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Sustainable regional development through networks The case of ASPIRE (Advisory System for Processing, Innovation and Resource Efficiency) to support industrial symbiosis for SMEs

(Background Paper for Plenary Session 5 of the Programme)

Final Draft

This background paper has been prepared by Ms. Sarah King, for the Seventh Regional 3R Forum in Asia and the Pacific. The views expressed herein are those of the author only and do not necessarily reflect the views of the United Nations.

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Sustainable regional development through networks

The case of ASPIRE (Advisory System for Processing, Innovation and Resource Efficiency) to support industrial symbiosis for SMEs

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Executive summary

The material consumption of the Asia-Pacific region continues to grow. The emerging Asian middle class and regional consumption growth will result in increased waste generation. Within Australia, the national material footprint is higher than for the United States. The need for us to develop along a sustainable trajectory and manage (or eliminate) our waste, while our level of affluence and population continues to increase, is more important than ever. The newly developed UN sustainable development goals reflect this challenge and aim to: '…substantially reduce waste generation through prevention, reduction, recycling and reuse' (United Nations 2015, p. 27). Industrial symbiosis (IS) supports the goal of the 3Rs with particular emphasis on reuse and recycling. IS reduces waste by re-considering it as a resource input to another company. This results in business to business collaboration and follows the well-known saying 'one man's trash is another man's treasure'.

The Australian ASPIRE case presented in this report is an example of four Melbourne municipalities deploying a digital match-making tool to support industrial symbiosis (IS) in their respective regions. ASPIRE was developed by the CSIRO and the project was led by the City of Kingston (CoK) Economic Development department. ASPIRE was supported by a grant received from the Victorian Government Digital Futures Fund. It adopts a unique business model which relies on a digital match-making website and social business networks. Network facilitation led by municipalities and supported by CSIRO.

ASPIRE is a novel case as it targets small to medium enterprises (SMEs) which comprise most of the businesses in Australia (by number) and make up almost 80% of manufacturers. SMEs are major contributors to commercial and industrial (C&I) waste and are not typically targeted in waste reduction programs. They typically send 50% of their waste directly to landfill and these resources are generally readily recyclable or reusable. There are significant opportunities to improve capture of these resources and divert them from landfill.

ASPIRE is a match-making website for business. To operate it, businesses set up a profile and enter waste resources or resources they would like to receive. They are provided with a list of businesses they could potentially collaborate with, tailored to their profile. Companies then identify which suggested matches they wish to follow up on and contact other companies as needed. ASPIRE is successful when web-based collaboration suggestions develop into physical exchanges between businesses. This project is in its early stages and a few industry benefits have been captured. Benefits are economic, environmental and social. They include reduction of waste costs, reduction of input resource costs, diversion of waste to landfill, reputational merit by demonstrating recycling and environmental sustainability initiatives, access to new business connections and information, and collaboration opportunities. Benefits for municipalities include reduction of landfill in their region and sustainable economic development.

The ASPIRE case demonstrates the role of municipalities as network facilitators and entrepreneurs, supporting innovation-led solutions. It showcases their power to act as change agents to support sustainable development.

1 Introduction

The year 1987 marks a key date for introducing the concept of sustainable development. It was the year the Bruntdland report, 'Our Common Future', was published and placed a global perspective on the issues of population, biodiversity, food security, energy, industry and cities. The need for these issues to be addressed jointly rather than in isolation was a key finding of the report. The Bruntdland report marks the introduction of a holistic perspective to how we live and our impact and dependence on our environment. A major contribution arising from this report was the definition of sustainable development '*…meets the needs of the present without compromising the ability of future generations to meet their own needs'* (WCED 1987, p. 8) and this definition remains in common use today.

Sustainable development has become a consistent theme in global policy development since the Brundtland report was published and has more recently been superseded by the concept of Green Growth, which was discussed at the UN Conference on Sustainable Development (UNCSD), held in June 2012 (Lorek & Spangenberg 2014). A green growth policy agenda has been actively pursued by South Korea in their 5 year plan from 2009–2013 and PR China has elements of green growth in its 5 year plan 2011–2015 (Mathews 2012).

In 2009 the Asia-Pacific region gathered to form the Regional 3R Forum, which aimed at coordination and promotion of the 3Rs – reduce, reuse, and recycle. The aim is to cooperate on the 3Rs, gather to discuss policy strategies for promotion of the 3Rs and share useful information (UNCRD 2016; MoE 2016). Participating countries include, among others, Australia, New Zealand, the People's Republic of China, India, Japan and the Republic of Korea who meet annually at a regional forum.

The United Nations Sustainable Development Goals (SDGs), as part of the 2030 Sustainable Development Agenda, were adopted by world leaders in 2015. They build on and replace the Millennium Goals and are in force for the next fifteen years. There are 17 global goals and 169 targets that broadly address poverty, inequality and climate change (United Nations 2015). Three of the SDGs address sustainable resource production and consumption:

> Goal 8 which aims to promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
>
> Goal 9 which is to build resilient infrastructure, promote sustainable industrialisation and foster innovation.
>
> Goal 12 to ensure sustainable consumption and production patterns (United Nations 2015, p. 18).

And more specifically within Goal 12:

> Goal 12.5 in particular, addresses the 3R and aims to 'by 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse' (United Nations 2015, p. 27)

Associated with sustainable development and green growth is the concept of the circular economy (CE) which has become popular as the business model by which to achieve sustainable development

(Ghisellini et al. 2015). The CE addresses our predominant, linear 'take, make, dispose' (also referred to as take-make-waste) industrial system by replacing it with a circular, closed-loop system where resources are used more efficiently and waste is minimised (Ellen MacArthur Foundation 2013). In PR China the circular economy is being pursued as a top-down policy while in the UK, Japan and the USA it is a bottom-up approach to decoupling economic growth from resource consumption (Ghisellini et al. 2015).

Each of these key terms: sustainable development, green growth and the circular economy, share a similar vision of introducing resource efficiency and closed-loop processes for industry while maintaining economic growth and productive, healthy societies. Through the Asia-Pacific 3R Forum and the SDGs they are increasingly being reflected in government policies.

In order to achieve sustainable development – to raise people out of poverty, cope with increasing populations and resource consumption – at the heart of all of these issues is resource efficiency and the question of how we deal with waste, and ultimately eliminate it entirely.

2 The Issue – Regional Context

2.1 Global, Asia-Pacific Context

The Asia-Pacific region is one of the most dominant in terms of global material consumption. It superseded consumption by the rest of the world (ROW) in 2005. Notably the region continued its growth from 2008 onwards, throughout the global financial crisis, while the ROW plateaued, see Figure 1.

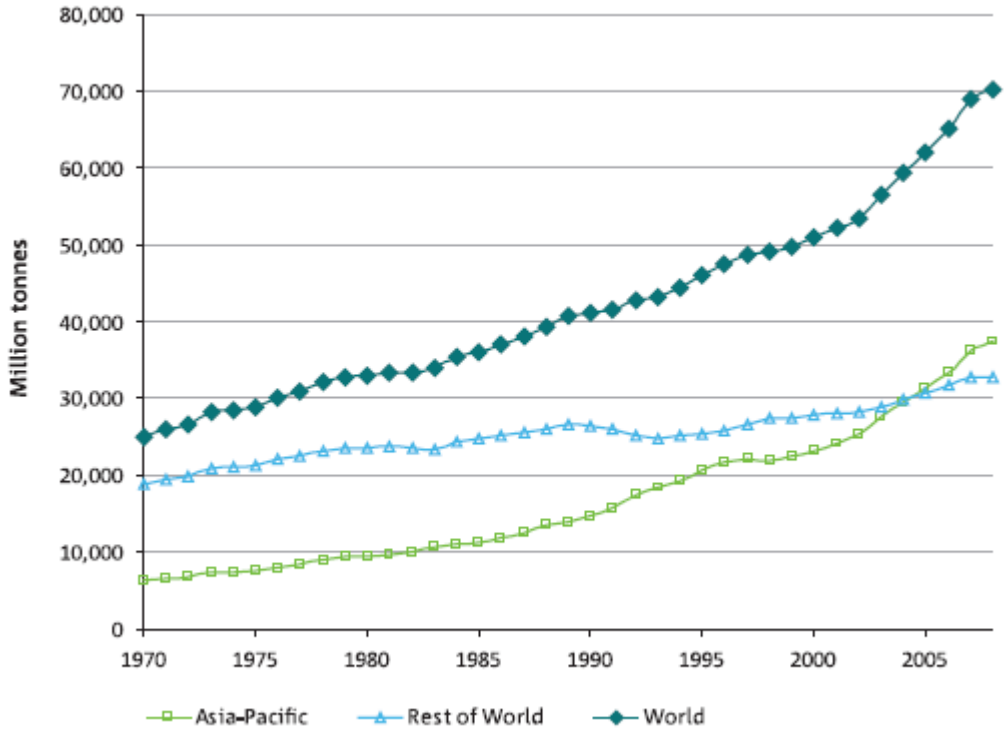

Figure 1: Domestic Materials Consumption, 1970–2008 (West & Schandl 2013, p. 6)

Increased population and affluence are also key drivers of waste generation and resource extraction (West & Schandl 2013). The growth of the Asian middle class is staggering by comparison to the rest of the world. In 2009, the purchasing power of the Asian middle class accounted for 23% of the global market. By 2030, the size of the middle class within the Asia-Pacific region, is expected to dwarf that of any other and to account for a forecast 60% of the global market by 2030 (Kharas 2010), see Figure 2. This dramatic increase in consumption will be a driving factor for waste generation within the region.

