

Appropriate Innovation for Asian Emerging Markets in a Digital World: A Strategic Framework

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SUMMARY

Growth in spending in Asian emerging economies will be driven to a large extent by lower-middle income and lower-income households. They constitute a vast “2nd tier” underserved market, much of it located in smaller cities, towns, and rural areas. This study develops a framework for appropriate innovation strategy aimed at this substantial market. We identify key relevant characteristics of the leading Asian emerging economies of ASEAN, China and India; that often do not get sufficient attention. The proposed strategic framework then builds on selected examples of appropriate innovation; incorporates the potentially important role of unconventional partnership between business and social enterprise for this market; and develops the supporting role of digital technology, in particular, additive manufacturing (3D printing). We conclude by presenting policy implications of an appropriate innovation strategy, involving government-business collaboration.

Keywords: Appropriate innovation, Asian emerging economies (ASEAN, China, India), additive manufacturing (3D printing), export strategy, business-social enterprise partnership, government-business collaboration

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INTRODUCTION

This study develops a framework for *appropriate innovation strategy* aimed at Asian emerging economies' vast underserved markets. It builds on a different, and more granular analysis of these markets; incorporates the potentially important role of unconventional partnership between business and social enterprise; and develops the supporting role of digital technology, in particular, additive manufacturing (3D printing). The proposed approach to innovation is also more likely to be within the reach of small- and medium-scale enterprises (SMEs).

Different perspective on Asian emerging markets

The usual focus on Asian markets emphasizes factors such as rising per capita GDP, and a growing

high income “urban upper middle class” in leading mega-cities such as Shanghai, Delhi, Bangkok

and Jakarta. It is broadly suggested that Asia could account for 50% of the growth in global consumption by 2030, reaching 40% of total global consumption expenditures by 2040 (McKinsey Global Institute (MGI) 2019, 2021). The region is also projected to drive the post-COVID pandemic global recovery, led by the economies of ASEAN, China and India (IMF 2022; World Bank 2022).

On closer examination, the vast majority of people in Asian emerging economies will be lower-income for years to come -- but with high aspirations and significant buying power. The growth in spending in these economies will be driven to a large extent by lower-middle income and lower-income households. These constitute a huge underserved “2nd tier” market, much of it located in smaller cities, towns, semi-urban, and rural areas. Effective

innovation for this market requires a shift in perspective by firms and governments.

Different perspective on innovation

Innovation is central to the competitiveness of firms, and the growth of economies. The usual innovation strategy of governments and firms aims at developing advanced technology, through leading edge research and development (R&D), targeting high-value products and services (e.g. WIPO 2021; Global Trade and Innovation Policy Alliance 2019). This is essential for strengthening productivity and international competitiveness. However, it has often proven to be a challenge for many firms, particularly SMEs. It is also not essential for the very large 2nd tier markets in Asian emerging economies. Substantial opportunities await firms that can tailor products, services, and business models to the specific needs and conditions of these markets. For this, the concept of innovation should go beyond preoccupation with novel new-to-the-world and highly advanced technologies.

The concept of *appropriate innovation* is aimed at addressing the unmet needs and constraints of consumers in the vast 2nd tier markets in Asian emerging economies (Abonyi and Abonyi 2021). Appropriate innovation builds on extensive consumer engagement, and creatively embraces local constraints as the basis for developing and commercializing new products, services and business models. Although at its core is product innovation, it is really a *business model innovation* that involves fundamentally changing the way firms do business, incorporating novel digital technology, and new types of collaboration (World Economic Forum (WEF) 2022). Appropriate innovation is also more likely to be within the reach of smaller firms (SMEs) with limited R&D resources and capabilities.

Organization of the paper

Given the market-driven nature of appropriate innovation, it is essential to have a granular understanding of Asian emerging economies. Therefore Section 2 summarizes key characteristics of 2nd tier markets in ASEAN, China and India, not usually a focus of attention. The concept of *appropriate innovation* is defined in Section 3, illustrated by selected examples. *Social enterprise* as an important non-traditional partner for business in

appropriate innovation is discussed in Section 4. The role of digital technology, in particular *additive manufacturing* (3D printing) to support user-responsive innovation, is presented in Section 5. These building blocks are integrated in Section 6 in a *framework for strategy of appropriate innovation*. Selected *policy implications* of appropriate innovation are in the concluding section (7).

ASIAN EMERGING ECONOMIES' 2ND TIER MARKETS: ASEAN, CHINA AND INDIA

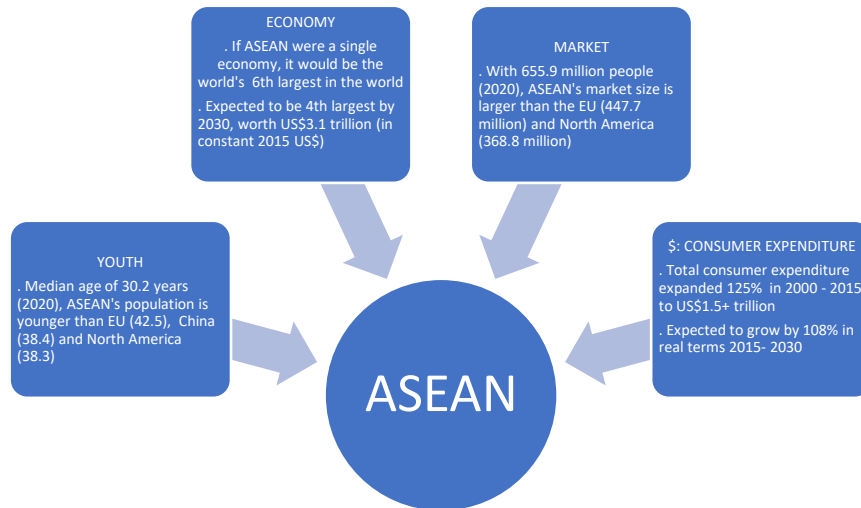
Usual perspective on Asian markets

General economic data on Asia are readily available from sources such as the World Bank, International Monetary Fund (IMF), and the Asian Development Bank (ADB). These are useful for giving firms a broad perspective for investments and exports. However, they are of limited usefulness for identifying particular market segments and consumer groups that can guide specific product market strategies. For example, knowing that GDP per capita in China in 2020 was US\$10,430.73 (constant 2015 US\$, World Bank) tells little about which groups of households, and in what geographic areas, are likely to have particularly promising buying power. Attention also tends to focus on what is seen as a growing high income class in the region's leading mega-cities, such as Shanghai, Delhi, Bangkok and Jakarta.

Detailed analysis of household income distributions in Asian emerging economies reveals a complex and fragmented market landscape. It shows that the vast majority of the households in these markets will be lower-income for years to come; but with substantial and rising buying power, and high aspirations. They constitute a huge 2nd tier market, much of it located in secondary cities, towns, and semi-urban, and rural areas, with significant potential for firms with focused and creative product market strategies. Therefore a deep understanding of the characteristics of this market is essential for competitive success.

ASEAN's 2nd tier market

Overview of ASEAN shows a very attractive region in a number of dimensions, with significant potential as a market, and projected consumer expenditures (Fig.1).

