

LESS TRASH, MORE TREASURE

Exploring niche strategies for large-scale diffusion of waste valorisation technologies by circular companies in Asia



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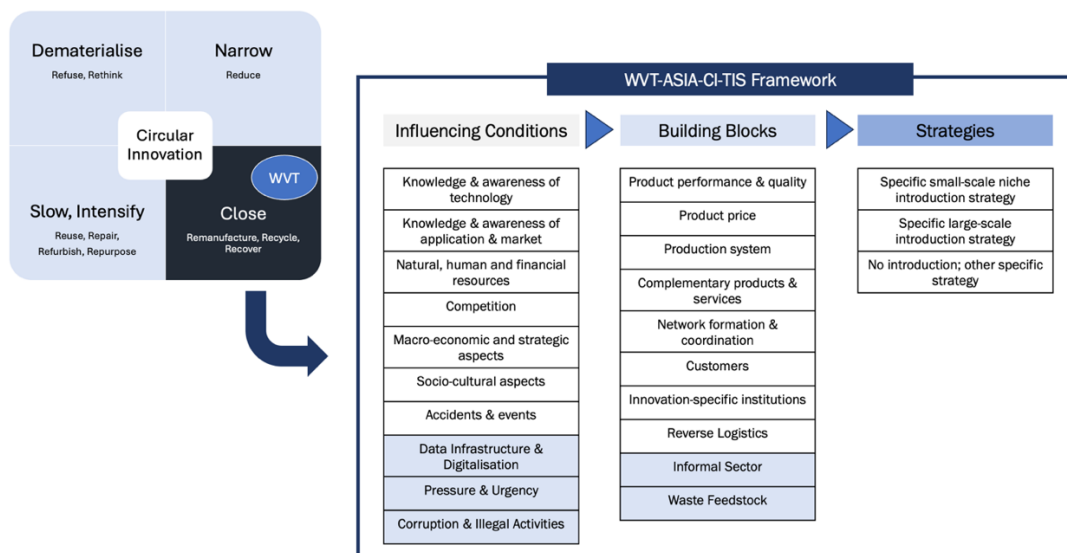


EXECUTIVE SUMMARY

Every year, the world generates 7-10 billion tonnes of waste. Rapid population growth, urbanization, and increased consumption is projected to increase this number by 70% in 2050. Asia generates the most waste globally and also imports a significant amount of waste from other regions. The production, import and management of waste pose serious health risks and environmental problems. Traditional waste management methods, such as landfilling and incineration, are unsustainable and contradict the principles of resource conservation. Out of the waste collected worldwide, only 15% is recycled, with the remaining 85% sent to landfills, including open dumps. Notably, 17 of the world's 50 largest dumpsites are located in Asia.

Waste valorisation can be a crucial solution for sustainable waste management in Asia. This circular innovation transforms waste into higher value products, offering both environmental and economic benefits. Despite the existence of waste valorisation technologies (WVT), they have not been widely implemented due to numerous technological, financial, regulatory, institutional, social and market risks. Niche strategies can play a role in minimising these risks, but identifying the right ones and understanding the market conditions for their deployment can be challenging for companies.

The Technological Innovation System (TIS) framework lays out a comprehensive approach to formulate and study niche introduction strategies from a company perspective. Originally developed by Ortt & Kamp (2022), it was later modified by Engelen (2023) for the context of circular innovations. This research builds on these two works and adapts the framework to the contexts of Asia and the waste valorisation industry. New drivers and barriers were discovered via a literature review of 57 papers, yielding two new building blocks (BBs): 'Informal Sector' and 'Waste Feedstock'. For influencing conditions (ICs), two new factors were also added: 'Pressure & Urgency' and 'Corruption & Illegal Practices'. The existing IC 'Data Infrastructure' was modified with a heavier emphasis on digitalisation to capture the role of digital platforms and artificial intelligence. These changes resulted in the Asia-CI-TIS framework and the WVT-CI-TIS framework that, when combined into the WVT-Asia-CI-TIS framework, allows for a thorough analysis of conditions affecting waste-valorising companies in Asia and the appropriate niche strategies to implement.