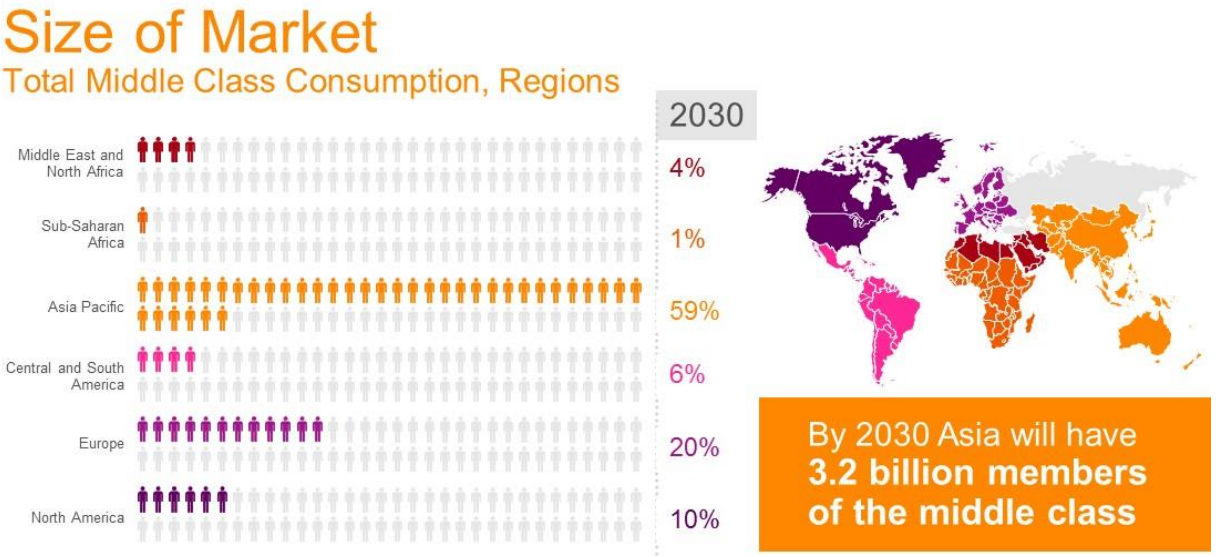

Figure 2: Total Middle Class spending by region in 2030 (King et al. 2014, p. 11)

An OECD comparison of waste generation for municipal solid waste (MSW), which one might suggest is an indicator of consumption, found Australia ranked as fifth highest of thirty-three nations, and almost 100 kg per capita above the OECD average. The OECD data shows Australia generates more waste per capita than New Zealand, Germany and the United Kingdom (OECD 2016). Australia also sends 58% of its municipal waste to landfill, recovering 41% and incinerating 1%. This contrasts with other countries where New Zealand sends 100% of its waste to landfill and Germany where none of its waste is sent to landfill; rather it is recovered or incinerated (OECD 2015). Australia's relatively high resource consumption and waste generation demonstrate the importance of resource-efficient activities.

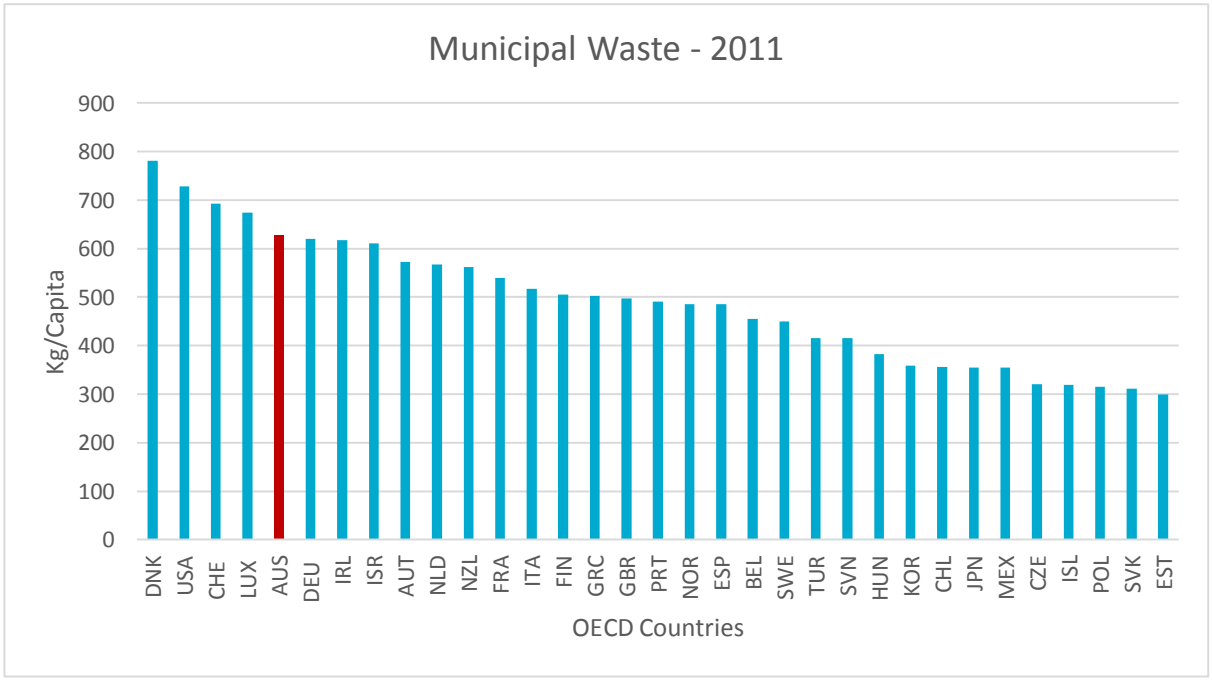

Figure 3: Municipal Waste in kg/capita based on 2011 OECD data – Australia is highlighted as the 5th highest waste per capita (OECD 2016)

2.2 The Australian Context

The global recognition of the importance of sustainable development and environmental issues such as climate change suggests a need for western economies, such as Australia, to adopt policies and practices that address resource consumption and support economic growth and development underpinned by sustainable development principles.

Australia is a high material use country with estimates of 44 tonnes per person/year, the highest in the Asia-Pacific region (UNEP 2015). The use of the term 'materials' in this context includes biomass, metals, minerals and fossil fuels, therefore Australia's high material use is partly due to the mining sector and the extractive industries, where some of these primary resources are exported rather than consumed domestically. An alternative measure, material footprint, is a consumption-based estimate of resources and Australia's national material footprint (MF) has been calculated to be 35 tonnes per capita (t/cap). This is higher than the United States' 25 t/cap and is an indicator of resource productivity (Wiedmann et al. 2015). Australia's material use and material footprint indicators demonstrate the importance of adopting resource efficiency measures.

One of the challenges in Australia for waste management is its three tiers of government and multiple State and Territory jurisdictions, each with different waste classifications and waste regulations. Different waste policy approaches have been implemented across states, resulting in tensions across borders. An example of different landfill levy approaches in two different states illustrates the perverse outcomes that can result. Most Australian states have a landfill levy in place, except Queensland which dropped its landfill levy in 2012. As reported in the media, this resulted in an estimated 40,000 tonnes of NSW waste per annum being trucked to Queensland, which places many more trucks than necessary on already congested roads. The price signal is so powerful that some operators excavated waste from NSW landfills, and collected a rebate for trucking it to Queensland (Hannam 2014). Following two years of Queensland having no levy and NSW having waste trucked out of state to be landfilled, NSW then imposed penalties for waste tansported more than 150 km from where it was generated. The different policies in each state clearly have different drivers. The NSW position is that waste generation should be managed by the community that generated it. Waste also creates jobs, an estimated nine jobs for every 10,000 tonnes of waste (Hannam 2014). Queensland, on the other hand, views the landfill levy as a tax on business and a disincentive for business to recycle (Trembath 2012). This example illustrates the power of policy instruments and the impact of a non-harmonised approach to waste policy.

