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From waste to sustainable materials management: Three case studies of the transition journey

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ABSTRACT

Waste policy is increasingly moving on from the 'prevention of waste' to a 'sustainable materials policy' focused agenda recognising individual wastes as a resource. In order to comparatively analyse policy developments in enhanced waste management, three case studies were selected; San Francisco's *Zero Waste Program*, Flanders's *Sustainable Materials Management Initiative* and Japan's *Sound Material-Cycle Society Plan*. These case studies were chosen as an opportunity to investigate the variety of leading approaches, governance structures, and enhanced waste policy outcomes, emerging globally. This paper concludes that the current transitional state of waste management across the world, is only in the first leg of the journey towards Circular Economy closed loop production models of waste as a resource material. It is suggested that further development in government policy, planning and behaviour change is required. A focus on material policy and incorporating multiple front runners across industry and knowledge institutions are offered as potential directions in the movement away from end-pipe land-fill solutions.

Contents

Abbreviations: 10YFP on SCP, Rio 20+ 10-year framework of programmes on sustainable consumption and production; 3R's, reduce, reuse, and recycle; CE, circular economy; CR's, circulative resources; EEA, the European Environment Agency; EPR, extended producer responsibility; EU, European Union; GDP, gross domestic product; KPIs, key performance indicators; MFA, material flow accounts; MOEJ, Ministry of Environment, Japan; MSW, municipal solid waste; NGOs, non-governmental organisations; OECD, organisation for economic co-operation and development; OVAM, public waste agency for Flanders; SMM, sustainable materials management; SRMs, secondary raw materials; SMCS, fundamental plan for establishing a sound material-cycle' society; TM, transition management; UNEP, United Nations environmental programme; ZW, zero waste.

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1. Introduction

Waste is a guaranteed component of any urbanised landscape and the management of waste has existed for centuries. Propelled by an economic philosophy of exponential growth through consumerism, the availability, complexity and rapid manufacturing of consumer products is creating highly unsustainable levels of 'waste' material outputs. These point to the urgent need to remodel the way waste is managed (Rootes, 2009; UNEP, 2011).

Waste management has for the most part provided end of pipe solutions, whereby increasing amounts of discarded materials are buried, dumped out at sea or turned into ash, creating the need for the extraction of further raw materials. These methodologies do not make the best use of the waste as a resource or do not deliver satisfactory environmental outcomes. The waste sector is better understood as a necessary part of the sustainability agenda, requiring more holistic solutions that take into account the concepts of sustainable production and consumption and the circular economy.

The waste industry is now recognised as an underutilised 'resource industry' in its own right, with increasing focus on waste having inherent economic value. Formal and informal recycling practices have emerged as a dominant force, central to most waste management programs in the developed world (Karani and Jewasikiewitz, 2007). Furthermore, increasing focus on economic innovation and entrepreneurialism during recent times of slow international growth has also seen more economic policy focus on waste management.

Significant policy innovations in waste management have emerged over the last decade to address the growing demand for materials and mounting evidence of ecological and societal impacts of our throw-away consumerist economy. Whilst some policies aim at reforming the traditionalist waste management frameworks, others fundamentally reconceptualise and reframe it altogether (Cramer, 2013; Lauridsen and Jørgensen, 2010).

The world of waste management is moving away from conventional landfill and recycling of both municipal and industrial waste towards integrated waste policy. Programs involving zero waste targets and 100% diversion from landfill are increasingly noted with rising urban densities and land prices in major cities across the world. Sustainability outcomes, sustainable production and consumption behaviours and circular economy programs all underpin new standards in governance structures and waste policy intervention. Furthermore, environmental regulations, material cost and material scarcity are also creating an awareness of eco-design benefits in linking end of life waste materials as recycled/returned inputs to earlier production stages (Andrews-Speed et al., 2012; EEA, 2014; UNEP, 2011).

Although Circular Economy thinking has shown closed loop systems can provide greater social and environmental benefits when confined to bottom-up supply-chain management systems, advantages of waste governance at multiple spatial levels can also be noted (Mazzanti and Montini, 2014; Ghisellini et al., 2016).

The following review will focus on three exemplar case studies to illustrate three different approaches to waste management across the world and the increasing value seen in the policy management of waste as a resource. Each case is considered an exemplar of a local, regional or national enhanced waste management policy program

2. Methodology

In order to comparatively analyse policy developments in enhanced waste management, three case studies were selected; San Francisco's *Zero Waste Program*, Flanders's *Sustainable Materials Management Initiative* and Japan's *Sound Material-Cycle Society Plan*. These case studies were identified as opportunities to investigate the variety of leading approaches, governance structures, and enhanced waste policy outcomes, emerging globally.

A review of academic literature as well as authoritative assessments conducted by key government bodies and research agencies produced substantive understandings of each case. Political documents, policy instruments, industry reports and published quantitative results were analysed. Interviews with relevant officials were conducted and the authors of existing case study materials were also engaged.

2.1. Case studies

2.1.1. San Francisco (Zero Waste Program): 100% diversion from landfill

In the first case study the details of the San Francisco Zero Waste program are presented. This case was selected because it is one of the more publicised and recognised recent zero waste initiatives and is often used as a zero waste exemplar. Since 2002 this city has had considerable success in driving a zero waste program having achieved their goal of 75% diversion of waste from landfill and incineration in 2010, with current estimates stating an 80% diversion rate. It is also recognised as the national leader in waste management within the US. We provide a brief overview of San Francisco's actions, examined through publicly available government and policy documents produced and published by the San Francisco Environment department as well as building upon the work of Krausz, 2012 and other secondary academic and industry reports.

2.1.2. Flanders (Sustainable Material Management): Selective collection and recycling

A prominent example of the transition from conventional waste management to an integrated materials policy is the Flanders's Sustainable Material Management (SMM) program. The case was selected on the premise that the initiative was one of the first regional attempts at such a policy. This case has been selected since thee change trajectory has been the focus of in depth study and multiple publications (Paredis, 2013) which enabled deep insights into how the initiative took shape and the relevant outcomes that ensued. In this case study the emergence of the concept of materials in the waste discourse within Flanders is analysed and some of the activities, outcomes and future directions are outlined.