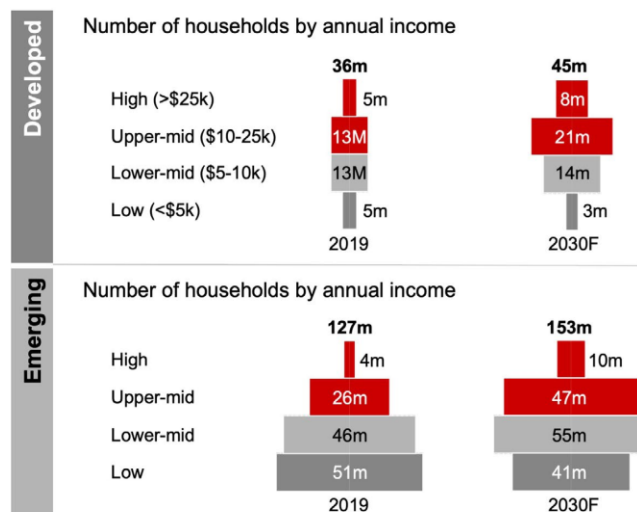


Sources: authors' own, incorporating data from *worldometer* (<https://www.worldometers.info/>); and *Euromonitor International* (2016)

Figure 1. Overview of ASEAN

A granular look at the ASEAN region provides a more useful picture to guide product market strategy (Fig. 2). In 2019 ASEAN's population was approximately 650 million (ASEAN 2019), comprising 163 million households (World Economic Forum (WEF) 2020). Of this total, 154 million households or 94.5%, had disposable incomes lower than US\$25,000 per annum (p.a.); and 115 million households, or around 70%, had less than US\$10,000 p.a.

By 2030 the ASEAN population is expected to increase to around 722 million, comprising approximately 198 million households. Of this total, 181 million households, or 91.4%, are expected to have disposable incomes less than US\$25,000 p.a.; and 113 million households, or around 62.4% less than US\$10,000 p.a. This reflects significant growth in ASEAN household real incomes, projected to create an estimated 140 million new consumers (WEF 2020). However, the vast majority of ASEAN households will continue to have disposable incomes less than US\$25,000 p.a.



Source: World Economic Forum and Bain and Co. (2020). This generally aligns with other such analyses and projections, e.g. *Euromonitor International* (2016).

Figure 2. ASEAN households by annual disposable income

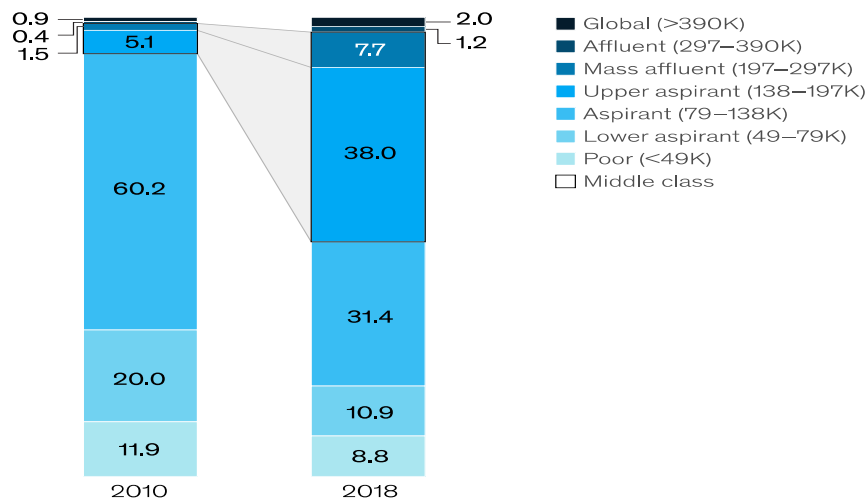
Contrary to common assumptions, the leading megacities of ASEAN may not be the main drivers of the region's future market growth. In a study of sales of 10 products in ASEAN urban areas, it was found that since 2010 demand in these megacities was no longer the fastest growing for half of these products (Nielsen 2017). The study predicted that by 2030 fastest growth for seven out of ten products will be in middleweight cities (500,000 – 5 million) and smaller urban centres -- such as Nakhon Ratchasima, Chonburi and Rayong in Thailand; Can Tho in Vietnam; Surabaya in Indonesia; Pampang in the Philippines, as well as developing towns and rural areas. For example in Thailand, 2010 - 2017 country-level demand grew at 1.2% per annum; while in Chiang Mai (1+ million people), it grew seven times that rate.

China's 2nd tier market

Since the reform and opening of its economy in 1978, China's GDP growth has averaged almost 10 per cent per year, further accelerated by membership

in the World Trade Organization (WTO) in late 2001. This growth lifted more than 800 million people out of poverty. China is now classed as an upper-middle-income country, with GDP per capita at US\$10,430.73 (constant 2015 US\$, World Bank). Growth slowed to 2.3 per cent in 2020 because of the impact of the COVID pandemic, but China's economy is projected to grow by 8.1 per cent in 2021, 4.4 per cent in 2022, and 5.1 per cent in 2023 (IMF 2022). Although it should be noted that to sustain future growth, China will have to address the challenges of increasing structural constraints, including demography leading to a declining growth of its labour force; slowing productivity; and falling returns on investment (Pettis 2020).

While the share of consumption in its domestic GDP is relatively very low, China's global share of consumption has grown significantly in recent years (McKinsey 2021). This growth is coming from "many Chinas", involving a range of income groups. Detailed breakdown of urban household disposable incomes provides a clearer picture of these groups (Fig. 3), and the overall size of the 2nd tier market.



Source: McKinsey & Company (2019)

Figure 3. Urban Households in China by annual disposable income (%) (2018 real renminbi terms; US\$1.0 = RMB 6.8785)

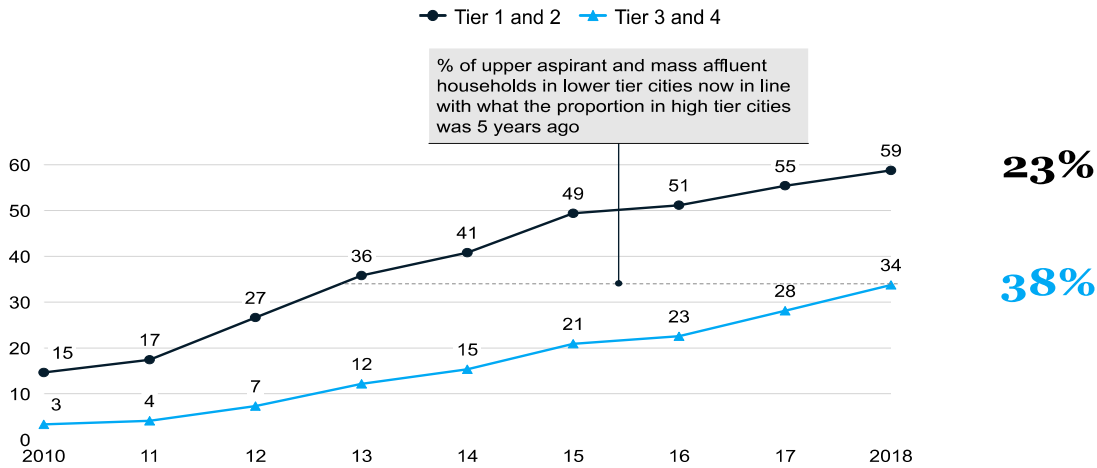
In 2018 over 90 per cent of China's households had disposable incomes less than US\$43,178 (RMB 390,000); and over 80 per cent were in the interval US\$7,124 - \$43,178 (including in Fig. 3 "Lower Aspirant" from US\$7,124 or RMB 49,000, and "Mass Affluent", up to US\$43,178 or RMB 297,000). The "Poor" segment, with disposable incomes up to US\$7,124 (RMB 49,000), constituting 8.8 per cent of urban households, are also not insignificant, given China's population size; and contain potentially relevant consumer groups for

appropriately designed and priced products. The McKinsey assessment is broadly aligned with other detailed estimates of household disposable incomes (e.g. Economist Intelligence Unit, 2016).

The fastest growth in urban household annual disposable incomes in recent years has not been in the leading mega-cities such as Beijing and Shanghai, that tend to get most attention. It was in lesser known cities such as Mianyang and Zigong in Sichuan province, and Yancheng in Jiangsu province

(Figure 4). These are provinces with significantly lower GDP per capita than Beijing and Shanghai. Households with annual disposable incomes of US\$20,000-\$43,323 (“upper aspirant” and “mass affluent”, RMB 138,000 – 297,000) now make up more than 34 per cent of the population in such

cities. Furthermore, households in rural areas should not be neglected in innovative business strategies, as in 2019 China’s per capita rural expenditures grew the fastest (China National Bureau of Statistics, 2020).