As Australia's population grows, so does waste generation. In 2010/11 Australia generated 62 million tonnes (Mt) of waste, 14 Mt of which was fly ash from coal-fired power stations. This approximates to every Australian generating 2.2 tonnes of waste per annum and notably, waste generation increases with income and level of urbanisation (Randell et al. 2014).

Australia divides its waste data into three categories; Municipal Solid Waste (MSW) as shown above, Commercial and Industrial (C&I), and Construction and Demolition (C&D). Commercial and Industrial (C&I) is highly diverse and includes commercial industries such as manufacturing, health care, retail and education sectors. It excludes local government waste collection, households, construction and demolition waste, and SMEs where waste is collected under a municipal contract (Encycle

Consulting Pty Ltd 2013). The manufacturing sector is a major contributor of C&I waste and SMEs generally comprise a large proportion of the highly diverse C&I sector. In 2010/11 there was 15 Mt of C&I waste generated and 59% of this was recovered (Randell et al. 2014). This is a slight increase from 2006/07 data where 56% of C&I waste was recovered (Encycle Consulting Pty Ltd 2013).

The major resources comprising C&I waste stream are: Paper, cardboard, metals, glass, plastics and food waste. Many of these waste streams are recyclable and the C&I waste sector offers the greatest opportunity for increasing recyclability of waste streams (Encycle Consulting Pty Ltd 2013). A summary of C&I waste streams from 2010/11 data is provided in Figure 4.

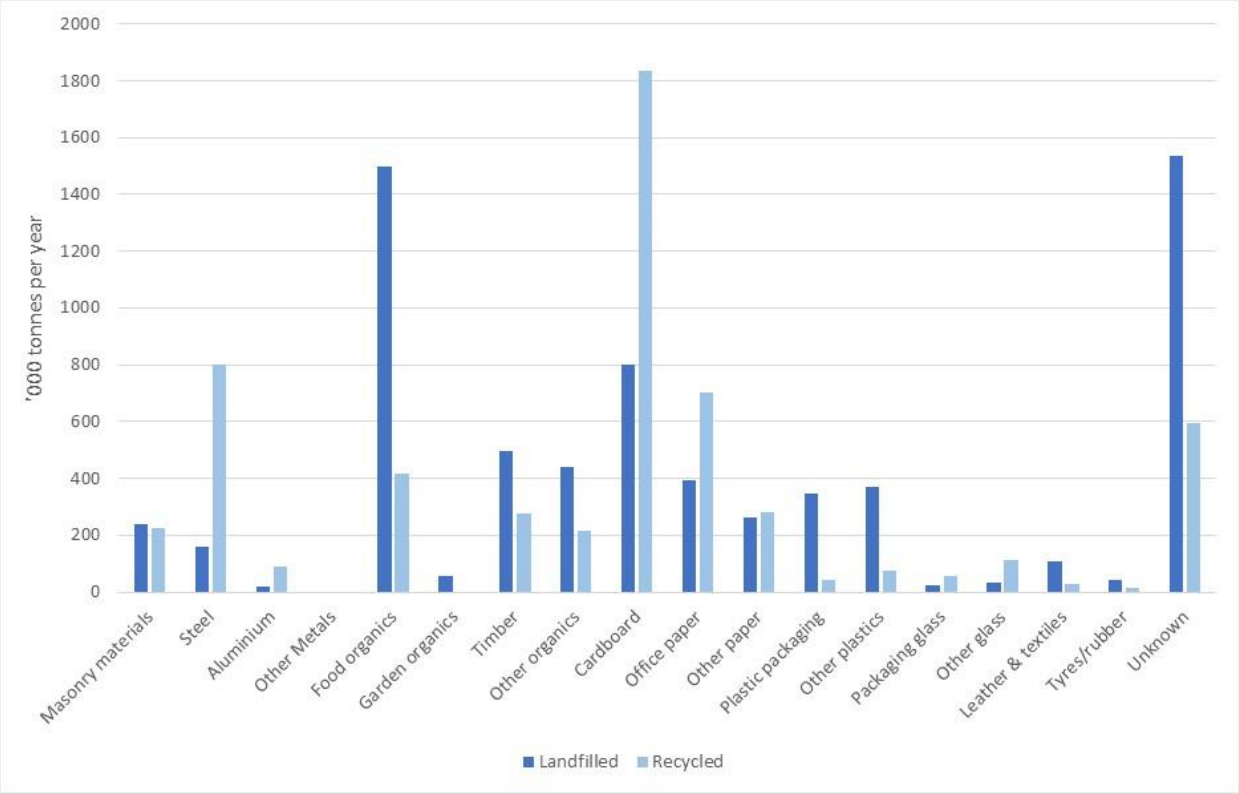

Figure 4: C&I waste/recycling streams by material (Encycle Consulting Pty Ltd 2013, p. 28)

A 2013 recommendation to reduce C&I waste was to identify opportunities for SMEs to collaborate on waste collection systems and investigate opportunities for industrial symbiosis (Encycle Consulting Pty Ltd 2013). As a policy at a federal, state or local level, industrial symbiosis results in reduced waste to landfill, improved regional economies and potentially greater employment. The most notable Australian example was the announcement by the NSW government of plans to support industrial ecology networks across the state (Corder et al. 2014) which resulted in 20,000 tonnes of recovered resources to June 2015. The program, now known as Circulate, has been extended for a further 2 years to June 2017. The focus of this program is medium to large businesses (NSW EPA 2015). The NSW Circulate program has received a substantial investment of $4.29 million to develop regional IS programs focused on target resources (NSW EPA 2015).

For companies, greater adoption of industrial symbiosis results in novel inter-organisation collaboration, greater resource efficiency and lower costs. IS networks are a useful mechanism to support inter-organisation collaboration. Within Australia, the low level of collaboration is of key concern. Australia ranked last on two OECD league tables, firms collaborating with suppliers and clients and firms collaborating with universities and publicly funded research institutes (OECD 2013).

Industrial symbiosis has the potential to improve collaboration between businesses while delivering beneficial economic and environmental outcomes.

3 Solutions – Industrial Symbiosis

3.1 What is industrial symbiosis (IS)?

Industrial Symbiosis (IS) involves collaboration between firms that enhances resource efficiency through by-product reuse. It is part of a broader field known as industrial ecology. IS is a sustainable and innovative solution for reducing waste to landfill, improving resource efficiency and adding value to waste resources. Simply put, industrial symbiosis is where a waste or by-product from one facility is used as an input to another. This follows the well-known saying 'one man's trash is another man's treasure'. Industrial symbiosis has an important role in supporting companies to reduce their environmental impact and operating costs, resulting in economic, environmental and social benefits.

A practitioner definition of industrial symbiosis networks is as follows:

> *Industrial symbiosis engages diverse organisations in a network to foster eco-innovation and long-term culture change. Creating and sharing knowledge through the network yields mutually profitable transactions for novel sourcing of required inputs, value-added destinations and non-product outputs, and improved business and technical processes (Lombardi and Laybourn 2012, pp. 31-32).*

Industrial symbiosis exchanges can occur as a result of by-product reuse, utility or infrastructure sharing and the joint provision of services (Chertow 2007) such as transport, waste management (Ashton 2008) or spare capability or warehouse space. Therefore, it is notably not restricted to resources or physical materials. Indeed, an example of collaboration in Melbourne came about due to one company (plastics recycler/remanufacturer) requiring warehouse space and another (automotive supplier) having underutilised space. This collaboration progressed when the automotive supplier became interested in the production activities of the recycler, now occurring on their premises. It resulted in both companies, which hadn't previously engaged with one another, formalising a collaboration through a joint venture. It is unlikely that these companies would have formed a partnership without the initial agreement to access underutilised space.

3.1.1 Global examples of industrial symbiosis

The classic example of regional industrial symbiosis is that of the industrial town of Kalundborg in Denmark. Kalundborg is self-organised, industry-led and it emerged organically over a period of time. This implies an absence of overarching government control and support, however the local municipality is a member of the regional network. Geographic proximity is an important feature of this industrial network and exchanges between companies (and the local municipality) include materials, water and energy (steam and heat) (Doménech & Davies 2011).

A second regional example is Kwinana which is an industrial zone located 40 km away from Perth, Western Australia. It comprises a number of heavy industry manufacturers such as cement plants, an oil refinery, and chemical and gas production plants. Kwinana is another example of a self-organised, industry-led example. Collaboration between companies commenced following the need to measure air and water quality for the region. Similar to Kalundborg, by-product exchanges have occurred for material resources (fly ash, gypsum), energy (heat) and water and also recycling collection (van Beers et al. 2007).