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2.1.3. Japan (Sound Material-Cycle Society): Improving resource productivity whilst simultaneously reducing waste output

Japan's recycling initiatives date back to the late 1970s. However the urbanisation of Japan's major cities in the mid 1980s combined growing economic affluence, high density population and mass-consumption, creating difficulties to resolve and manage waste and recycling within Japan's municipalities. Responding to these changes, Japan experienced a policy shift in waste and recycling management towards a national framework founding a 'Sound Material-Cycle Society'. Three fundamental plans were produced and published by the Ministry of Environment, Japan (2001, 2008, 2013). These available documents, as well as other significant academic and industry reports assessing the Japan Sound Material-Cycle Society plan, guide the findings outlined in this article.

3. Description

3.1. Diverting waste from landfill: San Francisco (Zero Waste Program)

In 1989, 90% of waste in California went straight into landfills. However the Integrated Waste Management Act, Assembly Bill 939 (1989), established goals to divert 25% of waste by 1995, 50% by 2000 and 58% of all waste by 2007. This initiative driven by the State of California prompted San Francisco City to further improve its waste management goals, exceeding the state's legislative requirements. In 2002, the Board of Supervisors in San Francisco took a leadership role in assembling a waste policy and program package that sought to divert 75% of waste by 2010 and 100% by 2020 (SF Environment, 2014). Specific waste streams were targeted through successive measures such as the Construction and Demolition Debris Recovery Ordinance in 2006 and the Food Service Waste Reduction Ordinance in 2007. In 2009 the Universal Recycling Ordinance involving a three-cart collection program was also rolled out to both private and commercial establishments and was the first for a major US city (Sullivan, 2011); the actual diversion rate is currently 80% (SF Environment, 2014).

The key player driving the program is SF Environment, a government body responsible for environmental policy development and implementation. The 2020 target of 100% diversion from landfill was marketed and labelled 'Zero Waste'. Awareness that several other known jurisdictions had adopted the term and similar diversion goals objectives (such as Toronto, Canada and Seattle, Washington) was the stated motivation for the Board of Supervisors to move forward with it (Krausz, 2012). Although no systematic process is linked to applying the Zero Waste label, extensive exposure and recognition has been achieved by successfully enacting the term through media channels and in the San Francisco waste reports and future vision documents, such as the Environment Code.

San Francisco's Zero Waste objectives were framed through the city's culture and vision of being recognised as a leading example of a sustainable city. This overall ambition is coming to fruition for San Francisco: the city received a United Nations award for best green building policies, and it also topped the North American Green Cities Index (SF Environment, 2014).[1]

Diverting waste from landfill and incineration was seen as a viable waste policy outcome supported by an increase in landfill levies, an already established 'pay-as-you-throw' mechanism and a strong anti-incineration mentality. The program enforced garden and food waste to be separated and processed into mulch or compost rather than co-mingled with general waste. With organic materials often accounting for two thirds of general waste weight, especially for large standalone dwellings, the third-cart program had clear cost-benefit outcomes. Measuring diversion was based on California's diversion calculation methodology which applied to all cities and counties under the state's jurisdiction. San Francisco ascertained their diversion rate according to weight data gathered from San Francisco's waste service contractor Recology (see Table 1). The current success of diverting 80% of waste from landfill can be attributed to an already existing recycling culture, which enabled societal openness to civic engagement and educational programs and readiness to make behavioural changes. The existing waste and recycling infrastructure, processes and systems also enabled adjustments to take shape.

Although the city's ambition to reach 100% diversion from landfill and incineration by 2020 has been highly regarded, many have pointed out the limitations and uncertainties in using mass recovered statistics and recycling percentages as it does not account for social or environmental externalities (see Pires et al., 2011). Zaman and Lehmann (2013) demonstrate that a focus on diversion rates can hide actual increases in waste generation. Thus the real merit of San Francisco's Zero Waste objectives is debatable within the context of an increasing need for sustainable production and consumption goals

Furthermore, in San Francisco reductions in waste at the production and manufacturing side of the product lifecycle are incentivised by soft voluntary based policy rather than a regulatory approach. By contrast, greater investment and policy measures are focused more aggressively on managing end of life cycle processes. Therefore the policy is still effectively directed at diversion rates from landfill. Whilst this is still a very positive effort, it does not fulfil the true intention of the zero waste philosophy, which is defined by the Zero Waste International Alliance (ZWIA, 2013) and Zero Waste Europe:

> *"Zero Waste is a goal that is both pragmatic and visionary, to guide people to emulate sustainable natural cycles, where all discarded materials are resources for others to use. Zero Waste means* ***designing and managing products and processes to reduce the volume and toxicity of waste and materials,*** *conserve and recover all resources, and not burn or bury them. Implementing Zero Waste will eliminate all discharges to land, water, or air that may be a threat to planetary, human, animal or plant health."* (our emphasis)

Strong industry lobbying behaviour has potentially disabled stricter front-end approaches. This pressure was particularly evident in the clashes experienced in implementing the earlier Plastic Bag Reduction Ordinance. During this time the American Plastics Council, American Chemistry Council and large supermarkets launched a campaign and legal attack against the City, which they eventually lost. The City was able to establish a Plastic Bag Reduction Ordinance in 2007 which then developed into the San Francisco's Extended Bag Reduction Ordinance in 2012. However whilst it has been difficult enforcing policy on industry, the Mayor and City Hall have taken a 'lead by example' philosophy, banning single-serve plastic bottled water containers within government departments by introducing an Executive Directive on Bottled Water, as well as an Ordinance for Environmentally Preferable Purchasing for Commodities (SF Environment, 2014). Although these attempts have been well received by the general community, gaining the approval of industry remains a challenge.

The 100% diversion goal has not yet resolved the issue of non-recyclable or compostable materials which will need to be managed or methods that assess specific material value and externalities. Higher density living and inner city apartments have also raised challenges for the City, with previous building codes

[1] http://www.sfenvironment.org/video/san-francisco-tops-the-the-us-canada-green-cities-index.

Table 1
This table presents the key success indicator for Zero Waste, San Francisco.