Source: McKinsey & Company (2019)

Figure 4. Household disposable incomes are growing fastest in lower tier cities (% of “Upper Aspirant” and “Mass Affluent” households)

In summary, China has a very large 2nd tier market that comprises a wide range of household income groups with significant spending potential. It reaches far beyond the wealthy in mega-cities such as Beijing and Shanghai, to include geographically distributed secondary urban areas and towns in less wealthy provinces.

India’s 2nd tier market

India has been among the fastest growing economies in the world in recent decades. It averaged annual real GDP growth of 6.8 per cent since 1992, becoming the 6th largest economy with a pre-COVID GDP of US\$2.81 trillion in 2019 (current US\$, World Bank). Nominal per capita GDP increased 18 fold, and real capita GDP 3.6 fold. This growth lifted about 270 million people out of poverty (World Bank). The COVID pandemic resulted in an unprecedented -7.3 per cent contraction of the economy in 2019. However, it is projected to rebound and grow 8.9 per cent 2021, 8.2 per cent in 2022, and 6.9 per cent in 2023. (IMF 2022).

Domestic consumption has been the key driver of growth, accounting for close to 60 per cent of GDP. Consumer spending, which totaled approximately US\$1.735 trillion in 2019 (IMF), is projected to reach US\$6 trillion by 2030 (World Economic Forum (WEF), 2019); as the relatively young

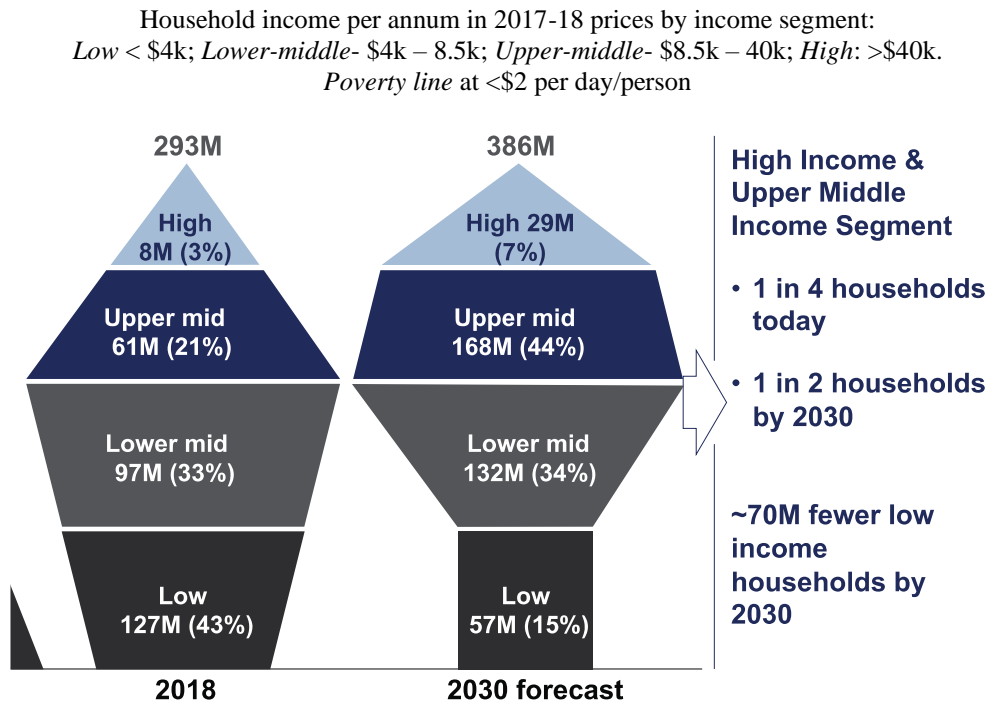
population is expected to increase from around 1.39 billion in 2021, to over 1.5 billion by 2030, bypassing China (UN projections).

Demographic growth and increasing household disposable incomes are transforming the Indian market. As in the case of China and ASEAN, consumption growth is coming from a range of disposable income groups and geographic areas that comprise “many Indias”. This provides market opportunities beyond the wealthy households in mega-cities such as Delhi and Mumbai, to households with significant growing disposable incomes located in smaller geographically dispersed urban centres and developing rural towns.

One of the most detailed and comprehensive ground-level assessments of Indian households is the periodic ICE360 Household Survey. It looks at a wide range of factors such as progress in household disposable incomes, household expenditure patterns, living conditions, and participation in the market economy. The survey (Fig. 5) shows that India has a large and increasing number of high income households. However, over 90% have disposable incomes less than US\$40,000 per annum. This is broadly the 2nd tier market. Middle income households, including lower middle income (US\$4,000 – \$8,500) plus upper middle income (US\$8,500 - \$40,000), constituted a potential market of 158 million households in 2018. This is projected

to increase to 300 million households by 2030, when about 80 per cent of incremental spending will be by middle-income households (World Economic Forum (WEF) 2019).

At the same time, the low income group (less than US\$4,000) of 127 million households in 2018, projected to decrease significantly to 57 million by 2030, also contains potential consumers for innovative products targeted to this particular market segment.



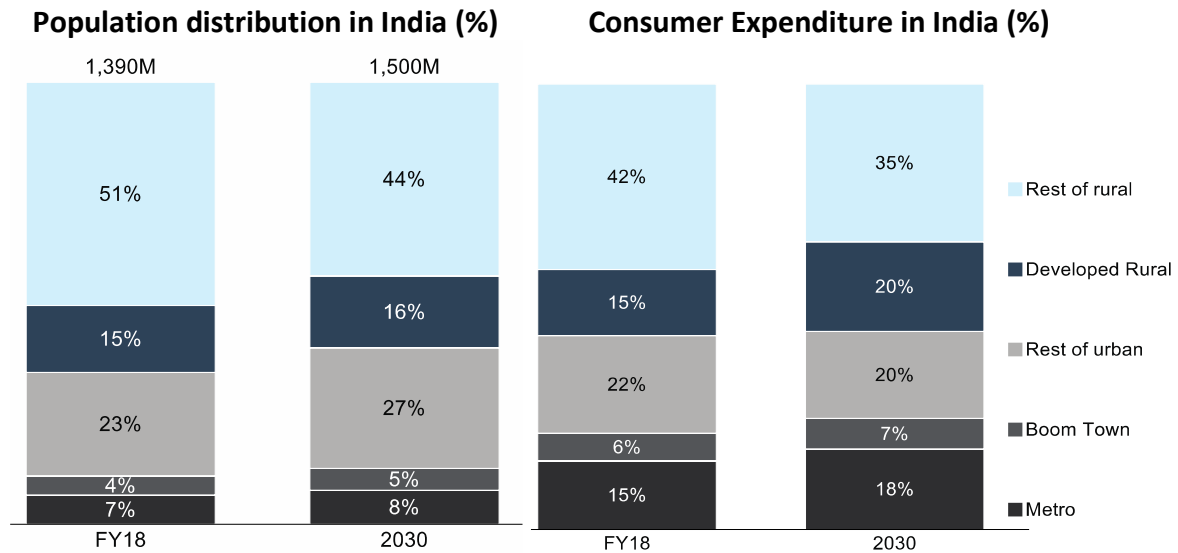
Source: People research on India’s consumption economy (PRICE) projections, based on ICE 360 surveys (2016, 2018); World Economic Forum (2019)

Figure 5. India household disposable income distribution

Analysis of urban-rural distribution, population growth, and consumer expenditure patterns, provides further information for guiding product market strategy for India’s 2nd tier market (Fig. 6). The “Metro” group of cities are the largest and generally richest cities with populations over 5 million, including Delhi, Mumbai, Bangalore, Hyderabad, Chennai, Kolkata, Pune, Surat, and Ahmedabad. The “Boom Towns” are the next largest and generally next wealthiest cities of 2-5 million, including around 30 cities such as Agra, Bhopal, Jodphur, Nagpur, Nasik, Ranchi, Lucknow, Vijayawada and Kochi. Together these two groups of approximately 40 cities are expected to provide a US\$1.5 trillion market opportunity by 2030. The market potential of India’s secondary cities is reflected in a pre-COVID projection that the 10 fastest growing cities in the world in terms of year-

on-year GDP during 2018 – 2035, were all in India (Oxford Economics 2018).