Attempts have also been made to plan or design industrial symbiosis within eco-industrial parks (EIP). Since 2005, South Korea has ambitiously worked to integrate industrial ecology principles across regional industrial zones. The Korea Industrial Complex Corporation (KICOX) is a government-led initiative to identify and support the implementation of IS projects in partnership with industry. One EIP project was established in the city of Ulsan, home of Hyundai Heavy Industries and the Hyundai automobile company. KICOX provides funding of up to 75% of any project. Funding arrangements also include a 20–40% royalty payment in return for a successfully commercialised project. This provides a good incentive for government facilitators to identify projects with a good likelihood of commercial success, while also helping to remove financial barriers for a company to implement a project. The motivation of industrial ecology and KICOX in Korea is to reduce industry costs and environmental impact.

Progress has been made in PR China with its 1,500 industrial parks to implement both new EIPs and retrofit existing industrial parks with cleaner practices and identify industrial symbiosis opportunities (Tian et al. 2014). This follows the implementation of the Circular Economy Promotion Law in 2009 (Chertow & Ehrenfeld 2012) and is another example of planned or designed industrial ecology.

Global examples might be self-emerging or planned, however the combination of both approaches can also be successful (Paquin & Howard-Grenville 2012; Baas 2011). Indeed the acknowledgement of both approaches being applied simultaneously was a key finding of research on KICOX (Behera et al. 2012). There is also a third way – networks. The network is a middle ground between on the one hand, self-emerging, industry-led examples in the style of Kalundborg, and on the other hand the EIP examples that often rely upon government intervention or leadership, many of which have failed while some have prospered (Behera et al. 2012).

3.1.2 Networks and Industrial Symbiosis

One of the most successful and globally renowned facilitated network examples is from the United Kingdom, known as the National Industrial Symbiosis Program (NISP), which was funded by the UK landfill tax (van Renssen 2012). It is the most successful example of a nationally implemented, regionally focused (Paquin & Howard-Grenville 2012) network-based program. A five year, independent review of the benefits of NISP between 2005 and 2010 showed significant economic, social and environmental benefits (Laybourn and Morrissey 2009). Many of the participants in the program were SMEs and its success has resulted in the OECD supporting industrial symbiosis as vital for green growth and the WWF nominating it as one of the world's top 20 business innovations (van Renssen 2012). Industrial symbiosis networks are emerging as a powerful agent for engaging small and large scale industry.

Networks involve facilitation and planning from an independent third party and agency from organisations and industry representatives. Often networks are implemented in a regional context and local authorities may act as facilitators to improve economic development within a region (Aid et al. 2014). Networks are emerging as having the potential to greatly influence resource efficiency and sustainable development for regions. However the importance of social processes and structural characteristics of industrial symbiosis networks are not well understood (Doménech & Davies 2011). Social Network Analysis (SNA) can assist here, and is the study of nodes (companies) connected by one or more relations (Marin & Wellman 2014). SNA can provide insight on the

network structure and position of a company within a network as these aspects have an influence over company performance within an IS network which fosters inter-organisational collaboration.

3.2 Digital Solutions to Industrial Symbiosis and Material Exchanges

Given the complexity of industrial and social networks there is a need for tools that assist with knowledge codification (Schiller et al. 2014) and the array of digital possibilities and platforms provides many opportunities to design a digital system suitable for supporting industrial symbiosis. Digital tools are useful to support networks and facilitators in collecting and codifying data from multiple SMEs to identify IS opportunities, however one significant challenge is the taxonomic characterisation of resources (Grant et al. 2010; Trokanas et al. 2014). The use of a waste classification alone is insufficient, as it will only cover by-products and wastes from the output side of a facility. A waste classification can have limited applicability to resource inputs. Moreover waste classifications in Australia vary between states and are split between the activities of waste management, recycling and reporting (Rajaratnam & Lamb 2011).

There have been a number of global attempts to design digital systems to facilitate the development of IS and web-based waste exchange networks. Many digital tools to address waste have been developed but without funding, they lack longevity (Doyle & Pearce 2009). This has certainly been the experience in Australia for a number of web-based waste exchange networks. The Victorian WastePro Waste eXchange database and the Construction Connect database have both been developed, deployed and closed in recent years. Reasons for the failures remain underexplored but are likely due to a lack of industry awareness, the passive nature of waste exchange databases, and information confidentiality issues (Corder et al. 2014). The issue of waste data confidentiality was certainly a concern for a US example where it was noted that competitors can estimate production based on waste data (Doyle & Pearce 2009). A still active waste exchange (last viewed August 2016) is the NSW ‘Waste Not’ website (Fyfe et al. 2011) which remains online but a lack of activity is evidenced by the posted information which dates back to 2011 (ISF 2015).

Despite the potential benefits digital tools provide in addressing the information challenge for industrial symbiosis, they are no panacea. The identification of a potential exchange in a digital tool doesn’t necessarily result in a successful exchange between companies. While digital tools are excellent at capturing explicit knowledge, industrial symbiosis also uses tacit knowledge and this cannot be codified (Grant et al. 2010; Swan et al. 1999). Trust cannot be conveyed or captured in a digital tool. Similarly the removal of barriers and commercialisation are factors which generally remain outside of the digital domain (Grant et al. 2010). In order to have a better chance of success, digital tools are best designed as a support for a social network; or in the context of this report, a business network, where companies have existing relationships and build new ones through inter-organisational collaboration.

4 The case of ASPIRE

ASPIRE is an Australian example of industrial symbiosis where a digital tool supports a social business network, deployed across a region. ASPIRE extends beyond passive digital systems, where information is posted by 'sellers' online for potential 'buyers'. It goes one step further by actively suggesting business to business collaborations. Similar to the UK NISP example, ASPIRE requires organisational agency to act on website suggested collaborations. However it differs as a result of operating within a regional network of facilitators that actively work with companies on ASPIRE.

4.1 Antecedents to ASPIRE

There were a number of conditions that led to the ASPIRE project. The economic development team within the City of Kingston (CoK), a local council or municipality in Melbourne, hosts a sustainable business network. This consists of workshop events and business breakfasts that are attended chiefly by SMEs based in the Kingston region. The business network provides opportunities for inter-firm collaboration and knowledge sharing, such as information on how to improve resource efficiency. As part of this network, CoK council facilitators were receiving information about increased costs for companies. Waste to landfill levies increase year on year in Victoria which in turn results in increased costs for business in waste contracts and disposal. The 2013/14 landfill levy price increase for the state of Victoria was enough for many companies to notice the increasing impact that waste costs were having on their business profitability. Companies were also experiencing increased pressure from their clients, employees and supply chain to demonstrate sustainable business practices. Lastly, they were ready for digital technologies to be used to a greater extent within their business.

The CoK discussed this problem with Australia's national science agency, CSIRO, as a result of them both being members of the South-East Manufacturing Innovation Precinct (SEMIP). One of CSIRO's goals is to deliver scientific research to benefit Australian industry. The ASPIRE project was an Australian first to deliver a waste match-making market directly to industry. Jointly, CSIRO and CoK developed the grant application for a Victorian government 'Digital Futures Fund' to deliver an industrial symbiosis solution to benefit Victorian SMEs. The CoK was joined by three other Melbourne municipalities, Dandenong, Knox and Hume, a number of SMEs and the Australian Industry Group. This brought the number of regions to a manageable level for a proof-of-concept project. Each stakeholder provided cash and/or in-kind contributions.

The grant for a proof-of-concept ASPIRE project was successful and work commenced in 2014. The CoK is the lead partner for the Victorian government grant with CSIRO the lead for technical delivery. The ASPIRE project is a novel collaboration between CSIRO and multiple councils which amplifies the potential to benefit Melbourne manufacturers. The ASPIRE project would never have eventuated without the leadership of the CoK Economic Development Group and a supportive champion in their CEO.

4.2 Who is involved?

4.2.1 Melbourne Municipality Networks

Manufacturing is an important industry for the State of Victoria, Australia. It is the largest full-time employer in the State and second largest contributor to Gross State Product in 2011/12 (DSDBI 2013). The proof of concept ASPIRE project involved two geographic regions in Melbourne: Hume in the North and Kingston, Dandenong and Knox in South-East Melbourne.

For each of the three south-east municipalities; Dandenong, Kingston and Knox, the manufacturing sector is the largest employer in the region. The south-east region of Melbourne is generally recognised as a hub for manufacturing activity with 40% of the State of Victoria's manufacturing activity located in South-East Melbourne (SEMIP 2016). South-East Melbourne has over 90,000 manufacturing jobs, including over 300 exporters (Anonymous 2016). It hosts the three business networks, the Kingston Sustainable Business Network, South East Melbourne Manufacturers Alliance (SEMMA) and the South East Business Network (SEBN) located in Dandenong. It is also home to the South-East Manufacturing Innovation Precinct (SEMIP) which supports regional economic growth and connects with the major research institutes of Monash University, the CSIRO and the Australian Synchrotron.

