Chapter 12

Regional and International Cooperation to Advance Innovative Technology Transfer for Lao PDR and ASEAN

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1. Introduction

The interconnectedness of climate change, energy security, and economic stability is undeniable (IPCC, 2007). The ambitious objectives established to address any of these challenges cannot be fully achieved without recognising and addressing this reality. During this century, the world is confronting the formidable task of sustaining and providing an affordable energy supply to fuel economic growth without causing disruptions to the climate through emissions (Holdren, 2006). The challenge encompasses three primary dimensions: (i) environmental sustainability, which involves ensuring that energy production and consumption do not harm the environment by minimising greenhouse gas emissions and other pollutants that contribute to climate change; (ii) energy security, which entails guaranteeing a reliable and uninterrupted supply of energy to meet the demands of society and the economy, even in the face of geopolitical tensions, disasters, or other disruptions; and (iii) economic stability, which focusses on maintaining stable and affordable energy prices to support economic growth and development while ensuring that the transition to sustainable energy does not negatively impact the economy (IEA, 2011; Lee, Iliev, Preston, n.d.; Carver, 2011; Tomlinson et al., 2008; UNDP, 2015).

In the forthcoming decades, fossil fuels are anticipated to maintain their dominance in global energy, particularly due to the growth of energy demand in developing nations. According to the New Policies Scenario of the International Energy Agency, which assumed cautious implementation of recent government commitments, global primary energy demand is projected to increase by one-third from 2010 to 2035, with 90% of this growth occurring in non-Organisation for Economic Co-operation and Development (OECD) countries. The current share of fossil fuels in global primary energy consumption – approximately 81% – is expected to decline to 75% by 2035. Meanwhile, the contribution of renewables is anticipated to rise from the current 13% to 18% in 2035 (IEA, 2011).

Existing approaches will not expedite the introduction of clean energy technologies into international markets at a pace sufficient to meet demand. The rapid and widespread utilisation of fossil fuels has underscored the need to promptly deploy a comprehensive array of clean energy technologies. These technologies range from those designed to mitigate conventional pollutants such as sulphur dioxide and nitrogen oxides to more advanced options characterised by enhanced energy efficiency and the potential for significant reductions in emissions.

Effectively addressing the dual challenges of climate change and energy security will depend on innovations in clean energy. However, global clean energy innovation is proving to be slow. Analytical assessments reveal a disconcerting misalignment between the urgency of addressing the climate challenge and the historical timeframe required for technology systems to yield returns on investment. Furthermore, the current landscape of clean energy innovations is disproportionately dominated by OECD countries, a factor that will influence the pace and breadth of the diffusion of the most advanced clean energy technologies in the coming decades.

Energy poverty is a situation in which households are unable to access essential energy services and products, which remains a persistent global challenge in developing nations for the foreseeable future. Despite the rapid economic growth experienced by some developing countries, statistics are still alarming. Presently, more than 20% of the global population (1.4 billion individuals) lacks access to electricity, and approximately 40% of the global population (2.7 billion) relies on traditional biomass for cooking. Projections indicate that this issue will endure and potentially intensify in the long term, with an estimated 1.2 billion people still lacking access to electricity in 2030. Concurrently, the number of individuals relying on traditional biomass for cooking is expected to rise to 2.8 billion by 2030. The widespread use of biomass contributes to deforestation and exacerbates the significant climate impact of black carbon, a key contributor to global warming. Furthermore, household air pollution, resulting from the inefficient use of biomass in stoves, is projected to cause over 1.5 million premature deaths annually in 2030 – an alarming toll surpassing premature deaths from malaria, tuberculosis, or HIV/AIDS.

It is a disconcerting reality that, in the absence of an expedited transformation in worldwide clean energy innovation and technology, the world – especially developing nations – risks entrenching itself in an insecure, inefficient, and carbon-intensive energy infrastructure. Addressing this challenge underscores the growing significance of nations possessing the capability to employ effective tools in formulating robust national clean energy innovation strategies and programmes. However, a deficiency exists in comprehending the optimal tools and methodologies for planning, designing, and successfully implementing a national clean energy strategy (IEA, 2021). Specifically, developing nations face a deficit in fundamental technological capabilities or knowledge foundations. For these countries, insights gained and optimal approaches to policy and programme implementation in nations with comparable circumstances can serve as a valuable reference. Notably, China – with clean energy investment approaching US$50 billion in 2010 – stands as the foremost global source and recipient of clean energy investments (Bloomberg New Energy Finance and UNEP, 2011).

The advancement of economic integration in East and South-east Asia is fostering the development of infrastructure and streamlining trade processes. This integration has the potential to reduce the expenses associated with the movement of experts, thereby increasing the likelihood of South–South technology transfer or technology exchange amongst developing nations. Japan, China, Thailand, and other industrialised countries in the region possess transferable technical and managerial capabilities that can benefit less-developed nations. The recent rise in wages in these industrialised countries additionally motivates firms to shift labour-intensive operations and transfer-associated technologies to less-developed countries, including Lao People's Democratic Republic (Lao PDR).