The adapted and combined WVT-Asia-CI-TIS framework was applied to four case studies of Asian waste-valorising companies: EnviroTech in the Philippines, Ricron Panels in India, Kinava in South Korea, and Less & Co in Singapore. The status of the BBs and ICs for each case study was determined via interview or questionnaire with the companies. The TIS framework analysis identified lacking BBs and ICs in 20 different permutations, leading to barriers that can be grouped into 3 categories: 1) lack of customer demand, 2) incomplete or inefficient operations, and 3) lack of institutional support. Further analysis of

the strategies implemented by these companies, coupled with an exploration of additional appropriate niche strategies in the literature, resulted in a total of 41 niche strategies that can serve as a resource for companies facing similar barriers.

Barrier	Strategies Implemented	Additional Strategies
Lack of customer demand	#1: Educate & Raise Awareness #2: Product-as-a-Service #3: Product variants #4: Partnership & Alliance #5: Lead User #6: Third-party accreditation #7: Demonstrate value #8: Social media marketing #9: Explore multiple markets #10: Market positioning	#18: Giveaway #19: Aggressive penetration #20: Social proof #21: Stepping-stone #22: Crowdfunding #23: Influencer marketing #24: Leverage user-generated content #25: Remarketing & Retargeting #26: Sales Funnel Optimisation #27: Get specified #28: Money-back guarantees #29: Offer incentives #30: Product scarcity #31: Transparency & Accountability #32: Result-oriented contracting #33: Creative customer payment
Incomplete or inefficient operations	#1: Educate & raise awareness #11: Grants & Awards #12: Standalone / In-house #13: Simplify #14: Agility, Adaptability & Resilience #15: Local #16: Outsource	#34: Angel investors #35: Resource sharing #36: Knowledge sharing #37: Collaborative innovation #38: Digitise knowledge management #39: Contingency Planning
Lack of institutional support	#4: Partnership & Alliances #17: Advocacy	#40: Build authority & trust #41: Form 'pressure groups'

It is important to note that these 41 niche strategies are specific to the barriers found within the four case studies and may not be representative or applicable to all Asian companies with WVT. As conditions constantly change and new methods are continually being developed, companies should seek the most up-to-date evidence for effective niche strategies, guided by the WVT-Asia-CI-TIS framework. As demonstrated by this research, other circular companies can utilise the WVT-Asia-CI-TIS framework and replicate the process of formulating niche strategies that are tailored to their specific circumstances.

In conclusion, to achieve large-scale diffusion of WVT in Asia, companies must first understand and identify the barriers and drivers affecting their businesses. The adapted WVT-Asia-CI-TIS framework can help them systematically analyse these factors and assess whether the conditions are suitable for large-scale introduction strategies or small-scale niche strategies. If conditions are favouring the latter, the adapted TIS framework can provide an insightful big-picture of what BBs are lacking and what ICs can be used to influence progress. Companies should then formulate niche strategies that overcome the identified barriers or leverage the most advantageous drivers.

This research contributes to the scientific literature by highlighting the significant issues surrounding waste accumulation and waste management in Asia, as well as the role and contribution of WVT in material recovery and improved waste management. It also identified new and overlooked factors, such as the informal sector, corruption and illegal activities, that could have a major impact on the TIS. Furthermore, this research identified drivers and barriers faced by four Asia-based companies with WVT, along with appropriate niche strategies that can help them achieve success. Altogether, it presents a process for other circular companies to replicate and tailor to navigate their own set of barriers and drivers for large-scale diffusion. In addition, the cross-comparisons between different Asian countries and WVT via the case studies provided insights into circular innovation in Asia and the WVT industry, that can inspire and inform future policies and research.