Beyond India’s larger cities, the thousands of dispersed smaller urban areas are expected to provide a similar size market of close to US\$1.5 trillion. Furthermore, developed rural towns are projected to constitute an additional market of US\$1.2 trillion by 2030. Rural per capita consumption in general, is expected to grow 4.3 times by 2030, outpacing the 3.5 times expected growth of overall urban consumption. With increased access to financing by India’s underbanked and unbanked rural population through digital financial innovations (e.g. Paribas 2020), this may be turn out to be an under-estimate of potential town and rural market.



Source: World Economic Forum (2019), from Euromonitor, Oxford Economics, and People research on India’s consumption economy (PRICE) projections, based on ICE 360 surveys (2016, 2018)

Figure 6. Changing Population Distribution and Consumer Expenditure in India (2018, 2030)

It should be noted that many of the “Boom Towns”, including some of the projected fastest growing cities in the world, are located in relatively poor Indian states. For example, Agra is in Uttar Pradesh, one of the very poorest states, ranked 31st in GDP per capita of India’s 28 states and 5 Union Territories; Vijawada is in Andra Pradesh, ranked 17th; and Chennai and Tiruchirappalli are in Tamil Nadu ranked 13th.

Implications

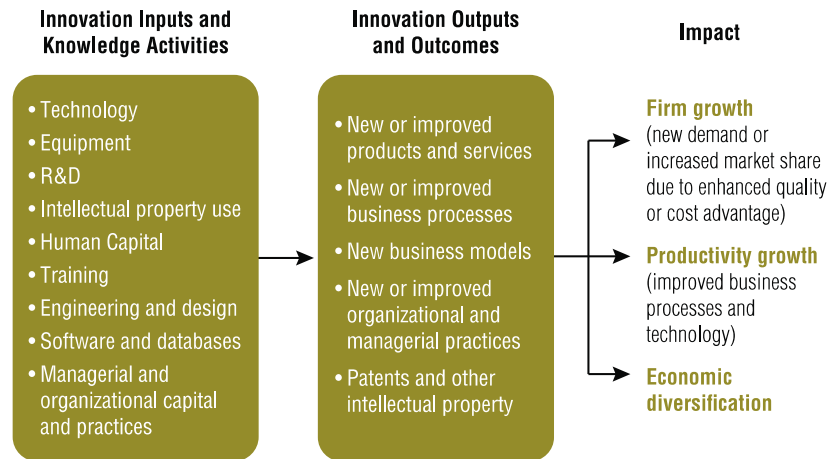
Detailed analysis of ASEAN, China and India, makes clear the fragmented and complex nature of these markets. It also illustrates the very significant opportunities that exist in the 2nd tier markets of these Asian emerging economies. To take advantage of these opportunities, firms must take a granular approach to understanding these markets, and in targeting product market strategies to specific customer segments and particular geographic areas. The nature of 2nd tier markets also suggests a different perspective on innovation for consumers in these markets, the focus of the next section (3).

APPROPRIATE INNOVATION FOR ASIAN EMERGING MARKETS

What is innovation

An innovation has to be *useful* in responding to existing or emerging market or social needs and demands; and *distinctive*, reflecting creative and novel ideas and actions. Ultimately it has to result directly or indirectly in new or better *value* in products and services for particular users. Innovation can come at all stages of the firm or industry value chain; from initial concept, design, development, production, sale, distribution, usage, and after-sale services. This concept of innovation is in line with generally accepted definitions, for example, as presented in the widely used *Oslo Manual 2018* (OECD and Eurostat 2018).

The usual perspective on innovation by both firms and governments tends to emphasize advanced science and technology (S&T) and leading-edge research and development (R&D), aimed at the technology frontier to create new-to-the-world inventions for high-value products. This reflects a supply-side perspective on innovation, with particular focus on inputs such as technology, R&D, and knowledge-related high-skill activities (Fig 7). This is essential for strengthening productivity and international competitiveness for both firms and economies. It is the approach taken by most governments’ innovation strategies (see for example *National Innovation Policies: What Countries Do Best and How They Can Improve*, Global Trade and Innovation Policy Alliance, 2019; and WIPO 2021).



Source: Cirera and Maloney (World Bank, 2017)

Figure 7. Innovation process

The supply-side approach, anchored in high level S&T and R&D, also reflects a “closed system” perspective on innovation (Chesbrough 2019). This sees the market and users more as a “sink” for outputs, than a primary “source” for novel ideas to drive the innovation process.

Innovation strategy with an emphasis on high level S&T and leading edge R&D, aimed at very advanced technology and high value products, is beyond the capabilities of many enterprises, especially SMEs. This, despite considerable efforts of a wide variety of governments (Global Trade and Innovation Alliance 2019). However, it is also not essential for product innovation for the very large 2nd tier markets of Asian emerging economies.

Operationally, in approaching Asian emerging economies, foreign firms tend to offer products similar to their home market sales. In adjusting to these markets, usually price is varied in some form (e.g. discounts, rebates, promotions). There is generally limited effort at adapting product features to particular needs, demands and constraints of customers and conditions (Deloitte 2006). Yet growing evidence from extensive market research suggests that consumers in Asian emerging economies increasingly prefer products that are responsive to local requirements and culture (e.g. Bluebell 2021; Kadence 2021). This indicates that to be successful, firms need to fundamentally change their innovation strategy, particularly for Asia’s 2nd tier markets.

Appropriate innovation Overview

The concept of *appropriate innovation* is a user-responsive and market-driven approach. It aims to

address the underserved and/or unmet needs of many Asian emerging economies’ consumers in the 2nd tier markets (Abonyi and Abonyi 2021). Appropriate innovation is also more within the reach of a wider range of enterprises, including smaller firms (SMEs). It starts from a deep understanding of specific market segments and knowledge of existing technologies. The focus of innovation is then on addressing particular consumer needs and demands, and reflecting the realities of local conditions and constraints.

The concept of appropriate innovation has its origins in the earlier idea of “appropriate technology” for developing economies. Appropriate technology typically refers to resource efficient, locally manufactured and maintained technology solutions in products and services for improving the lives and livelihoods of local communities and households (Lissenden, Maley, and Mehta 2014).

From a business perspective, appropriate innovation is related in spirit to approaches such as “frugal”, “sustainable” and “jugaad” innovation (Christian Le Bas 2016; Brem and Wolfram 2014). They all share the general attributes of designing and developing affordable and accessible products and services that respond to the particular needs and constraints of consumers and communities in emerging markets.

Appropriate innovation: the concept and examples

Appropriate innovation creatively embraces local constraints as the basis for developing and commercializing new products, services and business models. It highlights the key role of breakthrough customer insights, alongside the usual focus on breakthrough technology. This user-

responsive and market-driven approach builds on extensive and on-going consumer engagement for innovating products and services to meet local needs, tastes and conditions.

Relevant constraints may relate to consumers, for example involving household income, and access to financing; to communities, for example local capacity to service products; and market conditions, for example infrastructure and logistics constraints that may limit distribution and access to service. Therefore appropriate innovation may involve designing or adapting existing products and technologies in novel ways to respond to local consumer needs and constraints. It may also include developing new distribution channels for addressing constraints of “last mile” market access; as well as new types of collaborations, for example with social enterprise to enhance local product market credibility and trust.

Resulting products may also be adjusted to serve global niche markets (*reverse innovation*), including in the developed economies of Europe and North America for customer groups that are similarly constrained (e.g. in terms of cost/price), or have frugal consumption habits. This is likely to be particularly relevant in a more value-conscious post-COVID world.