During 2013–2014, two prominent Japanese companies, Nikon and Toyota Boshoku, established new facilities in Savannakhet Province, where the Government of Lao PDR is actively developing a special economic zone. A shared objective amongst companies establishing operations in Lao PDR is to capitalise on the widely recognised 'Thailand-Plus-One' strategy, which allows companies to leverage advanced capabilities from their existing facilities in Thailand and to tap into the abundant labour resources in Lao PDR by operating multiple facilities in both countries at various stages of development. As these companies commence operations in Lao PDR, labour-intensive processes are shifting from Thailand to Lao PDR; simultaneously, the facilities in Thailand are concentrating on higher value-added production. The newly established facilities in Lao PDR complement their counterparts in Thailand, thereby optimising the overall efficiency of the supply chains.

Nonetheless, there is a dearth of case studies focussing on domestic firms and quantitative research addressing the transfer of technology from Thailand and other neighbouring countries to Lao PDR. To address this gap, this chapter refers to a survey conducted in Vientiane and surrounding areas from late 2012 to early 2013, which investigated the dynamics of technology transfer to Lao PDR from China, Thailand, and Viet Nam – the key foreign investors in the country.

2. Current Policy Landscape in Lao PDR

Geographically, Lao PDR is surrounded by five countries – China to the north, Viet Nam to the east, Cambodia to the south, and Thailand and Myanmar to the west. Lao PDR possesses abundant natural resources, notably water resources sourced from significant waterways, including the Mekong River and its basin. Water resources – exploited for electricity generation through hydropower plants – constitute a pivotal element in the nation's economic development strategy spanning several decades.

In terms of demographics, as of 2019, the population of Lao PDR reached 7.12 million, distributed across an average household size of 5.5 persons, equating to an estimated 1,276,867 households. The population exhibited growth from 5.3 million in 2000, representing an annual growth rate of 1.8% between 2000 and 2019. The urbanisation rate, recorded at 36.50% in 2019, is anticipated to rise to 44.55% by 2030 (UNESCAP, 2022).

Classified as a lower-middle-income economy by the World Bank in fiscal year 2021, Lao PDR has emerged as one of the world's fastest-growing economies over the past 2 decades (UNESCAP, 2022). It has witnessed notable economic growth, with the gross domestic product (GDP) growth rate averaging approximately 7.0% since 2000. The COVID-19 pandemic did impact the economy negatively, resulting in a contraction of –0.5% in 2020. Projections indicate a gradual recovery, with expected GDP growth rates of 4.0% in 2021, 4.5% in 2022, and 5.0% in 2025, ultimately ascending to 6.5% by 2030, reverting to pre-COVID levels.

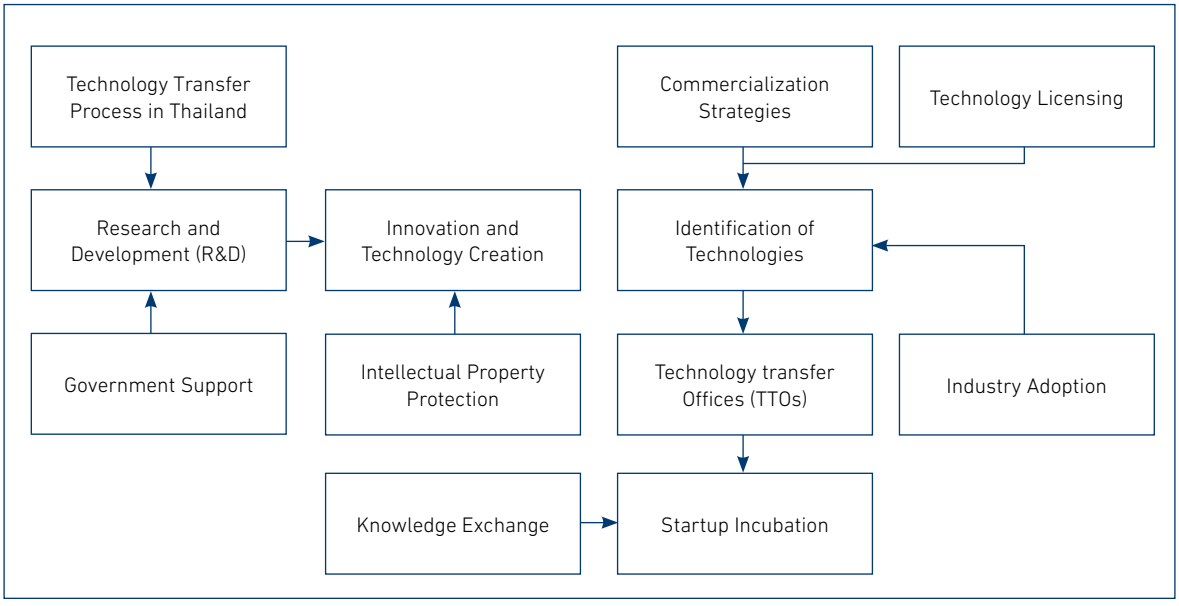
In terms of climate-change risks, Lao PDR is vulnerable to extreme events such as droughts and floods, which have been escalating in frequency and severity. These events have wide-ranging repercussions regarding food security, the water supply, public health, environmental management, and overall lifestyle. Climate change is anticipated to impact key industrial sectors, including mining, hydropower, and wood processing, as these rely on natural resources. Additionally, sectors such as agriculture, animal husbandry, forestry, and fisheries – dependent on specific climatic conditions – may experience reduced productivity due to water shortages and groundwater depletion. This would exacerbate food insecurity and poverty, given the predominant reliance of the population on agriculture for livelihoods (UNESCAP, 2022).

