

Article

Closing the Loop on Food Waste: Stakeholder Views and Experiences from Southeast Queensland, Australia

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Abstract: Every year in Australia, the household, commercial and industry sectors generate more than five million tonnes of food waste, with the majority of it ending up in landfills that are costly to run and diminishing in availability. There are urgent calls for effective waste management practices to better address the challenges related to increasing volumes of food waste. This study evaluates potential food waste collection and composting initiatives that will ensure the implementation of the appropriate policies and technologies, and best practice of utilizing food waste as a natural resource. A series of semi-structured interviews were conducted with practitioners from the Southeast Queensland waste industry to gain insights on the challenges and opportunities for implementing a Food Organics, Garden Organics (FOGO) system. The interviews revealed five key themes: levies and taxes, capital investment challenges, lack of capacity, contract inefficiencies, and separate waste streams. Organisations and companies in the waste industry heavily rely on funding in order to technologically advance. There is a divergence of attention between technology and policy. Advancement of technology grows faster than the policies that regulate the appropriate use and level of effectiveness of the introduced technology. Both policy and technological changes need to occur simultaneously for Queensland to evolve and develop a social-economic system that favours a non-wasteful and sustainable future.

Keywords: food waste; food organics garden organics (FOGO); closing the loop; circular sustainable economy



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1. Introduction

Every year in Australia, the household, commercial and industry sectors generate more than five million tonnes of food waste, with the majority of it ending up in landfills that are costly to run and diminishing in availability. Furthermore, landfilled food waste in Australia is estimated to result in nearly eight million tonnes of carbon dioxide equivalent over the year it takes to decompose [1]. These figures highlight the significant need to address the greenhouse gas contribution of food waste. There are substantial precedents globally of the resource recovery industry reducing the volumes of food waste ending up in landfill, effectively ‘closing the loop’ on the flow of nutrients from—and back to—the soil. There are also significant precedents of doing so in ways that contribute to the ‘circular economy’, where selling products containing composted food waste reduces the environmental footprint of cities, creates local jobs and fosters new and diversified industries to collect, transfer and process waste. In achieving the target of halving Australia’s food waste by 2030, the industry would also be addressing the United Nations Sustainable Development Goal 12, ‘Responsible Consumption and Production’ [2].

In Australia, there is the two-bin system with general waste and recyclables, and the three-bin system with general waste, recyclable, and green organics. Approximately 79% of Australians have access to the three-bin organics service. Between 2021 and 2022,

1.62 million tonnes of organic material were converted into products such as soil conditioners, manufactured soil, potting mixes and mulches [2].

Almost 50% of Australia's household waste is organic waste resources, which ensures abundance in supply for compost production [1]. Compost is used by farmers and gardeners to improve the physical and chemical properties of soil [3]. Compost is the combination of organic wastes such as food waste, yard trimmings, manures and wood chips in order to accelerate the breakdown of organic matter [3]. Good soil quality is essential and crucial for farmers and to the environment, as increasing demands need to be met and the restoration of disturbed ecosystems needs to be conserved for a sustainable future.

A wide range of stakeholders are involved in the reduction in food waste going to landfill. These stakeholders are communities, businesses, planners, scientists, engineers, politicians, lawyers, economists, local and state councils and the federal government. These stakeholders are aware of the disadvantage landfills have in their effects on built and natural environments because the land becomes undesirable and unusable for agriculture, residential, industrial and commercial purposes.

Food waste in landfills requires large sums of funding for management, maintenance and security [4,5]. Food waste can be used as a resource that gets recycled and sold as a product. It enters the market system and provides income to businesses, such as soil organic firms, horticulture, composting facilities, re-vegetation programs and nurseries and conservation parks.

The following sections presents the key literature findings on the global food waste problem, the main directions on the issue in the modern period, the Food Organics, Garden Organics (FOGO) collection system and Australian government initiatives.

- Global food waste and its environmental impacts

Food waste has been described as a part of general waste that has no value [5] and cannot be utilised to its full resourceful potential. On the other hand, food waste is identified as a 'wrong time and place material' that can be re-used in the food supply chain from primary production to household consumers [1]. It is corroborated that food waste is a method of re-using discarded food that is safe and nutritious for human consumption [6]. It is a resourceful opportunity that can be utilised in a cyclical way.

Food waste is a global issue that has varying effects economically, socially, and environmentally, depending on what part of the world it is occurring in and at what magnitude [7,8]. Waste involves loss of resources and has no benefits economically as it requires funding to operate landfill facilities [7,9]. Socially, landfill is considered as an undesirable piece of land, due to its odour and amenity. In the natural environment, pollutants leach, organic matter has a long decaying lifespan, chemicals degrade soil health that accumulates, and vermin are attracted, causing a hotspot and spread of diseases, posing both human and environmental health hazards [10].