The northern region of Hume is also an important manufacturing region with Manufacturing the second largest employer after Health Care and Social Assistance (Remplan 2016). Hume is part of Melbourne's northern growth corridor. It is close to the Melbourne International Airport and major transit routes such as the Hume Freeway to the north, the Tullamarine Freeway, the Western Ring Road and the Calder Freeway to the West. These transit routes support the efficient transport of manufactured products for Hume-based businesses.

4.2.2 Small to Medium Enterprises

The ASPIRE project targets (not exclusively) small to medium enterprises (SMEs). In Australia, small to medium enterprises are classified as those that employ fewer than 200 employees and they comprise 99.7% of all businesses and almost 90% of the Australian manufacturing sector (Australian Government 2012b). They are often overlooked in favour of larger companies when it comes to innovation and corporate sustainability (Bos-Brouwers 2010). This makes them an ideal group to focus on as the characteristics of SMEs differ greatly to those of a large business. SMEs are strongly influenced by their CEO, founder or owner, who often acts in the lead role. Strengths are that they are flexible and less bureaucratic than their larger counterparts. However they are resource poor, where resources include staff, capital and knowledge. Their smaller size means they have a stronger association with their region whereas a larger company may have an international focus (Bos-Brouwers 2010).

It is suggested that waste remains a low priority for many SMEs and while landfill should be the last option for waste disposal, it is often the first choice for SMEs. It is estimated that Australian SMEs send around 50% of their waste stream to landfill, which corresponds to estimates of waste generation by UK SMEs (Redmond et al. 2014). SMEs are therefore major contributors to landfill and great contributors to environmental pollution. This is further supported by evidence from the EU estimating that they generate 64% of pollution (Klewitz & Hansen 2014).

From a waste perspective SMEs suffer from not having economies of scale characteristic of larger companies. Their waste and by-product streams can also be diverse; cardboard, plastic, paper and timber waste are the most common waste streams for Australian SMEs (Parsons & Kriwoken 2010; Redmond et al. 2014) and offer the greatest opportunities for reduction. Common problems and barriers to addressing waste in SMEs identified by Redmond et al (2014) and a Hobart survey of SMEs (Parsons & Kriwoken 2010) are a lack of recycling services and information, no time for staff to separate waste streams, and the need to treat waste streams prior to recycler collection. SMEs also do not record their waste volumes, and the distance to recycling drop-off locations can be a barrier. A lack of storage space was also found to be a significant problem for NSW-based SMEs in the food sector as they needed to maintain hygiene standards (Corder et al. 2014). Given their high representation across the Australian economy, SMEs are an ideal target for a strategy to improve resource efficiency and reduce waste to landfill, and increasing costs of waste management are a driver for industrial symbiosis (Costa et al. 2010).

A recent report (2013) also found that that SME waste accounts for a significant proportion of the C&I landfill waste stream. And yet, for their contribution, SMEs have not typically been targeted for waste reduction programs. The report also evaluated waste costs and found that SMEs are able to secure recycling services at a cost neutral or cheaper point (Encycle Consulting Pty Ltd 2013) which means that cost is not a barrier to securing reuse or recycling alternatives to landfill. The ASPIRE project targets SMEs and aims to increase inter-organisational collaboration around waste resources, specifically to increase engagement and adoption of IS within Australia.

4.3 How does ASPIRE work?

ASPIRE is a combination of a digital online tool or match-making website supported by a regional facilitators working in regional networks. The combination of digital and social network elements are equally important and the development of a digital tool in isolation of a social network was the reason for the failure of some of the Australian ICT waste exchange tools described in Corder et al. (2014). In addition, over half of the tools to support IS reviewed by Grant et al. (2010) were no longer in use, providing further evidence of the short lifespan of attempts to offer a digital solution to the challenge of capturing, ordering and presenting data to support industrial symbiosis.

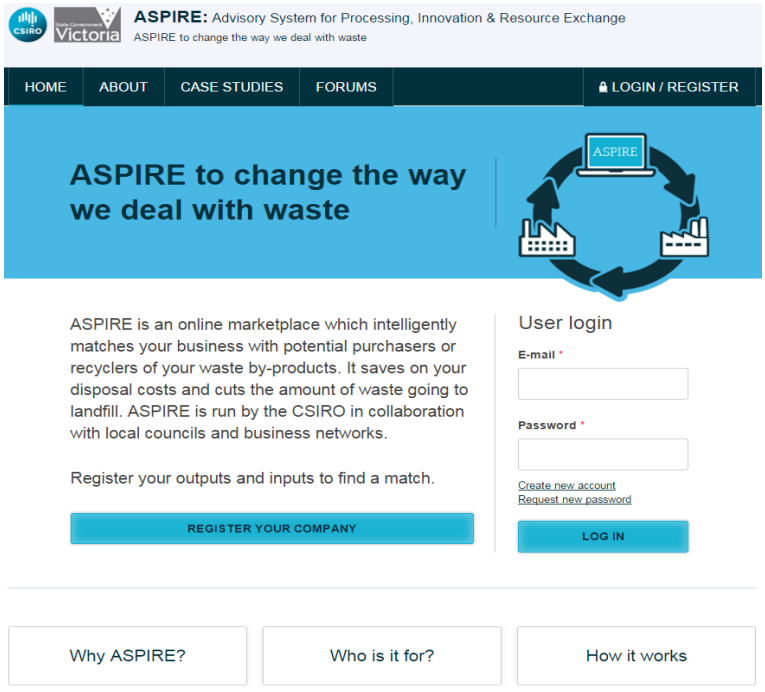

Figure 5: The ASPIRE match-making website

The ASPIRE digital tool is a market match-making website (see Figure 5) that operates in a similar way to a dating website by suggesting potential

company collaborations (but without guaranteeing successful matches).

Once a company has registered and entered company details such as location, website and contact information, they complete their profile by entering details of any surplus waste resources or input resources they might be seeking. ASPIRE's algorithm then actively matches companies based on potential resource exchange opportunities – outputs to inputs and vice versa. Match results are displayed to companies in a list. This additional match-making step improves opportunity identification and the likelihood of a successful resource transfer.

The ASPIRE process then goes through a number of additional steps, as shown in Figure 6.

1. **Suggested Matches** – companies select 'Find Suggested Matches' on the ASPIRE website and are presented with companies that match their profile and can either provide them with resources (inputs) or remove waste resources (outputs).
2. **Initiated Match** – companies identify promising matches from the list of suggested matches. They decide which companies they wish to contact by phone or email.
3. **Successful Transfer** – following a conversation, companies may decide to proceed with a collaboration, resulting in the ongoing transfer of a resource between two parties. A transfer may be informal, or formally recognised by a contractual arrangement.

At any point along these steps, suggested matches may become 'mis-matches'. That is, they are validated failed options for collaboration.

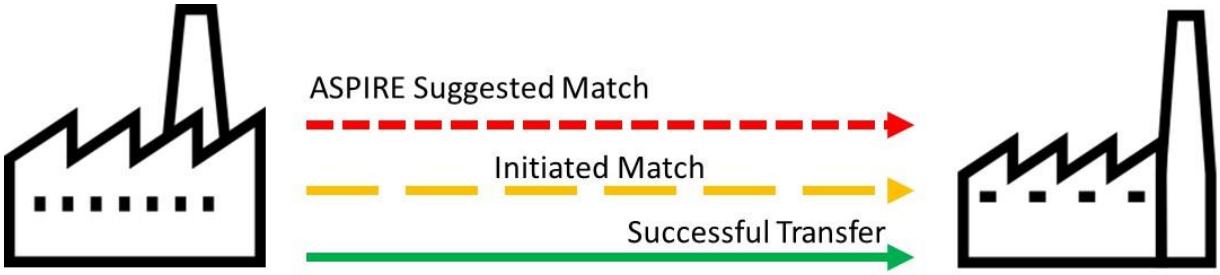

Figure 6: ASPIRE Match-making options

The social, business network aspect of ASPIRE is delivered through regional council partners. Council officers act as regional facilitators for ASPIRE. Visiting businesses within their local region is part of the service they already offer, so ASPIRE becomes part of the services they provide when engaging with the business sector. Councils also hold workshops and events which allow for business networking opportunities. These events are an opportunity to raise awareness, recruit new businesses onto ASPIRE and allow companies to meet each other face to face. Lastly, council officers are active throughout a number of procedural steps within ASPIRE. They control access to ASPIRE, only allowing companies from within their region to register. They also develop personal relationships with businesses through which they support match-making by independently suggesting potential collaborations or following up with companies regarding potential ASPIRE suggestions. Facilitator brokerage and support is a vital part of the ASPIRE business model.