However, Lao PDR has demonstrated notable progress in innovative technology transfer, a strategic initiative aimed at fortifying economic development and addressing societal challenges. Collaborative efforts between the government and diverse stakeholders have actively fostered an environment conducive to synergies amongst research institutions, industry players, and the public sector. This collaborative milieu has facilitated the seamless diffusion of cutting-edge technologies. Significant endeavours include the establishment of innovation hubs, incubators, and technology parks in Lao PDR, which serve as pivotal conduits for knowledge exchange and cultivation of inventive solutions. In parallel, concerted efforts have been deployed to cultivate partnerships with international organisations, leveraging external expertise to enhance the effectiveness of technology transfer initiatives. The sustained advancement in this sphere is key for Lao PDR, as it endeavours to unlock the transformative potential of innovation, stimulate economic growth, and enhance societal well-being.

3. Technology Transfer Process in Thailand

Thailand possesses a noteworthy background in technology transfer, exemplified by the process in Figure 12.1. The purpose of presenting this illustrative model is to provide a representative framework for understanding the analogous technology transfer dynamics applicable to Lao PDR. By sequentially depicting the stages involved, Figure 12.1 serves as a visual guide to facilitate comprehension of the intricacies associated with the transfer of technology, thereby offering insights into potential adaptation for Lao PDR context.

Figure 12.1. Technology Transfer Process in Thailand



Source: Panmaung (2020).

Research and development. Research and development initiate the technology transfer process in Thailand, marked by the commencement of investigative and developmental endeavours undertaken by academia, research institutions, and private enterprises. These entities play pivotal roles in advancing knowledge, fostering innovation, and laying the foundation for subsequent phases in the technology transfer continuum.

Innovation and technology creation. This represents the subsequent phase wherein inventive technologies emerge as outcomes of research initiatives. These advancements span diverse sectors, encompassing information technology, biotechnology, and manufacturing. The transformative nature of this phase underscores the pivotal role played by research efforts in catalysing advancements that contribute to technological innovation across multiple domains.

Intellectual property protection. Such protection assumes a critical role within the technology transfer process. Researchers and innovators strategically safeguard their inventions by leveraging intellectual property rights, which may encompass patents, copyrights, or other pertinent mechanisms. This proactive measure not only preserves the exclusivity of their creations but also establishes a legal framework that facilitates the subsequent transfer and utilisation of the developed technologies.

Technology transfer offices (TTOs). The integral component in orchestrating the technology transfer process is the presence of TTOs within numerous academic and research institutions. These specialised entities are entrusted with the pivotal role of overseeing and expediting the seamless transition of technologies from academia to the commercial sector. Many TTOs in Thailand are equipped with dedicated physical offices, underscoring their commitment to managing the complexities inherent in the technology transfer landscape.

Identification of technologies. The subsequent step involves identification of technologies, wherein potential technologies with prospects for commercialisation are discerned. This process entails a comprehensive assessment of the feasibility of the technologies, coupled with an analysis of market demand. The meticulous evaluation of these factors is imperative to ascertain the viability and potential success of the identified technologies in the commercial domain.

Commercialisation strategies. Following the identification of technologies, TTOs engage in collaborative efforts with businesses, entrepreneurs, and/or investors to formulate effective commercialisation strategies. These strategies encompass a spectrum of approaches, including licensing agreements, joint ventures, or the establishment of startups. By forging these strategic partnerships, TTOs facilitate the transformation of innovative technologies into commercially viable products or services, ensuring a dynamic and mutually beneficial synergy between the academic and commercial spheres.

Technology licensing. The process of technology licensing ensures that formal agreements are established to authorise third parties to utilise, develop, and market the technology in question. These licensing arrangements typically entail financial considerations, such as the payment of royalties or other mutually agreed upon financial arrangements. Through these contractual agreements, the originators of the technology grant permission for its utilisation, fostering wider dissemination and commercialisation under specified terms and conditions.

Startup incubation. In certain instances, the technology transfer process culminates in the establishment of startups. These nascent enterprises may receive support during their initial stages of development through incubators and accelerators. This phase of startup incubation is instrumental in providing the necessary resources, mentorship, and infrastructure to facilitate the growth and sustainability of these emerging ventures, thereby contributing to the successful integration of transferred technologies into the commercial landscape.

Industry adoption. The penultimate phase involves industry adoption, wherein established industries and companies embrace the transferred technologies, seamlessly integrating them into their operational frameworks. This adoption is driven by the recognition of the potential to enhance productivity and efficiency or to expand product offerings. Through this assimilation, industries leverage the transferred technologies to stay abreast of advancements, thereby contributing to their sustained competitiveness and growth.