The cost of wasting food for Australian households is AUD 8 billion annually and, for the Australian economy, it is around AUD 20,000 billion [8]. This economic setback is the calculated cost for growing, transporting, processing, and storing food, as well as the cost of transporting wasted food to landfills. This also includes the lost income for food to be purchased and reaching its final destination to consumers. One in five shopping baskets of food is thrown out by Australians and over 5.3 million tons of human-consumption-intended food is wasted from households, commercial and industrial sectors every year [8].

Globally, around 50% of food is wasted between production to consumption [7]. Landfills on a global level produce up to 70 million tonnes of methane gas each year [11]. Landfills are the third largest source of man-made methane emissions and landfills represent a lost opportunity for resources [11]. Within this context, it is critical to adopt effective and efficient methods for food waste management with a particular focus on collection methods.

- Food Organics, Garden Organics (FOGO) system

FOGO is the collection method of food and garden waste, including fruits and vegetable scraps, processed food, leftovers and any organic carbon-based materials, to create high quality compost [3,4,12]. This method has proven to be an effective way to divert organic reusable resources from landfills and from being considered as waste, which provides economic and environmental benefits and opportunities for the future [5]. This method focuses on segregating waste and changing people's perceptions about food and organic waste [8]. There is an urgent need to preserve resources for future generations and meet the needs of the present [10]. In the composting industry, there is a growing maturity where quality control and guideline management can trace and separate organic matter from plastics, glass, metals and so forth [5]. FOGO can enable the mainstreaming of commercial-scale composting practices by creating a food and garden waste stream.

- Australian government initiatives

About 10% of councils offer residents a three-bin FOGO waste collection system for solid waste, organic waste and recyclable waste. One of the states, New South Wales (NSW), has 42% of local councils providing FOGO. NSW is Australia's leading state for diverting food and garden organics from landfills and, alternatively, generating a valuable product [12], such as compost. NSW processes 2.5 million tonnes of organics a year and the industry is expected to rise over the next few years [12].

Another successful FOGO story lies in the capital of Western Australia, Perth, where the Local Council City of Melville has provided 7000 households with the FOGO three-bin system since October 2017 [10]. The system involved the green-topped bin for food leftovers and garden waste, red-topped bin for general rubbish, and yellow-topped bin for plastics, glass, metals and paper materials [10]. At the end of the FOGO trial, over 80% of people preferred to continue with the FOGO system [13].

The *National Food Waste Strategy* is an example of the Australian Government acting on diverting organics from landfill. This framework supports collective action towards the goal that is reducing Australia's food waste by 50% by 2030 [8]. This strategy was developed during a food waste summit in 2016 and successfully garnered all of Australia's environment ministers extended support [8]. The *National Food Waste Strategy* has four key priority methods, these being policy support, business improvements, market development and behaviour change [8].

The government is investing AUD 10 million to supporting research into reducing food waste, along with industries like AgriFutures Australia, Cooperative Research Centres, CSIRO, and Food and Agribusiness Growth Centre and Entrepreneurs' Programme. These groups are all involved in creating higher-value products to retrieve and convert food waste into alternative products [8]. These products are introduced to the market, promoting advancement in technologies.

A parallel method to FOGO (collecting both food organics and garden organics), Source Separated Organic Waste method (only collects food organic waste), is also implemented by the Australian Government to help reduce greenhouse gas (GHG) emissions generated from food waste, and to divert food waste from landfills by providing support to food rescue organisations [11]. It adopts a circular economy strategy that accounts for the capturing of food waste and reusing it as a resource [8]. It favours food waste avoidance over resource reuse, recycling, reprocessing and energy recovery, followed by waste disposal. The hierarchy is such that avoiding waste is the most preferred decision, followed by reusing, recycling, reprocessing, energy recovery and then disposal as the last option. By using circular economy as an approach, the waste hierarchy addresses food waste demands that find a solution across all food systems within the growing, supplying and consumption chain [8].

- Environmental impacts and opportunities of food waste

Methane is generated by decomposing organic waste in landfills, which is a great contributor to GHG emissions. By diverting this fate for food waste, it can be saved and

reapplied into the market and environment [14]. The way to accomplish this is by capturing the methane released and using it to generate energy, such as electricity, and various fuel sources like natural gas, coal or fuel oil [11]. Attention is drawn to the benefits of recycling food organics by creating compost and improving soil health and structure [1]. This provides an increase in drought resistance, reduces the need for supplemental water, fertilizers, pesticides, and chemicals to be used and creates clean and healthy products for consumption [1]. Generating compost from food waste does not only benefit the environment but also provides major benefits to the economy and society.