Lastly, the project undertook user acceptance testing to understand how industry users engaged with the website. The results of a number of interviews and workshops showed that users have many different conceptual models for resources and there was significant semantic variation employed when describing resources. Despite these expected challenges the design of the ASPIRE

website allowed for flexibility in resource descriptions while also having a prescriptive resource list. These issues have not prevented participation or registration on the website. However, they do illustrate the need for facilitator support for companies that have trouble setting up their profile for ASPIRE. One caravan manufacturer who attended one of the user acceptance workshops said:

> *We attended the initial meeting to register, it was an easy to understand process with an easy to understand and operate website*
>
> *Quick response times from the vendors meant the whole thing was up and running in no time and our waste removal costs have been reduced by around $5000 per year. The planet thanks us as well as less waste going into landfill is good for everyone! – Caravan Manufacturer*

4.4 Benefits of ASPIRE

The ASPIRE proof of concept was in development during 2014 and the website became active in November 2015. The project initially aimed for a demonstration involving 40 companies. It has surpassed this target as over 100 companies from the four member council regions are registered online just over 6 months from the website going live. This demonstrates the industry demand for alternative solutions to landfill and the demand for information that will assist them to reduce waste disposal costs.

The benefits to business are:

- Reduction of waste costs
- Reduction of input resource costs
- Diversion of waste to landfill
- Reputational merit by demonstrating recycling and environmental sustainability initiatives
- Access to new business connections and collaboration opportunities
- Access to information that supports sustainable business operations.

In the initial operating period data has been collected on the direct benefits of successful ASPIRE collaborations. Based on six validated industrial symbiosis matches between 11 companies, we estimate the following benefits (based on company-provided information):

Table 1: ASPIRE benefits after 6 industrial symbiosis projects

Performance metrics for six projects	Measure
Estimated waste diverted from landfill / year	60 tonnes
Waste cost reduction / year	$60,000
Resource input cost reduction / year	$13,500

Apart from the direct economic benefits afforded to businesses active on ASPIRE, there are also networking benefits. Companies are able to collaborate as a consequence of simply being members of, or participants on, ASPIRE.

We have had opportunities to engage with companies that have only come about because of our involvement in ASPIRE. Without being a member of ASPIRE, we wouldn't have been let in the door – Metals Recycler

The ability for companies to demonstrate their environmental credentials is also a driver for companies to participate:

Our company does the right thing as a matter of course. Our products are kind to the environment and safe to use. As part of working with ASPIRE, we have reduced our waste to landfill by 75% this year. We are now recycling resources rather than throwing them away – Chemical Manufacturer

In addition to the benefits for companies, the four council regions benefit as a result of the following:

- Increased awareness of SME waste/ by-product resources
- Supporting resource identification for re-manufacturing or reuse
- Improved business engagement with a tool that adds value to businesses in their region
- Sustainable economic development
- Reduced pressure on local landfill sites
- Potential identification of resource agglomeration opportunities within the region
- Increased capability in industrial symbiosis
- Collaboration and shared learning opportunities with other regional councils which have similar goals
- Being part of an Australian-first project.

The benefits to council and business stakeholders are social, economic and environmental and importantly, support the goals of sustainable economic development for the four member regions.

4.5 The importance of the business model

A business model fulfils a number of functions, including; articulates the value proposition, identifies the revenue generation mechanism and market segment, estimates cost structure and formulates a competitive strategy (Chesbrough 2010). The business model is an important part of the ASPIRE project as funding challenges have the potential to halt progress beyond the ASPIRE proof of concept project. A goal of the project was to identify a business model to provide ongoing revenue to support ASPIRE beyond the initial grant-funded term. Part of the reason for this was the experience of NISP in the UK. Despite reporting outstanding triple bottom line benefits (Laybourn & Morrissey 2009), government funding ceased in 2011 (van Renssen 2012). The removal of government support resulted in a decrease of resources allocated to NISP and efforts in the UK seem to have decreased in recent years. ASPIRE wanted to learn from the NISP experience to develop a self-sustaining business model.

There are three main aspects to fund, as shown in Figure 7:

1. the technology platform – its operation and continuous improvement

2. network facilitators - supporting events, workshops and face to face interaction
3. business management oversight - this is particularly relevant during an expansion phase.

Financially sustaining the business network and facilitators is very important. While the facilitators in the ASPIRE case can be part of an existing role of council facilitators (who regularly visit with companies), there is a need for greater support as the network grows. This creates a financial challenge as inter-organisational business networks are costly to maintain (Kadushin 2012).

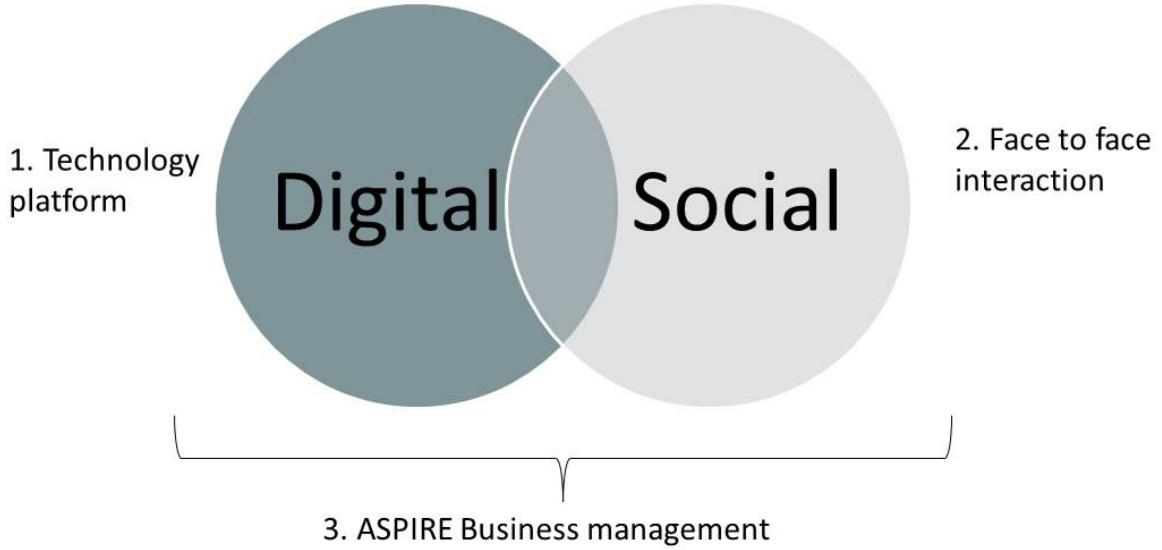

Figure 7: The ASPIRE Business Model involving digital and social elements

It could be suggested that companies who are active on the website and also attending network events, thus being socially active, might be in a better position to collaborate. They might be more successful in identifying and commencing IS relationships with new companies. The weaknesses of the digital tool are addressed by strengths of the social business network, and vice versa. Research to investigate this aspect of ASPIRE is forthcoming.

Since the inception of the proof-of-concept project in 2013, ASPIRE has received significant interest from businesses, recyclers, councils and other business operators. Part of the research supporting the project has been identification of the need to develop a sound, self-sustaining business model for continued operation. It is expected that if sufficient scale can be built, that is, sufficient registrations and successful exchanges between registered businesses, then a multi-sided market approach can support this sustainability. Revenue can be secured from a combination of regional network membership, individual stakeholders willing to pay for access and the regional data collected by ASPIRE has been identified as valuable in its own right. Regional data is attractive for special cases where waste authorities or state government departments are willing to pay for access to de-identified data. This is particularly relevant since there is limited available data on SME wastes and there are opportunities to identify agglomeration opportunities to intervene with collection or technology interventions if waste volumes are high enough in a particular area.

The project utilised Lean LaunchPad principals and customer discover interviews (Blank & Bob 2012) to validate our revenue model assumptions with the marketplace. Some of the seemingly logical revenue strategies were tested with the market, and failed to be validated. Firstly, charging individual companies for access to ASPIRE. For a number of companies that we spoke to, only

recyclers were willing to pay for access. For them, ASPIRE operates as a sales tool and it is reasonable to expect to pay for such a service. Another strategy that is often presented is to charge a success fee when a suggested match between two companies evolves into the physical transfer of one resource to another. This sounds simple but is difficult to implement for the following reasons. Successful ASPIRE exchanges are outside of the digital system, so would need to be tracked manually through the business network and/or by the facilitator, which is onerous. Moreover, some successful transfers do not result in a financial transaction or a formal contractual relationship between companies. Therefore adding a contractual or financial cost to a 'success' adds a burden to the successful industrial symbiosis transfer. Lastly, there is the possibility that implementing a company success fee might result in a lack of self-reporting by companies, to avoid any commercial implications. This would have the unintended consequence of driving success underground when the intention is that we profile and highlight success stories.