Future research could address the framework's limitations, namely the subjectivity in the TIS analysis and the inability to account for fast-changing conditions. A deeper understanding of the newly discovered factors, as well as the timing and sequencing of the niche strategies, could also be areas of interest to further pursue. Following this research's methodology, researchers could further extend the TIS framework's applicability to other regions or other specific forms of circular innovation. Finally, the assumption that circular innovations are inherently circular and sustainable could be tested using assessment tools or indicators to address the paradox between waste valorisation, circularity and sustainability.

5. CASE STUDIES

5.2 RICRON PANELS

5.2.1 ABOUT RICRON PANELS

Ricron Panels, a company based in India, collects multi-layered laminate plastic waste from the Fast Moving Consumer Goods (FMCG) and pharmaceutical industries that are of low value and difficult to recycle. The company converts the plastic into building materials such as construction panels and wood substitutes. The waste-based products can be applied in various ways, including flooring, roofing, brick pallets, and furniture. Started in 2014 as a pilot project, the company commercialised between 2015-2016 and now sells their products globally, including the US, Europe, Africa, the Middle East and Asia.

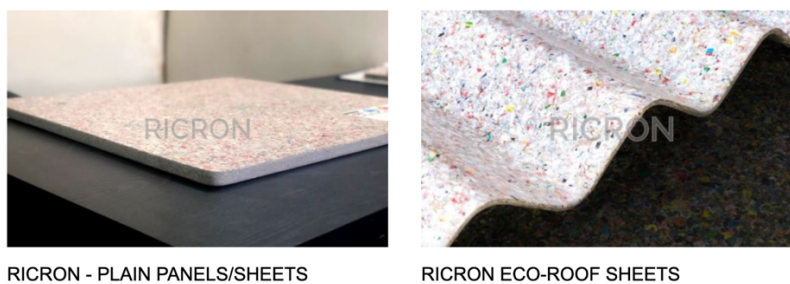


Figure 1. Ricron Panel's waste-based building products, from www.ricron.com

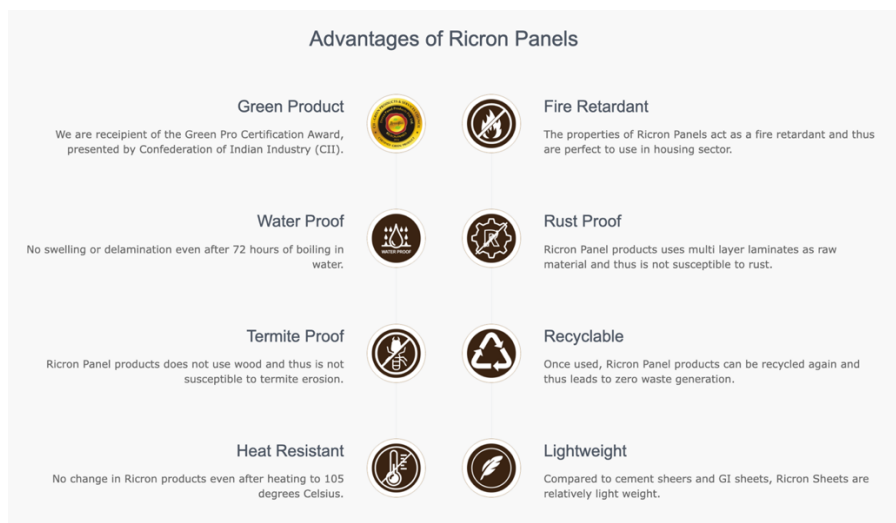


Figure 2. Advantages of Ricron Panel's waste-based building products, from www.ricron.com

5.2.2 WVT-ASIA-CI-TIS FRAMEWORK ANALYSIS OF RICRON PANELS

The responses from Ricron Panels were analysed and categorised according to the BBs and ICs. They are summarised below, and from there, the status of each BB and IC was determined.