The *National Food Waste Strategy* report [8] makes it clear that there are economic opportunities, such as increased employability and profitability, as well as a reduction in cost for businesses and households. While there is extensive dialogue on FOGO systems, there is limited research on the challenges and opportunities for implementing such systems in Southeast Queensland. There is limited research focusing on targeted composting initiatives and the waste separation mechanism in order to enable efficient food waste composting practices. Within this context, the goal of this study is to evaluate potential food waste collection and composting initiatives that will ensure the implementation of the appropriate policies and technologies, and best practices for utilizing food waste as a natural resource. The objectives of this study are to explore the challenges for implementing a Food Organics, Garden Organics (FOGO) system and to identify opportunities to enable better FOGO collection methods.

2. Materials and Methods

The study used an exploratory approach to evaluate potential future food composting initiatives that will ensure implementation of the appropriate policies and technologies, and best practice of utilising food waste as a natural resource [15].

2.1. Data Collection

Six participants were invited to participate in semi-structured interviews through a method of snow-ball sampling, whereby interviewees were invited to nominate other potential stakeholders [16]. This allowed a deeper exploration and discovered whether there was evidence consistent with a problem, rather than measuring the size of the problem or describing the diversity of the problem [17]. A small sample of industry practitioners were interviewed, as detailed below, with ethics approval (GU Ethics No: 2020/472). Invited participants included management and operations personnel with experience in industry and in local councils in Brisbane and Gold Coast (Southeast Queensland, Australia). Interviews were conducted in person on a date and time of participant's choice and convenience. The local composting facility was located in the same region. This geographic location was selected due to the proximity of the researcher's academic institution and the established links between industry partners.

The semi-structured interview questions (Appendix A) were developed based on the findings of the contextual literature review, and participants were provided with a participant information sheet. Interviews were digitally recorded using a smart phone and then transcribed for data analysis [18]. The summary of the participant list is shown in Table 1.

2.2. Data Analysis

Through an iterative coding process using the NVivo software, the emergent themes were identified. Within the coding process, initially, the in vivo codes were developed by labelling the data through a short word or phrase. Then, these codes were categorised into higher-order axial codes to deduce the interactions. Finally, five emergent themes were used to create the selective codes which demonstrated relationships to all categories [19].

Table 1. Summary of the interview participants.

Participant Code	Organisation	Length of the Interview
P1	Operations Product Manager at Composting Facility	60 min
P2	Senior Waste Project Officer at Local Council	60 min
P3	Branch Manager for Waste Logistics	60 min
P4	Director of Cities Research Institute at Griffith University	60 min
P5	Board Director for Waste Management Queensland Association	54 min
P6	Program Manager for Department of Environment and Science Queensland Government	42 min

3. Results

The series of semi-structured interviews identified five key themes related to the challenges and opportunities for implementing FOGO systems. These themes include: levies and taxes, capital investment challenges, lack of capacity, contract inefficiencies and separate waste streams.

3.1. Levies and Taxes

It was found during interviews that funding and cost were stakeholders' greatest concerns and problems. Waste levies determine the amount of funding and support provided to the waste industry. One participant explained, *"There is an absolutely lack of policy driving, and lack of policy action."* (P5) *"I think the main thing we haven't had is any waste levy, there has not been a driver."* (P2). Table 2 presents key factors related to levies and taxes supported by quotes.

Table 2. Key factors related to levies and taxes.

Key Factors Related to Levies and Taxes	Key Quotes
New waste levy in Queensland	<i>"When the waste levy is released extra incentives will be made to divert organic waste from landfill. If the funding is high enough and there is support from government, the waste industry has the chance to expand and develop technologically"</i> (P1)
Waste management as business	<i>"Waste management has always been a business, it is driven by profit, making profit, anything you do has to have a financial positive outcome"</i> (P2)
International best practices	<i>"The best thing about Europe is that at the directive, the European Union has coordinated policy from the top"</i> (P5)
Need for a unified coordinated approach	<i>"The fact is it needs to be Federal not State, the biggest struggle I found with this country, is the State government."</i> (P1)
Challenges related to governance structures	<i>"They need a goal to work for, they have to push for that change to happen, there has to be someone that is helping Council to make the right decision and the right help."</i> (P2)

Queensland State Government enacted a new waste levy in 2019 and has been identified as an incentive to divert organic waste from landfill (P1). Another participant added that waste management is a profit-driven business and that economic tools can greatly influence these processes (P2). There is a range of best practices for Australia to learn from European examples. For instance, P5 highlighted, Europe has been recognizing and acknowledging environmental directives. Members in State have developed and adopted targets that serve as key drivers in reducing waste. Australia is yet to fully develop these incentives and it is still on its way to transforming Australia's waste industry. Some participants stated that there is a critical need for a unified coordinated approach from all state government levels. Some participants expressed their frustration about the governance structures. For example, State Governments hold higher power and collect more taxes over Local Councils; the Local Councils cannot start making changes when costs are too high.