Product Innovation: Embrace Portable (Baby) Incubator

Embrace Portable Incubator (Embrace Global 2022) is small, light, easy to manage, and inexpensive product developed by Stanford students from field work in Asia (Nepal). Using a hybrid organization structure, comprising *Embrace*, a non-profit, and *Embrace Innovations*, a for-profit social enterprise, this social need was also turned into a business opportunity.

The Embrace incubator costs a fraction of the traditional incubator (around US\$25.00). It is simple in design, small, light, has no moving parts; made from locally readily available materials; and is easy and intuitive to use. It is therefore ideal in responding to an enormous underserved needs and constraints in secondary cities, towns, semi-urban, and rural areas in Asia’s 2nd tier markets. *Embrace/Embrace Innovations* has developed and markets related products internationally, including in the U.S..

Product and Service Innovation: Vortex Solar Powered Automated Teller Machine (ATM)

India’s *Vortex Engineering* designed an automated teller machine to meet the constraints of consumers in 2nd tier markets (Agarwal and Brem 2017). The total cost of ownership and operation is less than half a conventional ATM. It is solar-powered, using only 10% of the energy of a conventional ATM since it generates much less heat,

eliminating need for continuous air conditioning. Yet it is able to cope with temperatures ranging between 0C and 50C. The Vortex ATM has fewer mechanical and electrical parts, a fingerprint identification system so that a user number need not be entered, and it accepts crumpled and soiled banknotes, given more limited supply of freshly printed banknotes outside major urban areas. Over 8000 Vortex ATMs are now installed in previously under- and unserved emerging markets [throughout Asia, Africa and the Middle East](#), as the largest brand of solar ATMs worldwide.

Vortex has also developed supporting *Multivendor ATM software* for the back-end management of ATM systems. The COVID-19 pandemic has led Vortex to innovate a software called *Perfo* that allows financial institutions real-time management of ATMs remotely from home, reducing the need for travel and physical presence.

Product, Service and Business Model Innovation: First Energy’s Oorja Stove

India’s *First Energy* developed a “micro-gasification” stove with biomass-based pellet fuel for business and domestic users (Partnership for Clean Indoor Air 2022). Its *Oorja stove* provides a cleaner low smoke, healthier source of indoor cooking. The stove is also cheaper and more efficient alternative to gas (LPG) and diesel stoves. First Energy was acquired by *Thermax Limited*, global leader in the energy and environment sectors, extending Oorja’s market reach.

The primary target market now is commercial, e.g. restaurants in smaller cities and towns. For its initial (and still key) market of rural and semi-urban households, First Energy partnered with social enterprises with strong links to local communities, for better understanding market needs and demands, and to link to local women entrepreneurs to market and service the Oorja stove and its pellets. This added to brand credibility and market reach, particularly since mostly women shape household expenditures, and also influence commercial purchases of stoves.

Product, Process, Business Model, and Reverse Innovation:

GE Mac 400/600/800 Electrocardiogram (ECG/EKG)

GE developed in India and China electrocardiogram (ECG) machines, the MAC 400 and MAC 800 respectively (Singh 2014). The MAC 400 is very light at 1.3 kg., and small enough to fit in a backpack; using low-cost local components, and operating on long-life rechargeable batteries, given unreliable power supply. It has just four buttons and

a simple one-touch operation; small text-only display; small printer producing easy-to-read reports, adapted from portable ticket machines on buses. This allows for easy operation and servicing. The MAC 400 was initially priced around US\$800 (now below US\$500), as compared with the traditional ECGs at over \$10,000, with under US\$1 initially for a single ECG test (now around US\$0.20 per scan). GE partnered with the State Bank of India to provide no-interest loans for buyers through its extensive branch network in secondary cities, towns, semi-urban and rural areas. Given China's higher incomes, the MAC 800 is somewhat larger, with a telephone-style keypad for data input, and a full-size colour display; priced around US\$2,500.

GE introduced a modified MAC 800 as a new product category in developed markets such as the U.S., for primary care doctors' offices, rural clinics, emergency rooms, and first responders. This illustrates the concept of *reverse innovation* – from emerging to developed markets. GE then launched in 2009 a six year US\$3 billion “healthymagination” global initiative to develop a variety of low cost, high quality, health care innovations to expand access to such services in underserved communities. This is now a part of GE Healthcare's business, offering a wide range of such products globally (GE REPORTS HEALTHYMAGINATION).

BUSINESS AND SOCIAL ENTERPRISE COLLABORATION

An important element of an appropriate innovation strategy is collaborations for addressing business model gaps. First Energy's commercialization of the Oorja stove in partnership with the social enterprise Sakhi, illustrates the value of such unconventional collaboration for Asia's 2nd tier markets. *Social enterprise (SE)* may be defined as a revenue-generating, market-responsive enterprise, with social purpose as its value proposition. This is reflected in the core objectives of Sakhi: “Creating a marketing and distribution network for affordable products that enhance the lives of consumers and socially relevant solutions” and “Empower rural women entrepreneurs in smaller cities, towns and rural villages by providing entrepreneurial skills and market-based opportunities”(SURE 2022). This complemented First Energy's overall product market strategy, and addressed gaps in its business model for commercializing the Oorja stove to smaller cities, towns, and rural households. Sakhi provided essential support in marketing, distribution, and service; and in building trust and acceptance with local communities and consumers, particularly women, who play a key role in household expenditures. Similarly, Embrace's hybrid structure for the portable (baby) incubator innovation

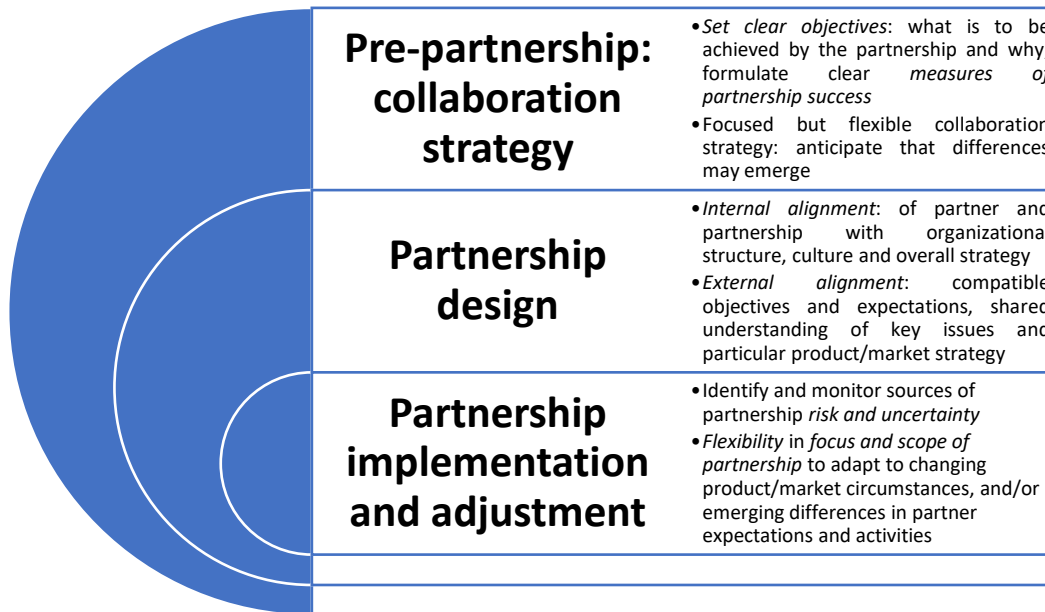
demonstrated the creative role of social enterprise organization as part of a business structure to support commercial ventures in Asia's 2nd tier markets.