Legend for status:

	Very supportive of large-scale diffusion
	Moderately supportive of large-scale diffusion
	Not supportive of large-scale diffusion
	Not applicable to large-scale diffusion

Building Blocks

Table 1. Building Blocks for Ricron Panels

Building Blocks	Applicability to Ricron Panels	Status
Product performance & quality	Ricron Panels' products are of good quality and solve a major problem involving water absorption and subsequent infestation of building materials. Their products are capable of solving specific problems of their clients (e.g. acid-proof floors for the Indian railway companies, better circular temporary housing for construction projects), which appeal directly to their clients and make their a products a no-brainer option to go with.	
Product price	The products are priced competitively with other construction options, while offering better quality and additional benefits. One client cited a 40% savings when using the company products in their construction project.	
Production system	Ricron Panels cited major logistical challenges in the beginning, as there were a lot of processes that went into the execution of the waste valorisation. The company currently manages the entire production in-house, with the purpose of making the processes easier to control and scale up.	
Complementary products & services	The company did not cite any complementary products or services that played a significant role in their business.	
Network formation & coordination	While production was gradually taken up in-house, the company had to develop a distribution network in order to reach and serve prospective clients. The company also worked with non-governmental organisations (NGOs), both in waste collection (such as river clean-ups) and in construction projects (such as building affordable housing for the marginalised communities). In addition, the company credited their success to the network of entrepreneurs and experts doing similar things and with similar goals.	
Customers	The lack of customer awareness and markets for waste-based products were the biggest barriers cited by the company. They invested significantly in educating their customers on a 1-on-1 basis and in developing a strong business case that catered to the specific problems of the client.	
Innovation-specific institutions	While the company was not born out of a government policy and did not rely on institutions much in the early stages, they are having more direct and active engagement with the government now, including a collaboration in which the government provided the company land for free to build their factory on. The company sees a positive shift in government policies and stated that they are satisfied with the policies put in place. However, they also noted the lack of regulations and policing on waste management, and suggested that further support such as tax breaks would be helpful. On the industry level, the company benefited from the Green Pro Certification Award by the Confederation of the Indian Industry, which boosted the credibility of their products.	

Reverse logistics	Ricron Panels noted the inadequate waste management infrastructure in India as a general barrier. They struggled initially with the procurement of the plastic waste, as the market for it was unchartered, undefined and unorganised, with no significant traders or transparent pricing. The company currently works with organisations to source their waste feedstock, but plan to also do the waste collection in-house in the future. They see their business as two-pronged: waste collection and production of waste-based products.	
Informal Sector	The company acknowledged the problems with the informal sector, which they deemed unfair and predatory to the informal workers. The company does not deal directly with the informal sector, but works with organisations who employ the informal workers in compliance with the relevant guidelines and provision of benefits such as healthcare. They also strongly felt that not enough is being done to assist the informal sector.	
Waste feedstock	The company obtains their waste feedstock from other organisations, and do not face issues with availability or seasonality, as the type of waste (multi-layered plastic) they work with is constantly abundant in the waste stream. In terms of quality and risk of contamination, their WVT was designed to handle such issues and their production system is able to deal with the waste feedstock quality accordingly.	

Influencing Conditions

Table 2. Influencing Conditions for Ricron Panels

Influencing Condition	Applicability to Ricron Panels	Status
Knowledge & awareness of technology	Ricron Panels experimented with different materials and processes to come up with viable products. The company faced logistical challenges in the beginning while introducing and scaling up production of their waste-based products and had to invest heavily in training and capacity building of their staff.	
Knowledge & awareness of application & market	The use of waste-based products for construction was new for the Indian market, and Ricron Panels had to put in significant efforts to educate their potential customers regarding their products.	
Natural, human and financial resources	Ricron Panels struggled with obtaining financial and human resources. They managed to secure financial support in the form of grants and financing instruments from different organisations. As the company grew, they opted to manage the entire production process in-house for better control, even though it required significantly more human and financial resources as they believed the benefits outweighed the costs.	
Competition	The company did not cite competition as a major barrier, as their product was very competitive in terms of quality and price.	
Macro-economic and strategic aspects	Ricron Panels recognised the situation in India (large demography and high waste generation) and the strategic need for a sustainable solution to the plastic waste issue. While the company didn't engage much with the government in the beginning, they do see increasing government support and policies for sustainability initiatives, and are now receiving benefits from the government such as free land to build their factory on.	
Socio-cultural aspects	The company recognised that the Indian society was seeking and willing to pay for more sustainable options, and believed that the average Indian citizen understood the logic and need for sustainability.	
Accidents & events	No accident or event was cited by the company as being a driver or barrier.	
Data infrastructure & digitalisation	Data and digitalisation were not cited as a major driver or barrier by the company.	