	Key Measurement Tool	Latest published diversion rate	2020 Target
Zero waste diverting waste from landfill and incineration	Diversion rate $= \frac{\text{weight of recyclables}}{\text{weight of waste} + \text{weight of recyclables} \times 100}$	80% landfill diversion	100% landfill diversion

Developed from Silva et al. (2016) pp 229.

Fig. 1. San Francisco's zero waste governance structure.

requiring a single waste disposal chute not supportive of a three bin program. The City recently passed legislation ensuring new apartment buildings implement a 3 chute system.

Beyond the waste reduction activities imposed within the City's departments and sectors under their direct control, 'preventive' policies at the front end of product lifecycles, such as producer responsibility frameworks, are quite limited in San Francisco. The SF Environment staff are well aware of this challenge as well as the misleading nature of using a diversion rate as the main indicator for waste management success. The future intention of the SF Environment's Zero Waste program is to shift towards more full-life cycle and reductionist thinking (Krausz, 2012).

3.1.1. A three pronged approach to governance

From a governance perspective San Francisco's Zero Waste program was implemented through a centralised and relatively simple governance and leadership structure. Most of the program's activities were enacted through the City's waste legislators SF Environment and its waste service partners, Recology, in consultation with San Francisco citizens (see Fig. 1). Many of the policy measures required serious economic investment and a hard policy approach which left little room for noncompliance. This tactic is best implemented from a centralised and locally positioned governance structure that enables close proximity for direct stakeholder consultation but does not require the approval of multiple and diverse actors.

Another mechanism that supported the centralised governance structure was the exclusive waste management rights provided to the innovative and forward thinking waste servicer, Recology, who had a long standing historic relationship with the City of San Francisco as well as significant investments in recycling infrastructure. The San Francisco authorities awarded a long term contract to Recology to handle all waste including recycling and landfilling until 2025. Although the regulated monopoly came under some fire by those that opposed the decision, the majority (71%) of San Francisco residents surveyed approved the decision (Krausz, 2012). The allocation of almost the entire San Francisco waste service to Recology was seen to allow for more direct engagement and experimentation with less time-wasting. This structure also ensured a greater economic incentive for Recology's further investment in composting and recycling capabilities and infrastructure (Tam, 2010).

Although this geographically confined and relatively centralised governance structure enables rapid dissemination and implementation of some policy directives, there are also limitations to it. These may include a lack of ownership and inclusivity amongst major industry players and other relevant stakeholders outside of the governance structure. The geographical containment is an interesting element of 'zero waste'. Examples of zero waste programs, initiatives, frameworks and policy directives, beyond the San Francisco case often reveal a spatially confined governance structure with a local or regional focus. This is consistent with the geographically bounded waste management configurations evident in traditional limited waste management practices and processes (Davies, 2005; Rootes, 2009).

If SF Environment's future goals of moving towards a full life cycle approach is to be reached then the complexities of the current 'three tier' governance model will surely escalate to include a multitude of additional actors. Therefore the challenge to implement closed-loop material policies remains, because material flows and economic activities lie outside San Francisco's jurisdictional control.

3.2. Re-conceptualising and re-governing waste policy: Sustainable material management in Flanders

Flanders, in Belgium, has been able to promote itself as one of the top regions in the EU for selective collection and recycling since the beginning of the 21st century. The earlier Flemish waste policies were considered satisfactory until in 1995 the Flemish government developed the environmental multi-year plan (MINA-plan) and determined that previous waste plans would be abolished in favour of a new waste policy direction that would integrate more holistically into the region's future strategic environmental visions. Although these new directives have produced wins such as a reduction down to 3% in household waste sent to landfill in 2006 and an increase in selective collection of household waste from 18% in 1991 to 71% in 2006, the total amount of household waste being produced hit an all-time high of 550 kg per person in 2000 and plateaued at that level (MIRA, 2011; Paredis, 2011, 2013). A growing concern amongst policy makers to prevent increasing generation of waste was evident in the policy debate and it was around this time that the Flemish government embarked on a transformation of waste policy.

A coupling of three evolutions inspired this transformation process: an evolution in thinking about waste policy, general environmental policy, and the organisation of government administration (Paredis, 2013). Pioneers from the Public Waste Agency for Flanders (OVAM) acknowledged the role of OVAM in initiating and supporting the transition and proposed Transition Management (TM) as a way to operationalise a shift towards materials policy. Transition Management was at the time gaining a reputation in the Netherlands as a viable framework to instigate policy and social change towards sustainable outcomes - one in which a government is aware of its limitations in steering system change and takes on an active role in networks, uses multi-actor

approaches and stimulates learning and experiments (see Loorbach and Rotmans (2010)). In an attempt to re-conceptualise and re-envision innovative waste management solutions, Flanders's TM process encompassed actors beyond the traditional waste management governance silo, who were open to change and innovation.

After consultation with the prominent Dutch scholar and practitioner Jan Rotmans and his team of Transition theorists at ICIS Maastricht, the Flemish waste authority adopted transition management as the appropriate process in creating the sustainable materials management program (Paredis, 2011). Shortly after, government officials set up a genuine transition trajectory, adopting a systems view which perceived conventional waste management as ineffective in resolving issues of unsustainability.

A new policy trajectory was developed: first introducing "prevention of waste", then "resource flow management" and finally "materials policy". There was a general consensus that the term 'materials policy' best encompassed the agency's new direction. The transition trajectory was anchored via the establishment of a transition platform for sustainable materials management, called 'Plan C'. (Plan A = business as usual, Plan B = optimisation, Plan C = system change). Plan C was the result of the envisioning exercise of OVAM's transition approach and reflected the shift from an executive role to a role of catalysing innovation (OVAM, 2011; Plan C, 2015).