As the First Energy – Sakhi partnership illustrates, collaborating with social enterprise can be of significant practical benefit in addressing business challenges, while also contributing to positive environmental and social impact; attributes increasingly valued by consumers in all markets. Such collaboration can blend social and commercial innovation agendas with an effective market-driven strategy. Social enterprises are generally anchored in local communities, working directly with households and businesses in smaller cities, townships, and rural areas. They can provide deep insight into needs, wants, perceptions, behaviours and constraints. They can also bridge the gap to local communities and consumers through new distribution channels, marketing models, and service assistance. Social enterprises can provide vital support for building product awareness, credibility and trust; support innovation; and encourage acceptance and adoption of new products (C&E Advisory Services Limited 2020).

In approaching collaboration, although interests may be compatible and overlap with respect to particular product/market strategies and activities, a commercial firm's basic business model and value proposition are not the same as that of a social enterprise. Therefore a framework for planning effective collaboration should include the following key elements (Fig. 8).

- *Pre-partnership collaboration strategy* that clearly defines partnership objectives, and specific issues/problems the partnership is intended to address, with associated measures of success; and a readiness to anticipate potential differences to emerge between partners, as well as new, unexpected opportunities for the partnership;
- *Partnership design* that ensures basic alignment with the firm's organizational structure, culture, and overall strategy (*internal alignment*); and shared understanding and compatibility of objectives and expectations with the partner on the particular product/market strategy that is the basis of collaboration (*external alignment*); and
- *Partnership implementation and adjustment*, including identifying and monitoring potential sources of risk and uncertainty to the partnership, given differences; and flexibility to adjust product/market strategy to changing conditions in the focus and/or

scope of the partnership e.g. to market feedback or competitor entrance.



Source: adapted from Catalyst 2030 and Resonance, 2021

Figure 8. Framework for business-social enterprise collaboration

ROLE OF ADDITIVE MANUFACTURING (3D PRINTING) IN APPROPRIATE INNOVATION

At the core of successful appropriate innovation is a deep, detailed, and on-going understanding of consumer aspirations, needs, demands and constraints. This information has to be translated into a practical, user-responsive product concept and prototype. An initial prototype then has to be adjusted and refined through interactive testing, and ideally low-cost experimentation, involving focused and guided interaction with potential consumers in their natural settings.

Digital technology in the form of additive manufacturing such as 3D printing, is introducing flexibility into the user-responsive market-driven innovation process, allowing firms, including SMEs, to explore and adjust design options through rapid development and market testing of prototypes. Furthermore, it allows for significant cost and time savings, as well as flexibility in moving from concept, to prototype, to pilot, to production. Whereas producing a functional prototype with traditional manufacturing can take months, with 3D printing firms can create a working prototype in less than a day to test market response. Existing

technology and products may be adapted iteratively to local needs and constraints, or entirely new products generated.

There are different types of additive manufacturing technologies (Engineering product design 2022). For the purposes of this paper, it may be used interchangeably with 3D printing. In general, the process involves adding layer upon layer of materials to make an object. Inputs can include plastic, metal or concrete; with new materials being rapidly developed and adapted. Products range from consumer goods to medical devices, auto parts and aerospace. With new class of better performing and reliable machines, more materials increasingly available, and greater ability to deliver well designed products, 3D printing is proving to be a significant time- and cost-saving option for product design and manufacturing.

The ability to flexibly design any structure with 3D printing, allows for more efficient “design for additive manufacturing”, empowering engineers to create better, lighter, and more complex parts and products. It also allows for significant process innovation through experimentation in manufacturing with parts in relation to the whole product, i.e. in novel ways of combining parts in the production the overall product. This can significantly reduce the number of discrete parts

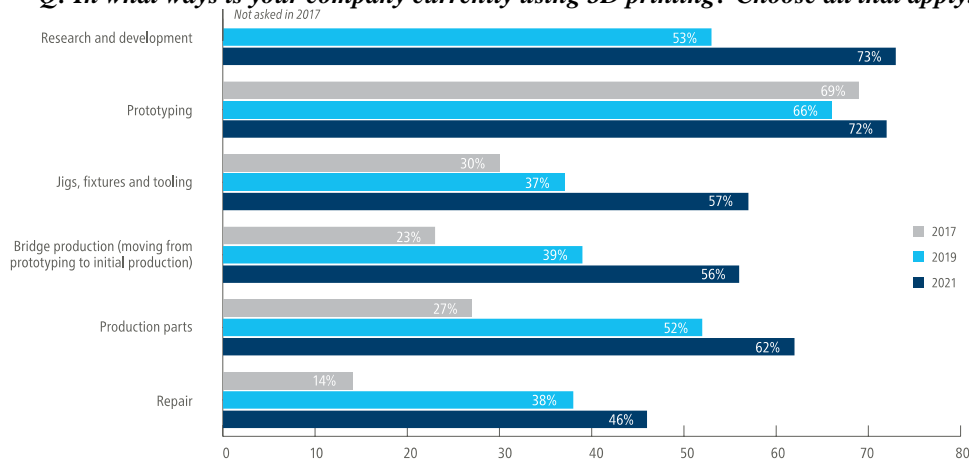
required for final assembly, increasing efficiency and decreasing time and cost.

Linking 3D printers, and also locating them close to market, allows shortening the time to get products and parts to where they are needed, provide significant efficiencies, and allows mass customization. For example, leading automotive manufacturers are increasingly using 3D printing (3erp 2020). Jabil, the world's third largest contract manufacturer, introduced in 2018 a global network

of additive manufacturing facilities in the United States, China, Hungary, Mexico, Singapore and Spain. It focused initially on footwear, industrial machines, transportation, aerospace, and healthcare; with further scaling up and diversification planned.

A survey of over 300 globally leading companies using additive manufacturing has shown its key role in innovation, with R&D and prototyping as the most popular applications, but with increasing use in flexible manufacturing as well (Fig. 9).

Q: In what ways is your company currently using 3D printing? Choose all that apply.



Source: Jabil (2021)

Figure 9. Trends in 3D printing

Application of 3D printing can also transform the innovation process itself, as illustrated by recent experiments with “rapid ideating” (Lifshitz-Assaf, Lebovitz, and Zalmanson, 2021). Instead of first brainstorming ideas, for example with whiteboards to create detailed new concepts, the traditional early stage of the innovation process, 3D printing technology can be used to guide and structure the creative process to rapidly generate multiple new possibilities for immediate experimentation. This allows fast convergence on practical design, and moving to the prototyping stage, which can then be quickly market tested.

Key constraints on the wider adoption of 3D printing, particularly by SMEs, are qualified and skilled staff, and cost -- including both capital investment and life-cycle operating costs (Jabil 2021). Such investments involve risk and uncertainty of sufficient payoffs, especially for smaller firms with limited finances who generally operate in a resource-constrained environment. Therefore what is a very promising, but essentially speculative investment related to innovation, must compete with other core business functions.