Pressure & urgency	Ricron Panels was internally-driven to pursue the business mainly due to the awareness of the waste issues and the urgency to develop solutions to mitigate the risks. One of the reasons they chose to narrow down to the construction industry is due to its significant environmental impact due to the sheer amount of materials consumed. They find the scale of the issues worrying, and the company website goes into great detail on the environmental challenges being faced and how Circular Economy can be a solution, as part of their effort to educate others. The company also believes the Indian society is aware of the issues and is supportive of efforts to improve them.	
Corruption & illegal activities	The company mentioned in general terms that waste in India was being discarded in illegal ways, causing harmful pollution to the environment, but did not cite any corruption or illegal activities that affected the company directly.	

No new drivers or barriers were mentioned by the company that were not already covered by the framework. It should also be noted that a few BBs and ICs were not relevant in the case of Ricron Panels, including Complementary Products & Services, Competition, Accidents & Events, Data Infrastructure & Digitalisation, and Corruption & Illegal Activities.

The figure below summarises the WVT-Asia-CI-TIS analysis of Ricron Panels:

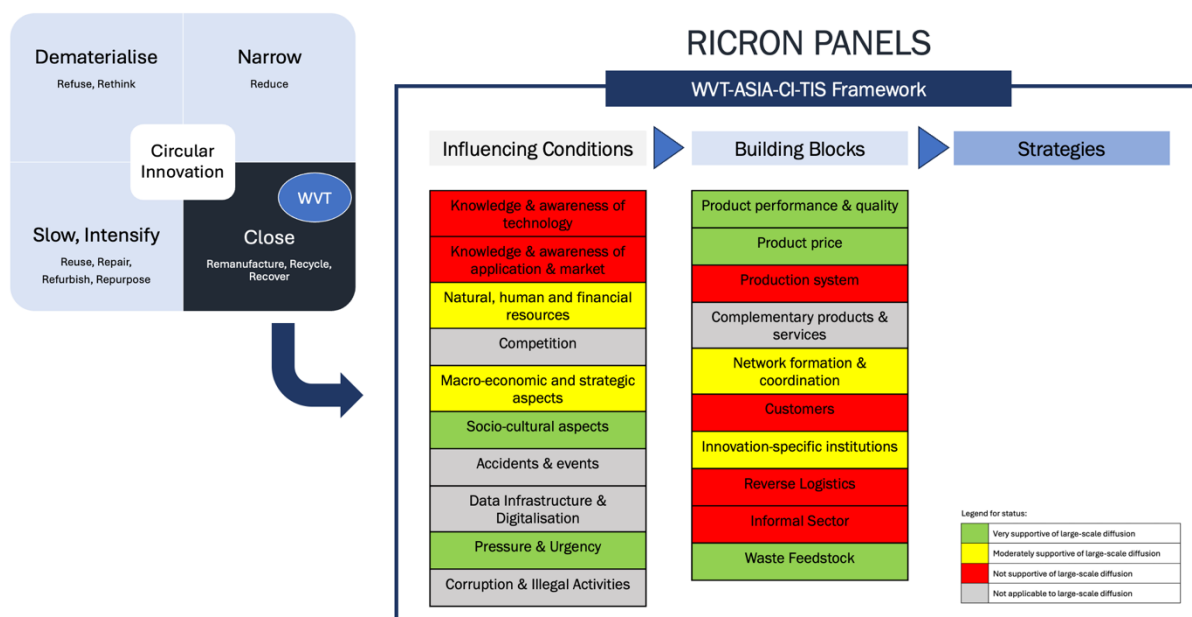


Figure 3. Summary of the WVT-Asia-CI-TIS analysis of Ricron Panels

Barriers

Ricron Panels struggled with the lack of consumer awareness and market for their products, consumer scepticism over the quality of their waste-based products, lack of a distribution network in order to reach prospective customers, and insufficient infrastructure for reverse logistics. They also had to invest in internal capacity building while scaling up to strengthen the knowledge of the technology among their staff. The company received little government support in the beginning but did benefit from other institutional support, and remain concerned over the prevailing issues affecting the informal sector that they indirectly work with.