The involved government entrepreneurs were able to instigate a significant mind shift: to really benefit the environment, waste needs to be designed out of the whole life cycle of the economy. The likelihood of the existing and dominant waste paradigm standing in the way of such a transformation prompted an acknowledgment by OVAM that the waste sector itself needed to change to accommodate a totally new discourse and very different management practices. In order to nurture innovative thinking, Plan C was first conceived by a group of front runners, as an independent non-profit organisation that strived for a broker and incubator function for innovation trajectories, acting as an intermediary in the quadruple helix (state, industry, civil society and science) (OVAM, 2011). From 2006 to 2008 significant time was spent building legitimacy and awareness amongst larger regime actors involved in the waste and materials sector. Eventually the push to focus policy innovation towards sustainable materials management started to gain much more salience and permanency amongst Flanders' decision makers. After a Round Table on Sustainable Materials Management in 2011, the Flemish government decided to embrace 'Sustainable Materials' as a spearhead policy related to the major societal challenges of the region (Regerin, 2011). The developed Flemish Materials Program encompassed 10 new levers;

1. *Sustainable design*
2. *Transparent materials cycle*
3. *Smart cooperation*
4. *Smart investment*
5. *Better regulation*
6. *New materials in a permanent cycle*
7. *Bio based economy*
8. *Critical metals in a permanent cycle*
9. *Sustainable housing and building*
10. *Sustainable chemistry and plastics in a permanent cycle*

It is generally acknowledged that the transition approach of OVAM, resulting in the transition network platform Plan C, played a decisive role in the shift from a waste to resource/materials discourse and embedded 'materials thinking' into the Flanders waste sector and beyond. As stated by Paredis (2011);

> *"All in all, the change in discourse from waste to sustainable materials management is undeniable. It is not only taken up in the Materials Decree and propagated by OVAM as main government actor, it also seems to find support with all actors involved in the waste/materials system: advisory councils, different sectors of the industry, knowledge actors such as universities and VITO, and NGO's. Politically, the build-up of the discourse coalition benefited from the possibility to link it to ongoing developments at European level and to the innovation and green economy debate at Flemish level*" (pp. 147).

The updated policy also sought to ensure that the program incorporated more players within the materials sector.

3.2.1. A transition management approach: Multi-actor governance in action

As mentioned the TM principles dictate a systems approach to innovation encouraging OVAM to include multiple actors who are front-runners in their fields of expertise. This significantly reconceptualised the governance from the traditional waste three tier model (government, households, waste company) to a multi-level and multi-actor governance structure. Although OVAM was at the centre of the governance model, heavy investment was made in participatory and collaborative processes that included participants from knowledge institutes, industry, expert consultants, the NGO sector and community in general. This encouraged creative risk and visionary solutions which eventually led to the production and installation of Plan C and later the Flemish Materials Program.

The actors within the transition arena did change and evolve with the process, as new players enter the policy arrangement and old actors either leave or reformulate their roles. However effort was made to ensure a wider inclusion beyond OVAM was maintained throughout (Paredis, 2011). Fig. 2 illustrates the current governance model of the Sustainable Materials Management program in Flanders.

The number and diversity of the actors involved in the Flemish waste to materials transition led to some opportunities and challenges for both OVAM and Plan C. Challenges arose with conflicting interests, overlaps in jurisdiction and confusion over funding arrangements and responsibilities. However the opportunities have included the acceptance of the materials concept by regime players in Flanders such as the chemical industry. The materials discourse was also successfully integrated in the ViA Agenda 2020 (Vlaanderen in Actie, 2012), which articulates the future vision for Flanders. The materials orientation also gained traction within the Environmental ministries at the European level (i.e. in the EU) (Paredis, 2011).

The Transition process used in the Flanders Materials Program expanded the often narrow concept and governance model of waste management by incorporating an inclusive participatory approach that brought together frontrunners across knowledge institutes, industry, consultancy, and the NGO sector. This collective process encouraged holistic innovative thinking and new industrial systems to unfold, including a booming interest in secondary raw materials, technospheric/urban mining and investment into sustainable plastics chemistry. Breaking away from the waste management silo, Flanders was able to move towards a material management program, highlighting the conceptual and governance changes necessary for innovation, sustainability and resilience.

Even though the transformation from waste to materials management is still in progress, early studies point out that changing mentalities around resource use are also dispersing into civil society. For example, there was an increase in home composting from 41% in 2006 to 52% in 2012 driven by the compost master strategy

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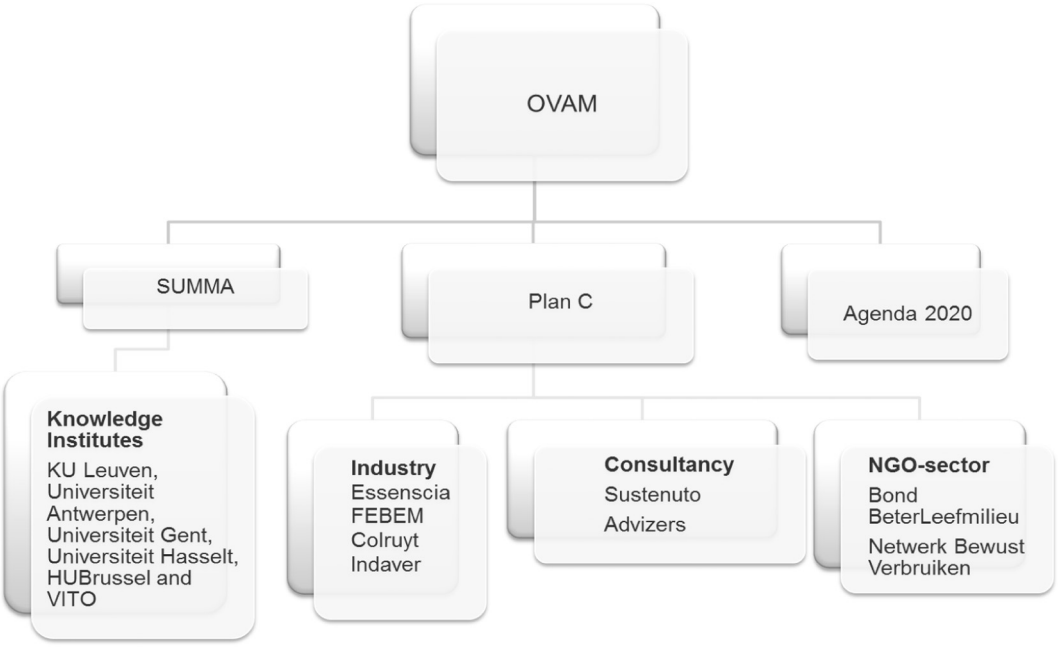

Fig. 2. Flanders's sustainable materials management governance structure.