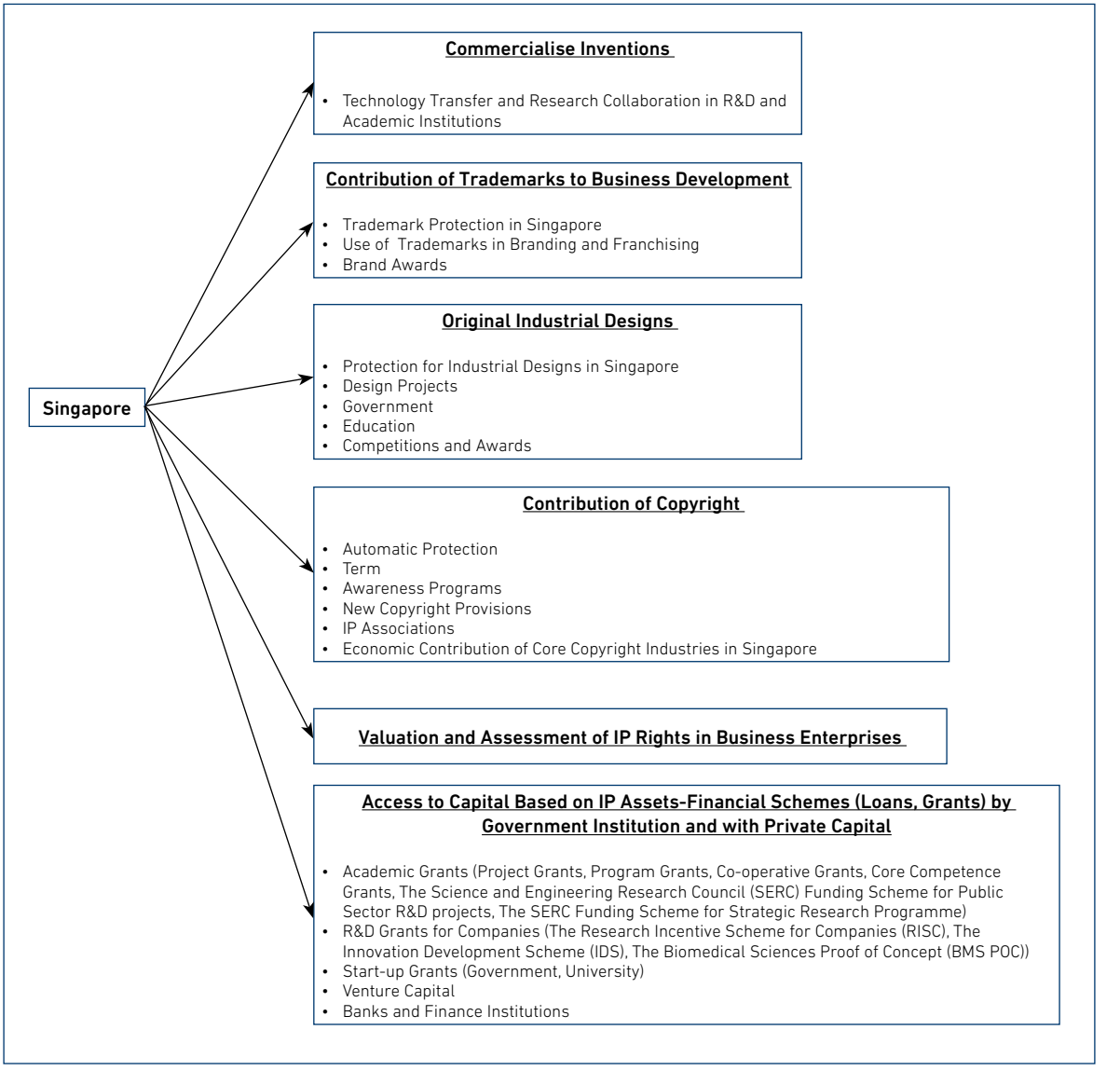
Knowledge exchange. The final stage underscores the significance of knowledge exchange, where sustained collaboration and information sharing persist amongst academia, research institutions, and industry. This ongoing exchange of knowledge serves as a catalyst for continued technology transfer and innovation, fostering a dynamic ecosystem that perpetuates advancements and synergies between the academic and industrial realms. This iterative process ensures a perpetual cycle of learning, adaptation, and progress within the broader landscape of technology transfer.

Government support. The government must assume a pivotal role in underpinning and incentivising technology transfer activities. The formulation and implementation of supportive government policies and initiatives constitute a cornerstone of this process. Such initiatives may encompass financial backing, grants, and the establishment of regulatory frameworks conducive to the seamless transfer of technology. The proactive involvement of the government serves to create an enabling environment, fostering innovation, collaboration, and the effective dissemination of technological advancements across various sectors.