Link Between BBs, ICs and Barriers

As discussed in Section 2.4, the status of the BBs provide an idea of the existing barriers to large-scale diffusion of the technology or product, and the ICs help explain why these barriers are present. In the case of Ricron Panels, the table below links the unsupportive BBs with the relevant ICs, and finally to the resulting barrier:

Table 3. Linkages between unsupportive BBs, the relevant ICs and resulting barriers for Ricron Panels

Unsupportive BBs	Relevant ICs	Explanation	Barriers
Customer	Knowledge & awareness of application & market	Given the novelty of the waste-based products, knowledge needed to be built among customers, who further required convincing business cases that prove Ricron Panel's products were the better option for them compared to similar competitive products.	Lack of customer demand
	Data infrastructure & digitalisation	Ricron Panels didn't mention using data and digitalisation, which could have caused them to miss out on useful data and digital platforms to reach and educate potential customers.	
Production System	Knowledge & awareness of technology	Ricron Panels faced logistical challenges in the beginning while introducing and scaling up production of their waste-based products due to unfamiliarity with the technology.	Incomplete or inefficient operations
	Natural, human and financial resources	The company invested heavily in training and capacity building of their staff in order to build up the knowledge of the technology and products internally.	
	Data infrastructure & digitalisation	Ricron Panels didn't mention using data and digitalisation, which could have caused them to miss out on useful data and digital tools to manage their production system.	
Network formation & coordination	Natural, human and financial resources	Ricron Panels built their distribution network from scratch in order to reach potential customers, which required resources from their side.	
	Knowledge & awareness of application & market	In building the distribution network, Ricron Panels had to educate their distribution partners and increase the knowledge regarding their waste-based products.	
	Data infrastructure & digitalisation	Ricron Panels didn't mention using data and digitalisation, which could have caused them to miss out on useful data and digital platforms to manage the distribution of their products across their network of distributors.	
Reverse logistics	Natural, human and financial resources	The lack of or incomplete infrastructure in India to retrieve waste has caused Ricron Panels to venture into doing waste collection themselves, seeing it as a necessary part of the business. This will require significant human and financial resources.	
	Data infrastructure & digitalisation	Ricron Panels didn't mention using data and digitalisation, which could have caused them to miss out on useful data and digital tools that can help them be more efficient in tracking waste flows and managing collection activities.	

Innovation-specific institutions	Macro-economic & strategic aspects	There were no innovation-specific policies or resources made available for Ricron Panels that they could benefit from, though that changed in later stages.	Lack of institutional support
Informal sector	Macro-economic & strategic aspects	While Ricron Panels's interaction with the informal sector is indirect, the company sees a significant need for improvement of the working conditions within the sector that will need to come from top-down government authority.	
	Pressure & urgency	The push to address the problems related to the informal sector will require significant pressure and urgency from stakeholders and the broader society in order to incite change.	