The business model that ideally fits the digital and social network structure for ASPIRE is where member networks pay a fee to join ASPIRE. The companies belonging to the network, then get free access to the digital tool and are supported by network facilitators and events. The ASPIRE case currently works with municipality networks, however other types of networks, e.g. manufacturing networks, could also be members of ASPIRE. Until there is a critical mass of networks paying a fee, there may be a shortfall during the expansion stages of the project to cover project management and operating expenses. This revenue gap could be filled by state or federal agencies which may be interested in supporting the goals of reducing waste to landfill, identifying innovation opportunities and improving resource efficiency and collaboration between businesses.

5 Municipalities leading transitions to sustainable development

5.1 The important role of regional network facilitation

An important feature of industrial symbiosis networks is the facilitator. There are many types of network facilitators and they play a vital role by providing context for network goals, recruiting new participants or acting as a broker (Konsti-Laakso et al. 2012). Regional authorities have been known to act as facilitators to improve economic development within a region (Aid et al. 2014), and this is a strength of the ASPIRE case.

An important feature of the facilitator is said to be trust and while trust between businesses in IS exchanges is acknowledged as important, this concept could equally be extended to trust between businesses and facilitators. Indeed, where an attempt was made to build IS within a region using a consulting firm, this failed as a direct result of the consulting firm not being embedded within the local community (Hewes & Lyons 2008).

In the ASPIRE case, council facilitators are responsible for running sustainable networks, hosting workshops and business breakfasts. Facilitators often meet directly with individual businesses to discuss their unique needs and advise them of events, tools (such as ASPIRE) and information that the council can provide to them. In some cases facilitators encourage companies to follow up on ASPIRE suggestions. Facilitators are the link between the digital aspect of the business model and the social. At times, their specific knowledge of the business needs in their region results in them making IS connections between businesses without the requirement of the ASPIRE system. The role of the network facilitator is so vital that the ASPIRE system would most likely fail in the absence of the facilitator which further underscores the importance of recognising the social aspects of the business model for ASPIRE.

5.2 Municipality as an innovator

The willingness of the CoK to engage with CSIRO on a proof of concept research project cannot be understated. CoK was the lead partner on a grant with the State of Victoria. By doing this, CoK carried all of the financial and technical risk of the project. A great level of trust was necessary between CoK and CSIRO for this to occur. They needed to trust the capability of CSIRO to technically deliver the proposed project, and trust that the novel project would be useful to and adopted by SMEs. Moreover, the CoK's reputation was also placed at risk should the project have failed to meet expectations. Instead a highly collaborative partnership between CSIRO and CoK has eventuated.

ASPIRE is an example of the public sector demonstrating entrepreneurship by undertaking a risk-taking activity by investing in a new technology to promote sustainable development. The four municipalities chose to directly engage in the ASPIRE activity to support sustainable economic development. By doing so, they built the requisite skills within their respective agencies to support industrial symbiosis activities. This decision is contrary to a more traditional view of government organisations, which might outsource such skills to the private sector. As a result, the municipalities

are actively involved in innovation rather than being restricted to creating conditions for innovation. They also demonstrate support for an innovation-led solution to the problem of increased costs for business and tackling waste to landfill. These are characteristics of entrepreneurial government organisations described by Mariana Mazzucato in her book 'The Entrepreneurial State' (Mazzucato 2015). To review the role of the municipality as an innovator we can apply the framework of transition theory to understand the important role they play in supporting sustainable development.

5.3 Transition Theory

Transitions research is a useful theoretical framework that helps to position ASPIRE within a broader governance and policy framework to demonstrate how it supports a transition to sustainable development. Transition theory is multi-disciplinary and aimed at understanding socio-technological transitions to a more sustainable society. It also proposes new forms of governance and new policymaking processes to achieve sustainable development.

The Multi-level Perspective (MLP) was first proposed by Arie & Kemp (1998) and further developed by Geels (2002) as a framework for understanding the process of technological transitions. In this perspective, three levels are described. First, the socio-technical (ST) landscapes which are named to reflect the 'hardness' they represent; infrastructure, highways, cities and factories. Alongside these 'hard' landscapes are the economy, social and cultural norms, political culture, worldviews and environmental problems (Geels 2002; Rotmans et al. 2001). Landscapes are exogenous and slow to change (Jackson et al. 2014). At the second, meso level are regimes, named as such for the 'rules that enable or constrain activities within communities' (Geels 2002, p. 1260). Regimes are built on routine-based behaviour. They result in technological trajectories that reinforce the status quo and are therefore responsible for housing incremental innovations. At the next level down are niches, which host radical innovation. Niches achieve this by being protected from regime-like social and technical norms. For example, technology may be insulated from normal market mechanisms. Importantly they provide a space for learning processes. The three levels closely relate to the macro (institutional), meso (networks and communities) and micro (individuals) represented in transition management (Rotmans et al. 2001).

The three levels of a technological transition supporting sustainable development are represented in Figure 8.

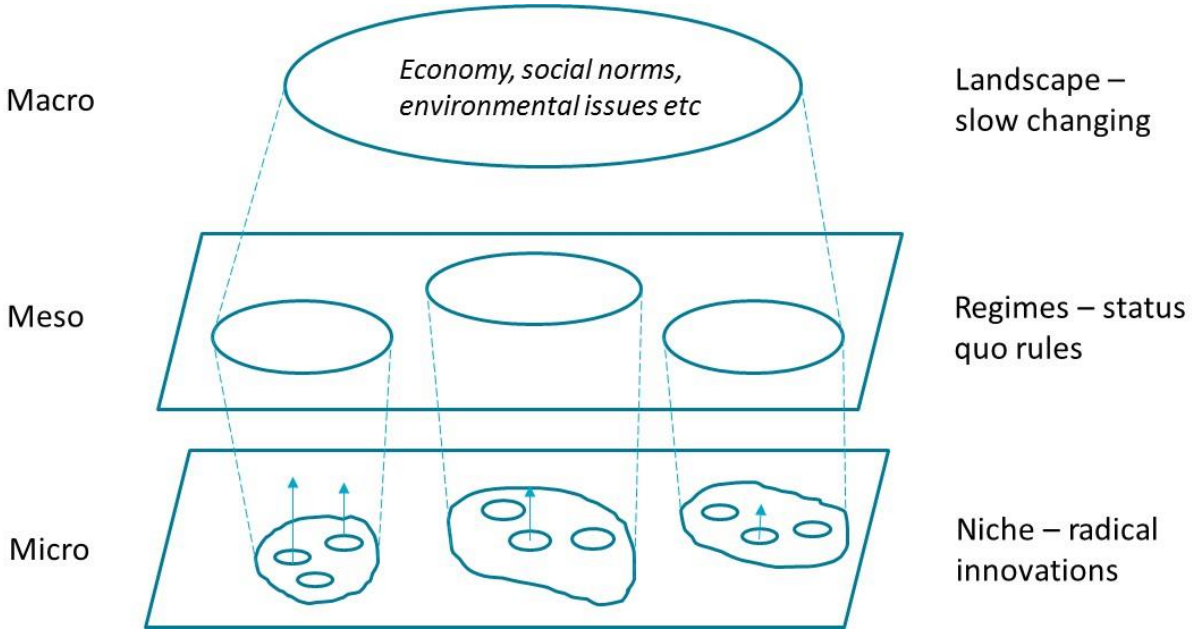

Figure 8: MLP Transition theory at the macro, meso, micro levels, adapted from Geels (2002)

If we view APSIRE through the lens of transition theory, it becomes an example of a radical innovation experiment. It has the characteristics of a niche innovation by being high-risk, experimental, potentially able to scale up, and repeatable in different contexts (Loorbach 2010). It also supports the goal of sustainable development through the promotion and success of industrial symbiosis. ASPIRE allows a space for learning by doing and a space to develop a social network of support which is consistent with technological transition theory (Geels 2002).

From the broader perspective of transition to sustainable development, the context of transition theory positions ASPIRE as a scalable, niche experiment. It helps us to understand the challenges the project has to move from the niche level, where experimentation is supported, to the regime level. Perhaps to ASPIRE's benefit, it involves both individual actors from industry and regime actors and agencies in the form of local council authorities. This networked business model may result in greater engagement between the levels of niches and regimes, which is noted as an important indicator for successful technological transitions (Geels 2002). As an early stage, proof of concept project, this engagement and connectivity bodes well for the future advancement of the project. Finally, while ASPIRE as a 'technology' is innovative, the role of the municipality as a leader for trialling the technology underscores their entrepreneurial role as an innovator.