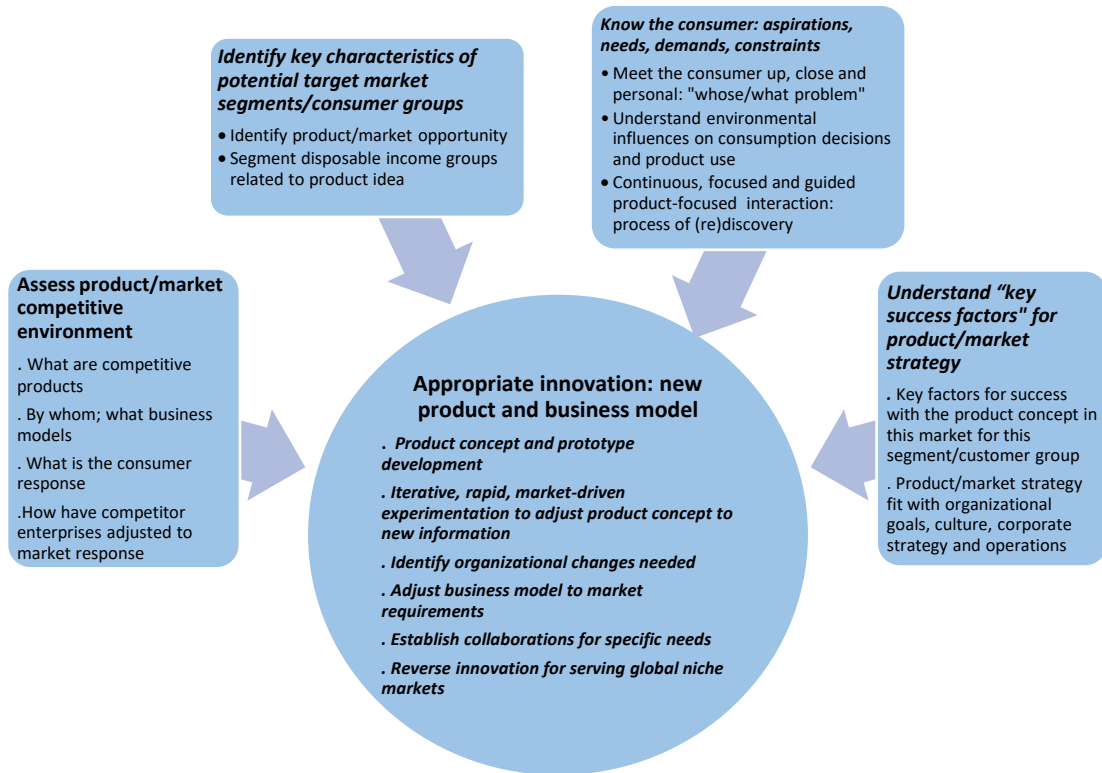
An encouraging new approach to the utilization of 3D printing, especially by SMEs, involves linking such printers to a cloud-based smart network as a way of lowering cost and risk, and expanding availability (Cui, Jin, Lei Ren, Jingeng Mai, Pai Zheng, and Lin Zhang, 2022). This involves connecting geographically dispersed 3D printers in a network, under the control of a cloud platform. A 3D printer can then be remotely accessed as a cloud terminal by multiple users collaboratively over the network, including on a pay-per-user basis. This can lower significantly the capacity and skill requirements for a firm; as well the capital and life-cycle costs of such technology. In this way, SMEs can innovate and market test new products, without significant investment in technology, personnel, and R&D facilities.

STRATEGIC FRAMEWORK FOR APPROPRIATE INNOVATION

Appropriate innovation is fundamentally a general *business model innovation*. At its core is a new type of product (or service). But the process of developing and commercializing this product, starting with focused and continuing guided

interaction with consumers in Asian emerging economies' 2nd tier markets, differs from conventional ways of doing business. It involves fundamentally changing the way firms do business, incorporating new disruptive (digital) technology,

and new types of collaboration (WEF 2022). Building on the earlier sections, key elements of a framework for an effective appropriate innovation strategy, are summarized in Fig. 10, then discussed in more detail.



Source: authors' work

Figure 10. Framework for Appropriate Innovation Strategy

Identify key characteristics of potential target market segments/consumer groups

Based on granular analysis of Asian emerging markets of interest, identify particular product/market opportunities: This involves identification and detailed assessment of a specific problem, need or demand that presently lacks an adequate market-based solution. It entails posing the following question: What is the nature of an unsolved problem (need) and/or unfilled demand, for a particular consumer group (e.g. households and/or businesses). This provides the basis for a product/market strategy in the form of a product concept, that is likely to respond to the perceived problem or need of a particular consumer group.

Examples: Identification of an opportunity can come from different sources. In the case of the Embrace Portable (Baby) Incubator it was the result of the identification of a social need for particular groups, that also became a commercial opportunity. In the case of the GE MAC 400 and 800, it was the

result of the limited commercial success of existing products, leading to the identification of underserved/unserved market segments.

Finely segment potential customer groups related to the particular product concept: This involves usual market segment analysis, such as key characteristics of potential consumer group(s), size (e.g. number of households or business units), age distribution, geographic locations, purchasing power in disposable incomes, consumption/buying history, access to financing/credit. It also involves a different perspective on forecasting future demand in 2nd tier markets. As these economies develop, their structures transform, size of disposable income groups and related consumption patterns also evolve, more than in developed economies. This may have an impact on future demand for the product under consideration.

Know the consumer: aspirations, needs, demands, constraints

Meet the consumer up, close and personal - continuous, focused and guided interaction: This is the core foundation of an appropriate innovation strategy mapping in detail unmet needs/demands and constraints. It requires starting with asking the questions: “What and whose problem are we trying to solve?”; and “What new options does it create in terms of product market strategy?” (e.g. World Economic Forum (WEF) 2022).

It involves deep, detailed and continuing interaction with potential consumers in their natural settings, e.g. in smaller cities, towns, and rural areas. This requires understanding their aspirations, as well as their product-related perceptions of needs and constraints. It also involves probing in depth, why existing products are not appropriate or insufficient to address needs/demands, assessing what are missing product characteristics, shortcomings of existing business models, e.g. product familiarization, distribution and service network, credibility/trust in the brand or enterprise. This step also requires deep understanding of how the environment/market context influences purchasing decisions and existing or likely product use.

Examples: The detailed characteristics of the Vortex ATM machine, and GE’s MAC 400 and 800, reflected a deep understanding of particular consumer needs and constraints. For example, in the case of the Vortex ATM, ease of operation, facility for using fingerprint identification, and acceptance of soiled banknotes, all responded to local retail user needs; as did software support that allowed back-end management remotely by banks. Similarly, every detail of the GE MAC 400 and 800 design involved extensive, on-going interactions with particular user groups, and reflected an explicit understanding of customer needs and constraints.

Assess the competitive environment for the particular product/market segment

What products are presently offered to respond to perceived need/demand: This involves a detailed analysis of products now being offered by competitors, and their key attributes, including price points and other characteristics. It requires an assessment of the number and nature of enterprises offering these products, asking the question: who are now, and are likely to be in the future, product/market competitors. It also requires a comprehensive assessment of the various business models being used, and their relative success and/or shortcomings, e.g. distribution and service networks, enterprise collaborations.

Examples: First Energy undertook a detailed analysis of the types of stoves being used by targeted households and commercial establishments, and

their implications for competitive success, and suppliers of these stoves. This included an assessment of the range of stove offerings (e.g. gas and diesel stoves) and factors influencing their adoption. For example, in the case of gas powered stoves, an important factor was the cost of gas (LPG) and related subsidies; as well as existing networks for product distribution, key inputs, and service. These factors shaped product development and business model design.

What is the response of the target consumer groups to the products now offered: This involves analysis of the relative success of present product offerings to the target market segment. It includes analysis of why these products have not responded sufficiently to the perceived need/demand, leaving an unfilled gap in the market, e.g. price points, particular product characteristics, distribution and service networks. Much of this information has to come from detailed and on-going interaction with potential consumers.

Examples: Vortex’ comprehensive analysis of existing ATM machines (and supporting services) in smaller cities, towns, semi-urban and rural areas revealed key problems/shortcomings of existing product offerings. This provided the basis for the identification and detailed assessment of underserved/unserved market segments.

How have (competitor) enterprises adapted products to market feedback: A key part of competitive analysis involves assessment of whether, how, and how successfully enterprises respond to market signals. This focuses on the extent and nature of innovations by competitors; including product, process and business model innovations, and their relative success. It is also vital information on key characteristics of the competitive environment, and likely nature and intensity of competitor response to new product introduction.

Examples: There were no similar products with respect to the innovations by Embrace, First Energy, Vortex, or GE. However, once product innovations were introduced and proved a viable market, the product/market evolved with new entrants. For example, GE’s MAC 400 was the world’s first ultra-portable ECG machine initially in emerging economies, and later in developed countries. Since its introduction, a variety of competitors followed (DAIC 2021).