Niche Strategies Implemented by Ricron Panels

In response to the above challenges, Ricron Panels applied a combination of strategies when they transitioned from a pilot project to a commercial enterprise. They opted to focus on the construction industry, where they identified leading clients that had specific problems that they could solve with their products. Two examples demonstrate this: the Indian Railway uses acid batteries for their trains that require re-filling in designated centres, but the acid posed issues due to spillage and corrosion of the facility floors. Ricron Panels was able to solve this issue with their liquid-proof building material. Another example relate to large construction projects that require the building of temporary shelters, toilets and facilities for the construction workers for the duration of the project. Ricron Panels's products enabled the construction company to build the necessary facilities for a similar, if not cheaper, price and better quality, and further compensated the company when they returned the building materials at the end of the construction project, completing the circular nature of the products. From these successful cases, the company then invested a lot of effort into 1-on-1 education with potential customers in order to increase awareness and acceptance of their products. Ricron Panels also partnered with relevant NGOs, both in obtaining plastic waste as a source of feedstock (from NGOs who clean rivers) and in securing business opportunities (from NGOs who build affordable housing for marginalised communities). The company further obtained a Green Pro Certification Award from the Confederation of the Indian Industry, which lent significant credibility to their sustainability claims. While the company did not receive or seek government support, they did benefit from receiving grants and awards from other non-governmental institutions, which provided them with both financial resources as well as expertise in the form of mentors and a network of entrepreneurs. To overcome the issues with reverse logistics, the company plans to take the same strategy as they did with production, which is to undertake those activities in-house by themselves, giving them more control over the process.

The table below summarises the strategies implemented by Ricron Panels in relation to the BBs and ICs being addressed:

Table 4. Summary of niche strategies implemented by Ricron Panels

Barrier	BB	IC	Niche Strategy
Lack of customer demand	Customer	Knowledge & awareness of application & market	<ul style="list-style-type: none"> Educate & Raise Awareness Partnership & Alliances Lead User Third-party accreditation
	Customer	Data infrastructure & digitalisation	No mention of strategy implemented
Incomplete or inefficient operations	Production System	Natural, human and financial resources	<ul style="list-style-type: none"> Grants & Awards Standalone / In-house
		Data infrastructure & digitalisation	No mention of strategy implemented

	Network formation & coordination	Natural, human and financial resources	<ul style="list-style-type: none"> • Grants & Awards
		Knowledge & awareness of application & market	<ul style="list-style-type: none"> • Educate & Raise Awareness
		Data infrastructure & digitalisation	No mention of strategy implemented
	Reverse logistics	Natural, human and financial resources	<ul style="list-style-type: none"> • Grants & Awards • Standalone / In-house
		Data infrastructure & digitalisation	No mention of strategy implemented
Lack of institutional support	Innovation-specific institutions	Macro-economic & strategic aspects	No mention of strategy implemented
		Pressure & urgency	No mention of strategy implemented
	Informal sector	Macro-economic & strategic aspects	No mention of strategy implemented
		Pressure & urgency	No mention of strategy implemented

5.6 ADDITIONAL STRATEGIES FROM THE ADAPTED TIS FRAMEWORK

This section aims to explore additional relevant and appropriate niche strategies that could address the barriers in **Error! Reference source not found.** above. The strategies were pulled from various sources and are non-exhaustive. First, a search was conducted on ‘strategies to overcome X’, with X being one of the barriers identified via the case studies. From there, a selection of strategies was made, backed by literature-based evidence. Rather than aiming to be a complete and exhaustive catalogue that covers all possibilities, the intention is to provide a sampling of strategies that are deemed appropriate for the respective barrier identified.

The table below lists and describes 24 additional strategies that were identified:

Table 5. Additional niche strategies from literature.

Barrier	BB	IC	Strategy (Source)	Description
Lack of customer demand	Customer	Knowledge & awareness of application & market	#18: Giveaway (Hu et al., 2018)	A strategy to giveaway free products, or parts of the product or service, to capture customers’ attention and interest.
			#19: Aggressive penetration (Dwisatyawati, 2022)	A strategy to implement aggressive pricing, marketing and sales force to draw mass attention with the expectation that the innovation will achieve scale and make profits in the future.
			#20: Social proof (Nifita et al., 2023; Scott & Barden, 2022)	A strategy to provide evidence that other people have used and benefited from the product or service, using testimonials, reviews, ratings, case studies or referrals.
		Socio-cultural aspects	#21: Stepping-stone (Dwisatyawati, 2022)	A strategy to target other markets that are geographically or culturally closer to the target market, as a stepping stone and to obtain references or proof of success.
		Natural, human and financial resources	#22: Crowdfunding (Kaartemo, 2017)	A strategy to obtain financing and support from the general masses by conducting a crowdfunding campaign.
		Data infrastructure & digitalisation	#23: Influencer marketing (Dwisatyawati, 2022)	A strategy to collaborate with online influencers who have existing audiences that are relevant to the product’s target customer.
			#24: Leverage user-generated content (Malthouse et al., 2016)	A strategy that prompts consumers to create user-generated content relevant to the brand or product that engages other consumers and lead to purchase decisions
			#25: Remarketing & Retargeting (Yüksel, 2023)	A strategy to reconnect with customers who have made a purchase from the business at least once before or attract the attention of potential customers who have previously visited on social media platforms and websites.