Table 2
Key success indicators for Japan's sound material cycle society with targets.

	Key measurement	Improvement on 2000 based on the most recent data	2020 Targets
Inlet: Resource productivity	GDP/natural resources input	51% improvement to 374,000 yen/ton	460,000 yen/ton
Inlet: Resource productivity excluding input of earth and rock	GDP/Natural resources input – earth and rock	10% improvement to 602,000 yen/tons	680,000 yen/tons
Circulation: Cyclical use rate	Amount of cyclical use/(amount of cyclical use + natural resource input	15.3%	17%
Output: The quantitative final disposal amount	Final weight of waste sent to landfill	67% reduction to 19 million tons	17 million tons

Developed from Ministry of Environment, Japan (2013).

of OVAM, which has effectively reduced household waste (Claes and Smet, 2012; OVAM, 2013). In addition, indirect evidence shows that for the whole of Flanders collection of donated goods increased 7% yearly from 2002 to 2010, effective re-use of collected goods per resident increased from 3.12 kg in 2003 to 4.32 kg in 2012 and the number of customers going to local re-use shops has increased to more than 5 million in 2014, generating a turnover of 45.5 million euro (KOMOSIE, 2014). In addition, there is a growing number of European companies involved in shifting to circular materials management (C2CN, 2015).

Other developments, such as the EU resource efficiency strategy and external pressures on resource availability and price, reinforced the conceptual and long term vision of Plan C and its policy community. Also, a growing number of front running companies embraced sustainable materials use as a corporate strategy, either based purely on economic logic or on a desire to show leadership in socially and environmentally sound business models (Nevens et al., 2014). Evolutions in product-service systems, chemical leasing, landfill-mining, closed loops of materials, product design, and local production and consumption, are all examples of system changes well beyond conventional waste management.

The Flanders materials program initiated by OVAM, was the first larger scale waste to materials policy restructure in the world (OVAM, 2013). In 2016, the main theme for Plan C is the circular economy, with the Flemish Materials Program having won a Circular award at the World Economics Forum for its dedication to shift towards a circular economy, the impressive amount of projects that have been started and its participatory nature in shaping sustainable materials management.

Not only did OVAM significantly promote a new materials discourse across the waste industry, it also initiated long term visions of practical application. Although relatively new in conception and requiring improvement, material management is making headway globally as a strong policy pillar in addressing the sustainable development goals to build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation and ensure sustainable consumption and production.

3.3. The 3Rs guiding Japan's National Policy towards a Sound Material-Cycle Society

The policy logic of the waste hierarchy (reduce, reuse, recycle, recovery, and disposal) prioritises the reduction and reuse of materials ahead of recycling and disposal solutions in order to reduce mass-consumption and waste generation (EEA, 2014; UNEP, 2011). Consequently Japan's Fundamental Plan towards Sound Material-Cycle Society incorporates reduce and reuse principles to enhance the existing recycling, recovery and disposal treatment processes.

Japan's vision to establish a 'Sound Material-Cycle Society' (SMCS), originated in 2000 through the successive development of the first Fundamental Plan, initiated by the re-structured Ministry

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of Environment, Japan (MOEJ). By 2008 a second 'Fundamental Plan for Establishing a Sound Material-Cycle Society' was published addressing goals until the end of 2015. More recently in 2013, a third Fundamental Plan was published, which revised the plans in light of the 2011 East Japan earthquake disaster, setting goals to 2020. The principles guiding the plan focused on the 3R concept (Reduce, Reuse, and Recycle). The policy required centralised government control in order to implement a legal framework adequate to ensure compliance and provide centralised subsidisation for the roll out of high-tech materials management infrastructure nationally.

The motivations to move towards SMCS shares a similarity with the geo-political and economic drivers of the Flanders SMM. Key reviewed documents alluded to Japan's desires to become less reliant on imports especially after the oil crises of 1978, and to achieve long term economic sustainability (OECD, 2012). Japan's international positioning as a leader in technology and innovation is also identified as a motivation for SMCS in persisting with Japan's global competitiveness in the emerging 'Secondary Raw Materials' industries (Ministry of Environment, Japan, 2008; Silva et al., 2016).

The Japanese 'Fundamental Plan for Establishing a Sound Material-Cycle Society' is perhaps the most elaborate Policy document in providing descriptive and detailed measurements and specific assigned targets in relation to the 3Rs principles. Resource productivity is measured by a reduction in resource inputs (inlets, imports) and the reuse of materials by ensuring an increasing cyclical use rate. Reduction is also measured by decreasing the final disposal amounts in tons (see Table 2).

The Fundamental Plan's (2008; 2013) Key Performance Indicators (KPIs) utilise a variety of already existing policy agenda and legislative frameworks, incorporation with newer directives. Some of the newer KPIs include a list of 'Effort Indicators' including: emissions measurements, number of recycling plans drawn up by local governments, average use years of durable consumer goods, resource consumption per capita and the reuse and sharing market size. Effort indicators are used as supplementary indicators to the main Inlet/Circulation/Outlet goals.

3.3.1. Recycling

The sophistication of Japan's existing recycling initiatives and infrastructure enabled a smooth rollout of legislation that further developed the collection of specific end of life materials. Acts include: Construction Materials (2000), End of Life Vehicles (2002), Container and Packaging (2006), Food Waste (2007) and Home Appliances (2012) (Hotta, 2013). Separation at source has been a popular mechanism, with a seven bin system commonly found across Japan's Municipalities. However Japan's reliance on high rates of incineration has led to relatively low recycling rates. In order to improve and implement initiatives that promoted the SMSC policies and the 3R's principles on the ground, MOEJ partnered with and subsidised the Eco-Towns program, which acted as a cornerstone of recycling performance through Eco-Industrial development implemented across selected towns (Hosomi, 2015). The MOEJ aims to develop Recycling Zones specialising in the management of specific materials. These areas will likely expand beyond one Municipality's control, requiring MOEJ to facilitate collaboration amongst the relevant stakeholders. The Fundamental Plan demonstrates the need to develop recycling industry locally and advance the quality of recycling processes in order to achieve material reuse and waste reduction.