4. Technology Transfer Policy in Singapore

Singapore distinguishes itself amongst Association of Southeast Asian Nations (ASEAN) Member States for its success in implementing technology transfer policies. Within the country, the pivotal roles of technology transfer and collaboration with industry are evident in the country's two primary universities and five polytechnical schools. In addition to these higher education institutions, the Agency for Science, Technology and Research (A*STAR) oversees 12 research institutes. This organisational framework underscores the Government of Singapore's explicit commitment to advancing and cultivating technology transfer within the nation. Figure 12.2 shows the general overview of the technology transfer policy in Singapore.

Figure 12.2. Technology Transfer Policy in Singapore



IP = intellectual property, R&D = research and development.

Sources: Cheah, Bellavitis, Muscio (2021), Kian et al. (2017), WIPO (2020), Lee and Win (2004); Liu, Subramanian, Hang (2021).

4.1. Commercialising Inventions

In Singapore, the two primary universities and five polytechnical schools hold a central position in technology transfer and industry collaboration. Additionally, A*STAR oversees 12 research institutes beyond these higher education establishments.

4.2. Profiting from Original Industrial Designs

Protection for industrial designs. In Singapore, safeguarding industrial designs pertains to configurations, patterns, shapes, or ornaments applied to articles through industrial processes. To be eligible, the design must exhibit novelty, which must be applied to an article through an industrial process, indicating an intention to produce or to have produced more than 50 copies of the article for commercial purposes.

Government. The Ministry of Information, Communications, and the Arts serves as the primary coordinating agency for the advancement of the design industry in Singapore. Established in August 2003, the DesignSingapore Council leads a national endeavour aimed at the cultivation and advocacy of design within the country. The council is responsible for executing initiatives to cultivate design-centric sectors such as architectural services, advertising services, visual communications design, interior design, fashion design, and product and industrial design. Additionally, it promotes Singaporean design on the international stage. In pursuit of fostering a more pervasive design culture within Singapore, the council initiates programmes to enhance design awareness in educational institutions, public establishments, and various activities.

Education. The instruction in design is integrated into the mandatory design and technology curriculum in lower secondary school (i.e. ages 13–14 years) and is elective during upper secondary education (i.e. ages 15–16 years). Specialised institutions, such as polytechnical schools and art schools, like the Nanyang Academy of Fine Arts and Lasalle College of the Arts, confer diplomas across various design disciplines. Furthermore, design modules are incorporated into the engineering programmes at Nanyang Technological University and National University of Singapore (NUS), where a master's programme in design technology is offered at the Singapore University of Technology and Design in collaboration with the Eindhoven University of Technology within the NUS Faculty of Engineering. The NUS extends its academic offerings to include degrees in architecture and industrial design through its School of Design and Environment.

Competitions and awards. Singapore hosts a variety of design competitions, exemplified by an initiative conducted by Samsung Asia, which involved the conceptualisation of covers and accessories for Samsung's MP3 player. Additionally, the Singapore Design Award, established by Enterprise Singapore in 1988 and administered by the Design Business Chamber Singapore since 2000, stands out as a prestigious international accolade recognising exceptional innovations globally. Open to both Singaporean and foreign designers, it encompasses diverse competition categories, including product design, graphic design, interactive design, and packaging design.

Design projects. Numerous design initiatives receive support or sponsorship through the DesignSingapore initiative. An example is the Singapore Design Festival 2005.

4.3. Contribution of Trademarks to Business Development

Trademarks. These play a crucial role as indicators of the origin of goods or services, enabling consumers to recognise and to differentiate between various brands. They offer legal protection for owners by prohibiting others from using similar logos or names that could mislead or deceive consumers. Securing trademark rights allows businesses to exclusively use their brand, fostering brand recognition, credibility, and customer loyalty. Consequently, trademarks enhance a business's competitiveness and help preserve its market share.

Trademark protection. In Singapore, the registration of a trademark remains effective for 10 years from the date of application. Sustained protection beyond this period is contingent upon the regular payment of renewal fees and the continued appropriate utilisation of the trademark. Applicants seeking trademark protection can opt for online submission via eTradeMarks or choose the traditional route of submitting a paper application to the Registry of Trademarks at the Intellectual Property Office of Singapore. Following submission, the application undergoes a sequence of procedures, including formal examination, search, examination, and publication, before culminating in the registration process. The anticipated timeline for processing a trademark application is estimated to be 4–6 months.

Use of trademarks. Numerous small and medium-sized enterprises (SMEs) in Singapore have achieved notable success and robust business growth by strategically investing in branding. Particularly prominent in this success are companies within the food and beverage sector, such as Barang Barang, BreadTalk, Expressions, and Ya Kun. The prevalence of private enterprises specialising in branding services further underscores the significance of this practice. Enterprise Singapore, operating as a statutory board under the Ministry of Trade and Industry, offers a comprehensive directory featuring contact details for approximately 50 brand specialists on its official website. Recognising the pivotal role of branding in facilitating business expansion, Enterprise Singapore has inaugurated the Branding for Internationalisation Programme aimed at assisting Singapore-based firms in establishing a global footprint.