		Competition	#26: Sales Funnel Optimisation (Beco & Zeren, 2023)	A strategy to optimise and manage the sales funnel using data and insights gained from online tools and social media.
			#27: Get specified (Dwisatyawati, 2022)	A strategy to be specified and mentioned in technical specifications of projects made by consultants or policy makers.
			#28: Money-back guarantees (Z. Huang et al., 2021)	A strategy to reduce customers' concerns about purchasing the products by providing a money-back guarantee in case of dissatisfaction with the product.
			#29: Offer incentives (Berman, 2006, 2016; Dwisatyawati, 2022)	A strategy to provide incentives to customers or partners to make product adoption and continued patronage more attractive and beneficial, such as referral rewards and loyalty programmes.
			#30: Product scarcity (Barton et al., 2022; Ortt et al., 2013)	A strategy to enhance the value and desirability of a product and increase purchase intentions by signalling its potential unavailability, playing on customers' fear of missing out.
			#31: Transparency & Accountability (Wong et al., 2021)	A strategy to gain trust by exercising transparency and accountability for the company's products, claims, and actions.
	Product price	Knowledge & awareness of application & market	#32: Result-oriented contracting (Dwisatyawati, 2022)	A strategy to provide a result-oriented contract that informs customers about the estimated return-on-investment if they purchase the product or technology in order to assuage their fear and perception of risk.
			#33: Creative customer payment (Dwisatyawati, 2022; Yazdanifard et al., 2011)	A strategy to provide customers with multiple and attractive payment options to encourage purchase decisions, such as instalments, leasing, cross-sell financing, etc.
Incomplete or inefficient operations	Production System, Reverse logistics and Network formation & coordination	Natural, human and financial resources	#34: Angel investors (Ramadani, 2012)	A strategy to seek financing from angel investors, typically successful entrepreneurs with the wealth and experience to help other entrepreneurs, who are driven by different goals other than profit as compared to venture capitalists.
			#35: Resource sharing (Chang & Hong, 2017; Freitag et al., 2016)	A strategy to overcome resource limitations by sharing tangible and intangible resources in finance, production and logistics among a group of businesses.
		Knowledge & awareness of application & market	#36: Knowledge Sharing (Lotfi et al., 2013; Wang & Hu, 2020)	A strategy to practice regular information and knowledge sharing among the supply chain to increase intra- and inter-organisational efficiency and performance
			#37: Collaborative Innovation (Wang & Hu, 2020)	A strategy to collaborate on innovation activities to improve on innovative abilities and performance within the supply chain.
		Data infrastructure & digitalisation	#38: Digitise Knowledge Management (Schniederjans et al., 2020)	A strategy to increase information and knowledge sharing within and among companies to improve supply chain management.
		Accidents & events	#39: Contingency Planning (Strachan, 2011)	A strategy to remain proactive in dealing with change, chance and uncertainties and to respond to them while holding on to long-term goals.

Lack of institutional support	Innovation-specific institutions and Informal Sector	Macro-economic & strategic aspects	#40: Build authority & trust (Bourne, 2015)	A strategy to be recognised as a trustworthy authority in the field, such as through the practice of thought leadership, in order to gain influence in policy-making.
		Pressure & Urgency	#41: Form 'pressure groups' (Grant, 2021)	A strategy to form interest or pressure groups to protect or advance a shared interest or set of beliefs