for priority industries						
	Digital twins: Promote deployment of digital twins for heavy equipment						
	IoT champion: Advocate creation of regional IoT champion for logistics and fleet						
	Digital logistics: Support the development of digital logistics providers and solutions [#]						
Improve production networks	Biodegradable R&D: Create regional R&D centre(s) for biodegradable, non-toxic plastics						
	Design crowdsourcing: Establish crowdsourcing platform for design [†]						
	B2B marketplace: Create ASEAN-wide digital marketplace for suppliers						
	Catalogue: Curate regional catalogue of Fourth Industrial Revolution technologies and lighthouses						
	Showcases: Set up regional Fourth Industrial Revolution showcase centres and testbeds						
	Logistics marketplace: Create ASEAN-wide online logistics and distribution marketplace						
	Digital Free Trade Zones: Roll out DFTZs across ASEAN [†]						
	Autonomous freight control: Set up regional control tower for future autonomous freight						
	Academy: Establish the Fourth Industrial Revolution Learning & Competence Academy for SMEs [#]						
	Circular economy: Launch education platform for sustainable manufacturing [#]						
Strengthen the ecosystem	Used materials marketplace: Set up digital marketplace for such materials						
	3D printing standards: Harmonize standards for additive manufacturing						
	Seamless data: Create seamless data exchanges for faster flow of goods [#]						
	Cybersecurity: Align and enhance cybersecurity framework [†]						
	Skills rubrics: Jointly develop future skills rubrics and training programmes						
	Funding programmes: Launch pan-regional funding programmes for Fourth Industrial Revolution solutions						
	Tax policies: Align such policies for adoption of Fourth Industrial Revolution technologies						
	Recycling incentives: Promote incentives for recycling biological material						

Source: A.T. Kearney analysis

Acknowledgements

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