Brand awards. Annually, Enterprise Singapore conducts the Singapore Prestige Brand Award ceremony with the aim of honouring the 15 most valuable Singaporean brands. This award is determined through a desktop evaluation, relying solely on publicly accessible information. The valuation process adheres to the internationally recognised and accepted methodology consistent with the one employed in the annual Best Global Brand competition, a collaborative publication by *Business Week* and Interbrand.

4.4. Contribution of Copyright

Automatic protection. In Singapore, copyright protection is inherently granted to creators upon the creation and fixation of their work in a tangible form. Registration is not a prerequisite for securing copyright protection; it is automatically conferred to creators. Therefore, as long as a work is independently created, it enjoys copyright protection. If two distinct works, originating from the same idea, are independently created, each work is eligible for separate copyright protection.

Awareness programmes. The Honour Intellectual Property (HIP) Alliance is a collaborative entity comprising government agencies, private organisations, and industry associations united by a shared commitment to advance education on intellectual property. In conjunction with the Intellectual Property Office of Singapore, the HIP Alliance is dedicated to instilling a culture of respect and recognition for original creative works. Its mission is encapsulated in the campaign, 'Saying No! to Piracy', which aims to educate individuals on the importance of acknowledging and rewarding the efforts of creators while discouraging intellectual property infringement.

Circumvention of technological measures. Given the growing ease with which digital copyright works can be replicated and shared, there is a pressing need to extend legal protection to the technological measures employed by copyright owners. This protection aims to prevent unauthorised access and to restrict the unauthorised use of their works, recognising the imperative of safeguarding digital content in the contemporary landscape.

Rights management information. Rights management information encompasses details that identify the creator of a work and the terms and conditions governing the use of that work. In the electronic domain, this information may be affixed to or integrated into a copy of the work. Alternatively, it may be presented in conjunction with the communication or public dissemination of a copy of the work. This practice is essential for providing transparency and clarity regarding the ownership and usage parameters associated with a particular creative work.

Economic contribution of core copyright industries. In 2004, NUS Consulting conducted a study to assess the economic impact of the core copyright industries in Singapore (Kah et al., 2004).The evaluation focussed on three primary indicators – output, value added, and employment. It identified five key copyright industries – software and databases; press and literature; music, theatrical productions, and opera; advertising services; and radio and television. These sectors were central to the analysis, providing insights into their respective contributions to Singapore's economy through the mentioned indicators.

4.5. Valuation and Assessment of Intellectual Property Rights

Accounting firms and private consultants in Singapore – inclusive of the major international accounting firms – have traditionally provided intellectual property valuation services tailored for various business applications. Despite the availability of these services, SMEs and startups often perceive them as an additional financial burden, given their constrained budgets. Many prefer to utilise their own valuation methods, such as the market approach, cost approach, or income approach. However, it is important to note that these generic methods may not be universally applicable to every valuation scenario.

Challenges arise when dealing with sophisticated technical domains, such as emerging technology fields where there are no established benchmarks. In such cases, the valuation process becomes more intricate, relying heavily on the technology's positioning within the market. This complexity can pose a significant hurdle for businesses seeking accurate assessments of the value of their intellectual property.

Generally, except for select startups, smaller SMEs in Singapore tend to not perceive intellectual property as an asset that can be leveraged for securing funding. Instead, intellectual property is often viewed as an additional cost, incurring more expenditure, which is met with aversion. Consequently, intellectual property tends to have a lower priority for SMEs, given their focus on day-to-day survival.

The lack of a concrete policy on intellectual property asset security within banks further compounds this situation. The concept of intellectual property as a tangible asset is still relatively new in Singapore, and SMEs, as a result, do not habitually list intellectual property on their balance sheets. Notably, there has been a rise in startups, particularly spinoffs resulting from intellectual property generated during research at the two universities. However, even with this growing trend, the valuation for seed funding remains a complex process. NUS, in such cases, employs its in-house expertise, relying on a formula that integrates income projections, market trends, and the inventor-entrepreneur's track record and merchandising.

4.6. Access to Capital Based on Intellectual Property Assets

Singapore provides a diverse array of financial schemes tailored to entrepreneurs and researchers, encompassing various stages of business development and research endeavours. These schemes encompass the following.

(i) **Seed funding for startups**. Initiatives designed to provide initial capital and support to nascent businesses at their early stages of development.
(ii) **Research and development grants**. Funding programmes aimed at supporting research activities, encouraging innovation, and advancing technological capabilities.
(iii) **Loans and subsidies**. Financial assistance in the form of loans and subsidies, often sourced from public entities, to aid in business growth and innovation.
(iv) **Venture funding from private sources**. Support from private investors, such as venture capitalists, to fuel the growth and expansion of innovative ventures.

These financial schemes are instrumental in fostering a dynamic entrepreneurial ecosystem by providing crucial support across various facets of business and research initiatives in Singapore.

5. Enabling Factors to Advance Technology Transfer and Policy Implications

Effective communication and knowledge dissemination are imperative for the successful transfer of technology. Motivation plays a crucial role in driving increased licensing activity, emphasising the significance of their engagement in transfer activities (Cummings and Teng, 2004; Thomas et al., 2020). Informal interactions with industry contribute positively to research collaboration, underscoring the role of individual actors in academic entrepreneurship as facilitators in the journey from laboratory to market (Ponomariov and Boardman, 2008).