3.3.2. Reuse

The SMSC Policy framework also expanded beyond recycling to Extended Producer Responsibility (EPR) with a law to promote effective utilisation of resources enacted in 2001 and the expansion of the Home Appliance Recycling Law where Japanese retailers and manufactures are held accountable in taking back home appliances. The law considers an item recycled only when, after take back, it is later 're-sold' as a 'resource' in the market. This policy encourages higher quality design and disassembly considerations at the manufacturing point (Ongondo et al., 2011). The Fundamental Plan also introduces the notion of high quality housing, designed for longitudinal generation reuse as well as outcomes pursued through the promotion of 'Common ownership' products, such as car sharing and shared housing.

Reuse is measured by a steady increase in the Cyclical Use Rate, which provides an indication of the utilisation of existing materials rather than those newly imported. The reuse and recycling mechanisms work closely together to ensure this KPI is met.

The Fundamental Plan's (2013) recently established 'Effort Indicators' include power generation and heat utilisation from waste within the circulation (reuse) strategies. Power and heat recovery through incineration debatably does not align with the reuse concept (Silva et al., 2016). However Japan has positioned incineration solutions across the 3Rs, particularly due to tightening landfill limitations and increasing land costs.

The concept of Circulative Resources (CR's) is a slightly alternative labelling approach used by the Japanese. Referencing the cyclical and circulative terminology continuously throughout the Fundamental plan is coherent with the more recent cyclical systems/circular economy discourse.

3.3.3. Reduce

In 2010 93% of Municipal Solid Waste (MSW) was treated through incineration processes, with only a small number of plants linked to recovered energy (Pariatamby and Tanaka, 2014). Although reports produced by the MOEJ promote a significant decrease in MSW generated, reliance on incineration has the tendency to obscure waste generation data by only accounting for landfilled waste. Although reliance on incineration is shown to be slowly decreasing, land restrictions in Japan enforce strict limitations on available landfill sites, thus incineration has been implemented widely: latest incineration plant numbers standing at around 1220 (Pariatamby and Tanaka, 2014). Despite the possible social or environmental penalties Japan's spatial limitations positons incineration favourably. It is important to recognise these different variables when assessing waste policy across geo-political regions.

Unlike San Francisco's Zero Waste program, aimed at an increased diversion rate from landfill and incineration, Japan's SMCS objectives focus on reducing the weight of waste disposed, by tonnage. Establishing quantitatively measured waste weight reduction rather than a diversion rate or targeted material recovery focus, perhaps provides a clearer indication of actual waste generation. However by not including materials sent to incineration, Japan's waste reduction progress does not fully account for materials lost in this process; thus the foundations of the 3R philosophy (Reduce, Reuse, Recycle), especially 'reduce', are not sufficiently met, or well developed (Connett, 2013).

Investigating the key documents associated with the SMCS transition produces similar findings to that of SMM with respect to the emphasis on the life cycle of materials. However use of the term 'society' here presents a new philosophy in policy direction with a focus of societal aspirations and community engagement. This suggests that SMSC moves beyond an objective focus on material management and is rather more encompassing. The Fundamental Plan refers to the philosophy of 'mottainai'[2]: a tradi-

[2] "In the first decade of the twenty-first century, Japan experienced a surge in the evocation of the word "mottainai" most simply translated as "wasteful." Children's literature, mass-market nonfiction, magazines, newspapers, songs, government ministries, corporations, and nongovernmental organizations deliberately used and defined the term as they took up the question of what was to be deemed wasteful" (Siniawer, 2014).

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tional cultural discourse suggesting that you only take what you need and wasteful behaviours are perceived as uncouth. This is line with the Japanese vision of a society living in harmony with nature (Siniawer, 2014). Drawing on 'mottainai' as a traditional Japanese value in the campaigning for SMCS provides a pertinent community engagement message, quite different to capitalism's promotion of consumerism. As stated in the 'Fundamental Plan for Establishing a Sound-Material Cycle Society' (2013);

> *"We seek to establish a sustainable society where we switch from a mass-production and mass-consumption and one-way style lifestyle established in the second half of the 20th century to a lifestyle enabling affluent life to coexist with environmental conservation...In this society, people will "know they have enough", "Reduce" will progress and "Reuse" will take root"* (pp. 15).

Although this policy agenda relies on less concrete legislative instruments, enacting a cultural discourse encouraging less wasteful consumption may further encourage sustainable behaviours amongst Japan's population, assisting with the Fundamental Plan's reduce goals.

3.3.4. A top-down 3Rs National Governance Policy

From a governance perspective SMCS is centrally driven by Japan's National governance body MOEJ. The MOEJ is responsible for the Fundamental plans enactment, however and relies on the cooperation of multiple stakeholders. This positions MOEJ also as an intermediary, facilitating partnerships and collaboration across the regional and municipal departments as well as integrating input from non-governmental actors, industry, knowledge institutions, community, special interest groups and experts. Although centrally driven, many aspects of the Fundamental Plan must be decentralised when implementation occurs on the ground. This is to allow for appropriate adaptations to regional conditions. For example the cooperation of many smaller regional and local actors is necessary in collecting recyclables deposited within the Municipalities particularly for locally embedded bio materials such as discarded food (Mazzanti and Montini, 2014).

Pursuing a SMCS from a National level enables the enactment of appropriate legislative frameworks expanding beyond a particular industry sector (waste management, recycling or manufacturing and production). The economies of scale required to erect and legitimise high-tech infrastructural solutions have been made viable through MOEJ subsidisation. This is also true for new emerging markets that are not yet ripe for large scale business investment such as product 'Reuse' industries, in which product guarantees are required in order to prevent stolen or non-functional items flooding the market. This centralised plan also validates the widespread dissemination of the traditional Japanese cultural discourse of 'mottainai' values.