UNDERSTAND “END-TO-END” KEY SUCCESS FACTORS FOR PRODUCT/MARKET STRATEGY

Identify and assess key factors for success with respect to this particular market segment/customer group: Given the nature of 2nd tier markets, price is a necessary consideration, but far from sufficient. The approach to identifying key product characteristics was discussed above, stressing breakthrough customer insights as much if not more than new technology. Beyond the product, commercial success requires assessment of all key dimensions of the product/market business model, including: marketing and distribution requirements, particularly the challenge of “last mile” delivery; after-sales service; effective options for familiarization of customers with a new type of product; building credibility and trust in both the product and the enterprise supplying it; customer access to finance; and opportunities and requirements for scaling up. Understanding the implications of government policy and the regulatory environment for product/market success is also essential, as these can provide both constraints (e.g. regulatory restrictions) and potential opportunities (e.g. aligning with government priorities and programs).

Examples: For First Energy, appropriate delivery and service networks for the Oorja stove were essential, in order to reach target households, and also to build credibility and trust in a new type of product from an essentially unknown supplier (First Energy). Partnering with social enterprises addressed these constraints; and created a focus on the role of women, who shaped expenditure decisions. In the case of GE, the firm was well known, but the product/market was entirely new. This required working closely with key customers (e.g. doctors in smaller cities, semi-urban and rural areas) to build product acceptance, and creating new types of partnerships for distribution (e.g. pharmaceuticals) and financing (State Bank of India).

Assess the “fit” of the product/market strategy with organizational goals, culture and overall strategy: As the examples illustrate, appropriate innovation often involves an entirely new and different product/market strategy, including business model. Therefore alignment with organizational goals, culture, general strategy, and operations is an important consideration. Unless there is such an alignment or fit, successful strategy implementation may be at risk, for example from capacity constraints, and also from resistance within the enterprise.

Examples: For Embrace, the original product concept responded to a social need. Therefore initially Embrace was established as a non-profit. Once a commercial market emerged for its portable baby warmer, it also evolved into a for-profit social enterprise. The resulting hybrid organization ensured a continuing alignment of strategy, operations, and structure. For GE, the entirely new product/market strategy associated with the initial MAC 400 innovation, required a basic change in organizational structure and culture (Singh 2014). It involved creating a new local India profit and loss (P&L) organizational structure that changed accountability from reporting externally and vertically to GE global headquarters, to reporting locally to the GE India CEO. This allowed both product development (R&D) and commercialization to be managed close to the market, including developing unconventional partnerships as needed.

APPROPRIATE INNOVATION: DEVELOPMENT OF NEW PRODUCT AND BUSINESS MODEL

Create or reconceptualize a new product for the target market segment/customer group: Building on the above (1 – 4), develop an initial *product concept* that responds to perceived need or demand, and related constraints. Adjust the initial product concept through low-cost and rapid experimentation, involving interactive testing of the product concept with target consumer group(s), and modifying product prototypes, for example using additive manufacturing (3D printing). This can include adapting technology from very different industries/sectors, as the bus printer for the GE MAC 400, and NASA phase-change material, a wax-like substance, for Embrace Portable (Baby) Incubators.

Identify and address particular gaps in the enterprise’s present business model for success in the target product/market: Key issues related to business model adaptation for appropriate innovation have been discussed (1-4), including in the context of the examples. These could include adjustments and innovations for informing/educating consumer groups about the new product; new types of marketing, distribution and service networks; financing options; creating a manufacturing ecosystem for scaling up, including the role of local materials and skills.

Assess the organizational changes/adjustments needed. This involves asking the question what changes are needed in our existing organizational strategy, operations (e.g. new technology), structure, and collaborations (partnerships) in order to

successfully implement, sustain over time, and scale up the selected product market strategy.

Establish collaborations to address gaps in the required business model: Non-traditional collaborations and partnerships can play an essential role in an appropriate innovation strategy. This was illustrated in First Energy's partnership with social enterprise, and GE (India) partnerships with pharmaceuticals and financial institutions. Collaboration with social enterprise can play a particularly important role in Asian emerging economies' 2nd tier markets.

Assess opportunities and requirements for reverse innovation strategy for global niche markets: Products developed for Asian emerging markets may also fit global niche markets, particularly in a more frugal and value-conscious post-COVID world. Therefore it is useful to invest time and effort in identifying potential markets and their specific implications, in developed economies for modified product(s) (Fig. 11).

Example: The GE MAC 400 (India) and 800 (China) led to the development of portable ECG for global niche markets, and the formulation of a broader corporate strategy called "healthymagination" for GE Healthcare Systems.

Figure 11.a Conventional Innovation for Emerging Markets

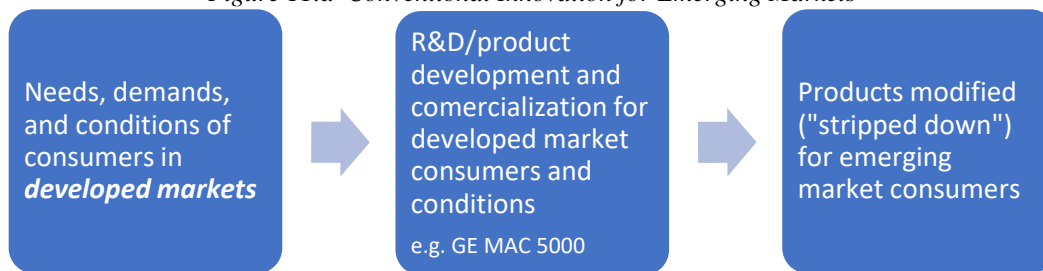


Figure 11b. Appropriate and Reverse Innovation



Source: authors' work

Figure 11. From Conventional Innovation to Appropriate and Reverse Innovation

CONCLUSION: POLICY IMPLICATIONS

Appropriate innovation has practical implications for public policy, as well as business strategy. Diversifying exports and adoption of advanced technology, are challenging priorities for many governments, such as Hungary, especially with respect to SMEs (e.g. Ministry of Foreign Affairs and Trade of Hungary, Hungarian National Trading House, and International Trade Centre 2017). A focus on appropriate innovation linked to digital technology, can complement existing programs of trade development and new technology adoption. Initiatives of business-government collaboration can help implement this strategy.

- Financial incentives for funding traditional research and development (R&D) should be expanded from laboratories to markets. This includes support for early-stage, product-related interactions with potential consumers in Asian emerging economies. Support is particularly important for development and testing of product prototypes and for adapting existing technology to local user needs and constraints.
- Establishing a network of SME resource centres can accelerate digital technology adoption. These can reduce costs by sharing technology, and facilitate collaboration for new product markets through the exchange of ideas and experience. Successful examples exist in Europe (European Commission 2022)

and Singapore (Agency for Science, Technology and Research 2022); and in Taiwan they serve as industry incubators and accelerators for product development and exports (Taipei Times 2020). As noted, support for the development of new cloud-based smart network of 3D printers can also strengthen practical SME capabilities.

- Such SME centres can link digital technology with support for focused market analysis. This involves providing granular information on Asian emerging economies that can help identify market segments and customer categories, market-entry options, and assist firms in tackling trade barriers. By combining (co-locating) achievable export possibilities with clear payoffs linked to the role of advanced technology (e.g. 3D printers for prototyping), such centres can accelerate adoption of digital technology.
- Facilitating alliances of firms with foreign partners is generally a key focus of many countries' trade-related support services.

Appropriate innovation for Asia's 2nd tier markets suggests expanding such programs to include unconventional partners, in particular, market-oriented social enterprises. As discussed, these can offer product credibility, local knowledge and market reach, particularly in Asian emerging economies where social innovation and commercial success may be closely linked.

The concept of *appropriate innovation* therefore provides the basis for effective business strategy, public policy, and government-business collaboration, aimed at Asian emerging markets. It builds on a different perspective of these markets, recognizing that growth in spending will be driven to a large extent by lower-middle income and lower-income households that constitute a huge underserved 2nd tier market outside of leading megacities. Appropriate innovation also links directly to effective application of digital technology, particularly additive manufacturing (3D printing). A strategy of appropriate innovation can therefore provide an important dimension to the competitive strategies of diverse economies.

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