The competence and motivation of a team significantly influence the absorption of technology within an innovation alliance. Both research- and market-oriented TTOs have a favourable impact on licensing activities (Soares and Torkomian, 2021). Incubators are instrumental in new product development and economic growth. The licensor's knowledge about the technology source within the transferor positively affects technology licensing (Dos Reis and do Carmo Durate Freitas, 2014; Lopes et al., 2018; Murovec and Prodan, 2009; O'Kane et al., 2017).

Management support is identified as a vital factor for researchers' engagement in technology transfer, and its absence can act as an inhibitor (D'Este and Perkmann, 2011). Adequate training is essential for the absorption of technology in the industry (Sung, 2009). Technology transfer positively influences the quality and quantity of research and society and vice versa (Veiga et al., 2020). The quality of work in public institutions significantly affects entrepreneurship, innovativeness, and competitiveness (Berbegal-Mirabent, 2018; Bradley, Hayter, Lin, 2018; Heher, 2006; Scuotto et al., 2020).

Research and innovation serve as critical drivers for the economic development of both industry and a country (Bozeman, 2000). Innovativeness is a prerequisite for academic entrepreneurship, creating avenues for research opportunities (Bornmann, 2013). Proactive policies and actions enhance transfer efficiency, and the return on investment from research and development requires consistent policy support. Exploration of technology licensing modes, beyond traditional linear approaches, aims for more impactful technology transfer (Fini et al., 2018).

Financial support instruments facilitate the development of investment-ready products, contributing to potent technology transfer. In the quintuple helix paradigm, societal impacts are identified as drivers for technology generation and adoption. Globally, the success of technology transfer has been extensively examined across various parameters, including diffusion, commerce, politics, environmental benefits, replacement benefits, human resources, and economics. Recent attention has been given to public value, encompassing the entire spectrum of sustainability (Lema and Lema, 2012).

Moreover, the policy implications pertaining to technology transfer in ASEAN Member States regarding net-zero emissions targets are intricate and encompass a spectrum of strategic measures designed to cultivate sustainable and low-carbon practices (Ambashi, 2010). These policy considerations are instrumental in steering the transition towards cleaner technologies and ameliorating the impacts of climate change. The following delineates key policy implications:

Renewable energy transition policies. The imperative lies in the implementation and reinforcement of policies that advocate the transition to renewable energy sources, including solar, wind, hydro, and geothermal. The setting of ambitious targets, provision of incentives, and establishment of a regulatory environment conducive to the adoption of clean energy technologies are indispensable for accelerating this transition.

Energy-efficiency measures. Introducing and enforcing policies to enhance energy efficiency across diverse sectors such as industry, transport, and buildings are paramount. This involves the establishment of energy-efficiency standards, promotion of energy-efficient technologies, and incentivisation of energy-saving practices.

Decentralised energy systems. Policies supporting the development of decentralised and distributed energy systems assume significance in bolstering energy resilience and diminishing reliance on centralised fossil fuel-based power generation. Incentives for community-based renewable energy projects and the establishment of microgrids constitute potential avenues.

Carbon-pricing mechanisms. The implementation of carbon-pricing mechanisms, such as carbon taxes or cap-and-trade systems, is a strategic approach to create economic incentives compelling businesses and industries to curtail their emissions. This approach internalises the cost of carbon, thereby encouraging the adoption of cleaner energy alternatives.

Incentives for sustainable transport. Policies geared towards fostering the adoption of electric vehicles, enhancing public transport infrastructure, and endorsing non-motorised transport alternatives are integral components in abating emissions originating from the transport sector. Incentivisation mechanisms, such as tax breaks or subsidies, can galvanise the adoption of sustainable transport technologies.
Support for research and development. The pivotal role of investing in research and development on clean energy technologies is underscored. Policies that lend support and financial backing to research institutions, startups, and businesses engaged in the evolution of sustainable energy solutions serve as catalysts for expediting the transition towards a low-carbon economy.

International collaboration and cooperation. Collaborative initiatives and the exchange of information on best practices for realising net-zero emissions within the ASEAN context are emphasised. Regional cooperation serves as a facilitative mechanism for technology transfer, capacity building, and the reciprocal sharing of experiential insights.

Capacity building and education. Policies should be strategically formulated to orient efforts towards enhancing the capacity of institutions, industries, and the workforce to navigate the terrain of clean energy technologies. Educational programmes and training initiatives assume a pivotal role in preparing the workforce for the shift towards a low-carbon economy.

Adaptation and resilience policies. Policies are urged to incorporate measures for climate adaptation and resilience. Such policies entail strategies to contend with shifting weather patterns and potential repercussions on energy infrastructure.

Fiscal and financial incentives. The provision of fiscal and financial incentives, including subsidies, grants, and low-interest loans aimed at encouraging investments in clean energy projects, is posited as a mechanism to entice private sector engagement and to stimulate economic growth concurrently with the pursuit of net-zero emissions.