As an island, Japan has tighter jurisdiction over its borders, enabling the monitoring of resource imports and exports nationally, validating the Fundamental Plan's inlet, circulation and outlet KPIs to be measured nationally. This is perhaps why a national materials strategy, directed and measured by holistic indicators, is being pursued.

It should be noted that within the Fundamental plan Japan has made significant headways to detail frameworks that demonstrate material flows from a domestic capacity as well as flows occurring over international geographies (see Fig. 3).

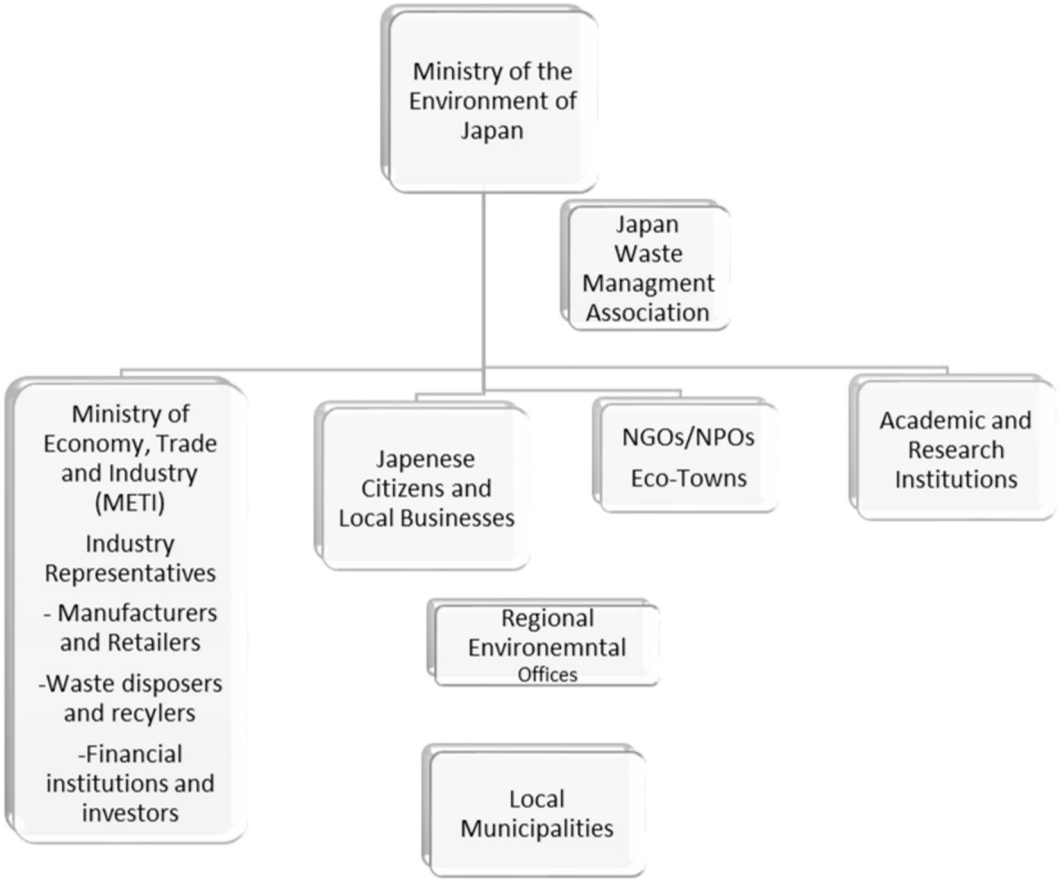

Fig. 3. Japans sound material-cycle society governance structure.

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4. Discussion

Waste policy is increasingly moving on from the 'reduction of waste' to a 'sustainable materials policy' focused agenda recognising individual wastes as a resource. The examined case studies bring to light policy directions, governance frameworks and regional conditions, propelling waste management towards resource and materials systems thinking encompassed in the sustainability agenda. In each case the waste department was amalgamated with an environmental authority illustrating the benefits of embedding waste policy within a wider sustainability program. Rather than analysing the cases in opposition to each other, value can be gained from viewing the cases as collaborative contributions to waste and materials management, viable to different levels of governance.

San Francisco's Zero Waste program is an example of implementing enhanced recycling policy through landfill diversion. Predominately this is achieved by improving recycling infrastructure capabilities and processes. The policy reach is limited to the geographical confinement of the city of San Francisco, where we find a relatively enclosed three tier governance structure similar to traditional waste management (government/waste-recycling company/community-service users). However the case also exemplifies some of the benefits of a locally confined governance structure.

Although the limitations in using diversion and recycling percentages as measures of success has been noted, the case demonstrates the positive flow on effects of close civic engagement. San Francisco's Zero Waste program is an example of a local authority incrementally shifting from its origins in waste management to reduction and production mechanisms and full-life cycle assessment thinking.

As a commonly used exemplar of a city reducing its waste, many external cities and businesses worldwide have since adopted the term Zero Waste in initiating similar diversion from landfill programs. This is evident in the diverse range of grassroots Zero Waste programs emerging across communities and businesses. The three-cart system emphasising localised management and distribution of food and garden waste as an agricultural resource has been particularly well received and applied across many regions and cities sharing similar contextual conditions.

Flanders's Sustainable Materials Management program is a significant regional level attempt in restructuring the waste governance system and linking end of life materials to inputs at an earlier production stage. SMM expands beyond recycling and landfill diversion goals, focusing on sustainable production and material reuse. This is pursued through secondary resources markets, which are nurtured by better secondary material source extraction and collection technologies, replacing landfilling and incineration. The program has also encouraged a booming secondary goods market, fuelled by a shift in consumer purchasing behaviours.

It has used a Transition Management approach, which incorporates multiple actors considered front runners in their areas of expertise, to enact inter-sectoral collaboration and solutions. This approach was particularly successful in engaging knowledge institutions and industry in the visioning and implementation of sustainable materials management. Flanders's SMM policy started at a regional level however has since gained considerable attention and interest across the EU and internationally.