6 Opportunities for the Asia-Pacific Region

The early success of the ASPIRE project in achieving the 3Rs and supporting sustainable regional development provides us with learning opportunities in the application to the Asia-Pacific region. The four areas are governance, regulation, infrastructure and business networks.

6.1 Governance

National level governments have the power to regulate waste. It is important that regulation is consistent across regions to prevent perverse economic drivers such as the Australian example of transporting waste between jurisdictions. Good governance also includes the consistent categorisation of waste streams at a national level which is then adopted at any sub-national level. Policy makers can also include the reuse of waste by encoding IS into policy or remove regulatory barriers for the reuse of waste.

As the example of ASPIRE has shown, local governments or municipalities can play a supportive role in bringing together companies in a sustainable business network. They can also act as facilitators and given their embeddedness within the region, there are sustainable economic development benefits of them acting as a leader for IS initiatives. Government agencies can be a key driver of IS activities and this was demonstrated by the ASPIRE case. They may also directly benefit as they have waste resources or manage waste infrastructure or recycling facilities.

Much of the government support for ASPIRE has been provided by economic development or industry-focused departments. This includes the municipality economic development teams and the initial grant provided by the Victorian State Department of Economic Development, Jobs, Transport and Resources. This is a contrast to the UK NISP example where government support was provided by the Department for Environment, Food and Rural Affairs.

The benefits of industrial symbiosis are both economic and environmental, so the issue of which government department should support industrial ecology/symbiosis efforts is pertinent. Economic development departments are predominantly interested in business cost reduction, new investment and jobs growth, whereas environmental departments focus on diversion of waste from landfill and reduction of CO_2. For a project that delivers both benefits, this can create an issue of where an industrial symbiosis project should most appropriately be located. Pragmatism drove the decision for ASPIRE to partner with economic development departments as this was where interest and funding was available at the time. However it is important to retain links and generate awareness within complementary environment departments (or vice versa) to prevent unintended regulatory barriers. For example, there is no benefit gained for an economic development department to support an IS project when regulation has been drafted by another agency that prohibits use or transport of waste between companies.

6.2 Regulate to innovate

In 1991, leading Harvard Professor Michael Porter proposed the idea that environmental regulation could prompt companies to innovate (Porter 1991). Since then, heated debate has ensued. Twenty years on there is clear evidence for what is now known as the Porter Hypothesis; that stricter environmental regulation leads to greater innovation (Ambec et al. 2013).

Taxes alone can result in decreased landfill, as in the UK where their landfill tax resulted in a decrease of construction waste entering landfill sites (Martin & Scott 2003). There is certainly a role for governments to regulate waste in a way that is designed for more than simply setting limits. It is possible to design policies that encourage or support innovation. An Australian example is the $465 million NSW Waste Policy where the landfill levy has been re-directed as infrastructure investment and to support recycling innovation (NSW Government 2013). This includes efforts directed at improving business engagement in IS through regional networks, known as 'Circulate' (NSW EPA 2015). This policy has the effect of supporting competitive investment in infrastructure and reducing C&I waste by diverting it from landfill. The industry waste levy has been re-directed to reduce waste to landfill by supporting business change, accelerating investment into recycling infrastructure and kick-starting waste innovation.

The NISP program was another example where the UK landfill levy was critical to supporting IS with industry and diverting waste to landfill. In fact, long-term public funding allowed NISP to achieve great success increasing recycling and collaborative IS projects. Regulation on its own can help to fund waste management or reduce waste to landfill. However by linking regulation to sound policy aimed at supporting sustainable business, recycling or IS activities, we can multiply its effect.

6.3 Invest in infrastructure appropriate for the socio-economic conditions

Waste management is costly and can be the major cost of city administration budgets in Asia. Cost estimates range from 20 to 50% of a city's administration budget for solid waste management. In Malaysia, the waste collection alone costs between 20 to 70% depending upon the size of the city. In India, the waste management costs collected are insufficient and a lack of funds are a serious problem in developing Asian nations (Agamuthu et al. 2009). It is essential that the funding available for waste management is sufficient.

It is also known that different countries have different waste mixes. For example, developed nations have higher paper-based waste and lower organic waste. The opposite is true for developing nations (Agamuthu et al. 2009). Investment in recycling infrastructure needs to be appropriate for the waste resources generated within a nation or region or the waste resources received through trade. This in turn means mechanisms to quantify waste volumes and types are an important and necessary part of waste management.

6.4 Establish sustainable business networks – quantify, reduce, reuse waste.

Networks are considered essential for innovation. They are a vital mechanism for SMEs to access knowledge, potential new innovation partners and create additional value for their organisation. Innovation networks have a low barrier to entry, other than the time investment required to attend and pursue opportunities (Konsti-Laakso et al. 2012). This makes participation in innovation networks a perfect solution for time-poor SMEs. Participation in a network by a SME requires a desire to access knowledge from outside the organisation and openness to collaboration.

Strategies that support goal-directed business networks will result in benefits for businesses taking part. Network goals can be to reduce waste, or seek opportunities to divert waste from landfill. Goals are important to attract companies with similar mindsets to engage in the network, increasing the likelihood of network success. It is important that networks are resourced to provide companies with adequate technical capability as this was found to be a major barrier for Chinese SMEs engaging in innovation (Xie et al. 2010). A network facilitator – ideally with links to the region – is essential. Sustainable business networks help build awareness of locally available waste resources and can help in identifying new market opportunities.

7 Conclusion

It is important to note that the ASPIRE project is in the early stages of implementation and evaluation. This report offers a preliminary discussion of the promising and unique aspects of the case in supporting 3R practices for SMEs predominantly in the commercial and industrial sectors. This report aims to present an Australian example of industrial symbiosis networks so that other Asia-Pacific nations may consider implementing similar programs that might be applicable to their respective business or industrial environments.

The goal of ASPIRE was to design a system that would cater for SMEs but also allow larger companies to access the system. SMEs have limited resources and are less likely to be in a position to directly fund access to consultants or focus attention on non-core business activities such as waste reduction, recycling or reuse. However, by working with a goal-oriented network, SMEs are able to leverage their limited internal resources to upload a profile on the ASPIRE website and quickly and simply review the potential B2B matches that could be of use to them. The ASPIRE case demonstrates how small-scale, niche experiments can be led by municipalities in partnership with a research provider to benefit industry and transition industry to 3R practices. The project also complements the goals of the circular economy, resource efficiency and deriving wealth from waste.

The medium term aim for ASPIRE is to divert the reliance of revenue from government and research sources over the long term. Government support is still necessary during the next phase of the project. Without interim support, the ASPIRE project risks stagnation by not evolving beyond the initial four Melbourne member council partner regions or alternatively, by not securing enough revenue from new networks during the next phase of growth, when there are still only a small number of municipality network partners.

The key success of ASPIRE is the development of a business model that includes social and digital elements to support IS for the C&I sector. ASPIRE aims to boost capability within existing economic development teams in local municipalities and leverages existing business networks rather than building a new network. ASPIRE directly benefits companies and indirectly benefits municipalities by reducing waste to landfill for their region and improving economic sustainable development. Research is ongoing to quantify the benefits of ASPIRE but individual company case studies demonstrate the positive economic, environmental and social benefits for business.

Overall the APSIRE proof of concept or demonstration project has been a success. It includes achievements such as:

- Delivery of a website to support B2B collaboration on IS
- Demonstration of successful IS collaborations
- Reducing business costs and diverting waste from landfill
- Adoption of a digital and social business model for IS networks
- A solution for SMEs to engage in 3R and IS activities.

Lastly, the municipalities in ASPIRE, particularly the lead partner CoK, demonstrated entrepreneurship and deep collaboration to engage in an innovation experiment to progress sustainable development in their respective regions. This networked example has yielded a unique approach to supporting IS for SMEs. It demonstrates the power of regional authorities to act as change agents and transition our industrial activities along a sustainable development pathway.

Abbreviations and Acronyms

3R	Reduce, reuse, recycle
ASPIRE	Advisory System for Processing, Innovation and Resource Exchange
B2B	Business to Business
CE	Circular Economy
C&I	Commercial & Industrial
CoK	City of Kingston
CSIRO	Commonwealth Scientific Industrial Research Organisation
IS	Industrial Symbiosis
KICOX	Korea Industrial Complex Corporation
SDG	Sustainable Development Goals
SME	Small to Medium enterprise

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