Collectively, these policy implications constitute a comprehensive framework that, if implemented cohesively, can strategically guide Lao PDR and ASEAN Member States towards the realisation of their technology transfer. This approach not only promotes sustainability within the region but also contributes substantively to global endeavours aimed at combatting climate change.

6. Conclusion

This chapter has presented a nuanced understanding of the factors propelling technology transfer and the intricate policy landscape essential for fostering a sustainable and low-carbon future in ASEAN Member States, including Lao PDR. The plausible enabling factors for advancing technology transfer underscore the significance of effective communication; motivation; research collaboration; and the pivotal roles played by TTOs, incubators, and management support. These factors contribute to the journey from laboratory innovation to market application, emphasising the intricate interplay required for successful technology transfer.

The policy implications for technology transfer in ASEAN Member States towards achieving net-zero emissions present a comprehensive framework encompassing strategic measures aimed at cultivating sustainable practices. The policies cover renewable energy transitions, energy-efficiency measures, decentralised energy systems, carbon-pricing mechanisms, sustainable transport incentives, research and development support, international collaboration, capacity building, education, and adaptation and resilience policies. This holistic framework, if implemented cohesively, serves as a strategic guide to realise net-zero emissions, promoting sustainability within the region and contributing to global climate-change mitigation efforts, with technology transfer as an enabler.

The identified policy implications offer tangible pathways for ASEAN Member States to navigate the complex challenges associated with technology transfer and energy sustainability. The success of these policies hinges on their effective implementation, fostering collaborative efforts, and adapting strategies in response to evolving technological landscapes and socio-economic conditions. Regular monitoring and evaluation are paramount to ensuring that policies remain adaptive and efficacious in navigating the complex terrain of technology transfer and energy sustainability.

7. Remarks

Advancing technology transfer and attaining net-zero emissions in ASEAN Member States demand a systematic integration of plausible enabling factors and strategic policy measures. This imperative underscores the need for a concerted effort from diverse stakeholders, including academic institutions, industry entities, policymakers, and the broader community. This chapter delineates key considerations for the strategic trajectory ahead:

(i) **Strengthen collaboration and communication**. Advocate for the creation of collaborative platforms facilitating effective communication and knowledge dissemination amongst academia, industry, and policymakers; and emphasise interdisciplinary collaboration to address intricate challenges and to amplify the impact of technology transfer initiatives.

(ii) **Motivate engagement**. Implement targeted strategies to augment motivation, recognising their pivotal role as drivers in technology transfer; and institute reward mechanisms, recognition programmes, and career development opportunities for personnel actively engaged in technology transfer activities.

(iii) **Enhance team competence**. Invest judiciously in continuous training programmes aimed at enhancing the competence of technology transfer teams within innovation alliances; and promote cross-functional teams, amalgamating diverse expertise for a comprehensive approach to technology transfer.

(iv) **Optimise TTOs and incubators**. Reinforce both research- and market-oriented TTOs, ensuring their proactive involvement in facilitating licensing activities; and harness the catalytic potential of incubators for fostering new product development, economic growth, and the transition to a low-carbon economy.

(v) **Promote management support**. Advocate fervently for robust management support for researchers involved in technology transfer, recognising its pivotal role in overcoming barriers; and incorporate considerations of technology transfer into institutional management strategies.

(vi) **Invest in research and development**. Prioritise strategic investments in research and development for clean energy technologies, fostering innovation aligned with sustainability goals; and institute funding mechanisms supporting startups and research institutions dedicated to clean energy solutions.

(vii) **Foster international collaboration**. Strengthen collaborative ties with international partners to promote joint research, technology transfer, and knowledge exchange; and actively participate in global initiatives focussing on sustainable development and technology transfer for climate-change mitigation.

(viii) **Build capacity**. Develop and implement targeted policies for capacity building at institutional, industrial, and workforce levels; and expand educational programmes and training initiatives to equip the workforce with the requisite skills for transitioning to a low-carbon economy.

(ix) **Develop climate-change adaptation and resilience policies**. Integrate climate-change adaptation and resilience measures into technology transfer policies, considering potential climate-change impacts on energy infrastructure; and develop comprehensive strategies to enhance the resilience of clean energy systems to changing environmental conditions.

(x) **Provide fiscal and financial incentives for clean energy investments**. Provide well-targeted fiscal and financial incentives, including subsidies, grants, and low-interest loans, to attract private sector engagement in clean energy projects; and align financial incentives with broader goals, emphasising the attainment of net-zero emissions and sustainable economic growth.

Hence, the successful integration of these strategies necessitates a collaborative and adaptive approach, marked by continuous monitoring and evaluation. This adaptive approach ensures the refinement of policies based on evolving technological landscapes and socio-economic conditions. By addressing the identified enabling factors and policy implications, Lao PDR can strategically navigate challenges, aligning with its energy goals and ASEAN chair roles in 2024, fostering a sustainable and resilient future, thereby significantly contributing to global climate-change mitigation efforts through effective and innovative technology transfer policy.

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