Japan's Fundamental Plan towards a Sound Material-Cycle Society is a noteworthy attempt at implementing a national policy framework honouring the 3R philosophy. Enhancing an already sophisticated recycling and materials collections scheme, Japan is now shifting focus towards a 'sustainable society' with reduction and reuse objectives. Although the plan is initiated centrally by the Ministry of Environment in Japan, it also includes a diverse array of government and non-government actors both nationally and regionally. The plan has been successful in linking the Japanese cultural narrative of the 'mottainai' value as well as the Eco-Towns movement, whilst encompassing specific and quantitatively measured KPI's and monitoring mechanisms.

The influences of cultural and social motivators is evident within each case; San Francisco's culture of recycling and their desire to be perceived as a sustainable city, Japan and Flanders's concerns for future resource security as well as their capacity for technological innovation. Demonstrating the importance for waste and materials policy to be autonomously adapted and applied with the existing contextual conditions at the forefront of decision making (Mazzanti and Montini, 2014).

However these international programs illustrate that even as global leaders in waste management policy and practice, these programs are still in transition towards the integrated waste management models required for sustainable materials management in circular economy thinking. For example:

- Promoting diversion from landfill and increasing recycling percentages does not account for full-lifecycle assessment results and is therefore limited in accounting for wider social and environmental impacts.
- Whilst Flanders and San Francisco are focused on the restructuring of their waste management systems, they neglect ideas of managed sustainable consumption which aims to limit the increasing amounts of waste being produced.
- Japan has invested significantly in waste management recycling systems, governance and social systems for behaviour change, but they are still heavily reliant on incineration as their main waste management approach with much less focus on materials/resources recovery needed to achieve a "sustainable society".

Policy outcomes are also in a transition to a more inclusive model that involves local government, national government, industry and community in managing the change from waste management to materials management. The challenges include:

- Traditional governance for waste management is typically under municipality control due to localised waste generation and collection. Waste is typically managed as a cost-centre rather than as a potential value adding business. Little strategic focus is given to waste management other than through 'cost efficiency' imperatives.
- Transition in managing waste requires governments to lead the space with policy and potential infrastructure development in order to drive materials recovery and behaviour change. A governance re-modelling of a complex array of actors currently managing traditional linear material systems will be required in order for a resource recovery system to emerge.
- Industry involvement in the new resource recovery business model will be essential in extending the scale and integration of materials recovery through privatisation and commercialisation models. This is seen in San Francisco's partnership with Recology, and Flanders's and Japan's inclusivity of the relevant business sectors contained within their multi-governance programs.
- The co-evolution of policy alongside sustainable grassroots community and business initiatives such as, transition and eco-towns, peer to peer platforms, design innovations, open source technology and servitisation or product-service systems, leverage new possibilities in policy directions. This co-evolution is crucial in accelerating systemic shifts and is central to sustainable change in production, consumption and materials management.

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Production processes are now paying more attention to cost increases in raw materials and therefore are either trying to do more with less or reduce the raw materials required in their production processes. Policy incentives should be provided that maximise the use of materials already in the system in order to encourage closed loop production benefits.

- National interests in materials security and the desire to decrease reliance on external import quotas is consolidating national resource management strategies with waste and materials policy making.
- Material inputs costs account for a large proportion of overall business expense, particularly for those in manufacturing and production industries. This positons Extended Producer Responsibility as a reverse logistics opportunity to regain material assets lost to the supply-chain and reduce long-term costs.
- From a policy perspective, the risk of developing resource recovery solutions is that it may deflect from sustainable consumption behaviours by supplying additional material resources, possibly incentivising, or at least masking, the continuation of over-consumption (Krook and Baas, 2013). This should be considered in the development of policy for sustainable material management.

Together the cases present a vast range of metrics and tools used to analyse progress of diversion, productivity, cyclical use, material inputs, material cycles and sustainable design. This supports other studies demonstrating the expansion of multiple metrics and performance indicators applicable to enhanced waste management (Paredis, 2011). The key principles driving the Circular Economy, such as reverse logistics, functional economy and industrial symbiosis may also be valuable in providing holistic waste policy analysis.

Applying specific indicators in order to comparatively position the policy outcomes against each other was beyond the scope of this paper. However it is recommended that future research establish more concise metrics in which to investigate economic, social and environmental benefits and trade-offs for these different approaches. These opportunities and challenges act as a reminder that waste management necessitates greater innovative solutions and investment in order to drive it towards sustainable materials management. The traditional small step changes will not suffice, the complexities of material flows in production and consumption require a systems approach reconceptualisation and greater cooperation of engaged front runners who have the authority to implement changes. The global movement of materials and waste provides a platform for increased transnational cooperation. Future enhanced waste management programs should consider the experiences and lessons emerging from a variety of case studies in order to build upon best practices and avoid reinventing the wheel.

5. Conclusion

The last two decades have witnessed a shifting ideology away from the linear economy promoting a take-make-waste society towards holistic circular systems. Enhanced waste management is increasingly positioned as an opportunity to address the need for closed loop consideration of material/energy flows in order to achieve waste prevention and enhanced resource productivity (Ghisellini et al., 2016).

Since the release of Rio 20+ 10-Year Framework of Programs on Sustainable Consumption and Production (10YFP on SCP), more diverse sustainable innovation in waste and materials policy is emerging. This paper has explored three different enhanced waste and material transitions; the "Zero Waste" program in San Francisco, the "Sustainable Materials Management" vision in Flanders and the "Sound Material-Cycle Society" in Japan. Some of the major documents informing policy directives, legislation and future vision associated with waste transitions were reviewed. The case studies examined provided an opportunity to compare leading policy directions in enhanced waste management and governance structure, offering valuable contributions for practitioners and academics engaging in waste and materials policy.

This paper concludes that the current transitional state of waste management across the world requires the development of further government policy, planning and behaviour change. Enhancing material policy has considerable potential in assisting with the redefinition of the word 'waste' and the movement away from end-pipe land-fill solutions. Emerging frameworks such as Transition Management may act as a catalyst to enhance future governance structures by incorporating multiple front runners across government, industry, knowledge institutions and community. The transition towards landfill diversion and Zero Waste programs is only the first leg of the journey towards Circular Economy closed loop production models of waste as a resource material, designing waste out of the economy to achieve sustainable materials management.

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