It was argued that, without a supportive waste levy, there is no effective FOGO program in Queensland. Local Governments who had already initiated the FOGO collection program had to increase the levy to combat extra costs. The absence of a waste levy means that funding will have to come from the residents and commercial industry to fund the FOGO program.

3.2. Capital Investment Challenges

The most significant issue recognised Australia-wide is the fact that each state has their own policies and agendas when making political decisions, and this is one of the major factors that is hindering Australia's advancements. *"Many businesses operate in national markets and must meet different requirements in every state, territory and local council area."* (P5). The other issue is that, without money, the advancements for an effective waste-free future are difficult to achieve. The stakeholders interviewed placed major emphasis on investing into education and public awareness, particularly targeting businesses and commercial industry. The other factor that people do not think about is the cost of landfill. Waste and landfills are not an everyday topic or thought for people. When waste rates go up, they do not understand the reason behind it. If people were made aware of the waste handling cost and the potential opportunities waste has, through diversion from landfill, they would realise how much money could be saved. Education for people needs to happen with both young and old generations to ensure that the changes made are long term. *"With education you do really need to push if you want to get hold of it, for the long run and getting the information out there"* (P3). The main capital investment is education; without knowledge, there is no awareness of closing the loop for food waste.

3.3. Lack of Capacity

For FOGO to be introduced commercially and residentially as a working strategy, various factors need to be changed. The main factors are public awareness, education and politics. Contamination is the major issue that comes with FOGO, but if awareness and education are present then this problem can be eradicated. However, to build on this awareness, the political dynamics must be firm and constant. The key issue that exists now is the fact that nothing sticks in Australian politics and, therefore, a mix of opinions and myths are formed. *"The thing with Australia is that we don't have that top down. State Government has been weak historically, the leadership we have has been coming bottom up"* (P5).

Some participants argued that waste is yet to be part of Australia's key priority areas. Often, the industries struggle to find the funding for building necessary infrastructure. While companies and organisations will receive help and support from councils on occasions, it is not sufficient for the waste industry to make significant advances in the field. One participant pointed out that the council is creating short term solutions and maintaining the system, along with organisations, afloat to continue operating. The situation with FOGO is, if a third bin is introduced, it will require extra collection trucks, bins, caddies and treatment facilities. Without a clear target, there is lack of capacity in providing the infrastructure and resources to initiate FOGO.

3.4. Contract Inefficiencies

Throughout the interviews, another issue that arose was contracts. Contracts seem to be a barrier towards making advancements in the waste industry, politically and commercially. Funding is the primary ruler and, when councils are tendering contracts, they want to ensure that the agenda they are initiating is successful. *"When doing Council contracts is that they will give contracts to who can cover all their facilities"* (P1). There are a variety of different types of waste and many companies who collect the waste. There is commercial, residential, chemical waste and they all run under different contracts. An ordinary shopping district will have lines of bins from different companies of various waste logistics. They all have their own trucks coming to collect waste from their company bin. All these trucks are collecting the same kind of waste from the same place. One participant state that, *"This is*

about losing efficiency in collection and treatment, people think it is a commercial truck, that's a household collection truck, we have one collection truck for everything" (P5).

Contracts are a barrier and cause inefficiency for a logical and feasible collection system for one truck to pick up at commercial and residential districts. There are multiple route and contract anomalies and jurisdictional differences. For example, *"This is probably one of the biggest barriers, is you could have one bin, but there's a collection issue" (P5).* For companies to go FOGO and collect organic waste bins, the contract needs to be available from the council or between the waste collection facility and shopping district. There is no flexibility due to the existence of contracts and this makes advancement in the waste system difficult.

3.5. Complexity of the Ideal Separate Waste Streams

To introduce separate waste streams, the government needs to identify waste as an opportunity, economically, environmentally and socially, for communities. The situation is that technologies that are not introduced appropriately give the incentive that the strategy lacks efficiency and not only is money lost but so is trust from investors. Table 3 presents a summary of factors influencing the complexity of separate waste streams. It is difficult for those at the bottom of the power scale *when it needs to come from the top (P2).* In Australia, the consensus for waste are throwing all waste into one bin. It is the norm and there is no one questioning the impacts that this behaviour has in the long run.

Table 3. Factors related to the complexity of separate waste streams.

Factors	Key Quotes
Top-down approach	<i>"It needs to come from the top" (P2)</i>
Mixing vs keeping clean	<i>"In Australia we are much for mixing, whereas the trend in Europe is keep it clean and you're able to produce a higher product in the end" (P2)</i>
Consumption patterns	<i>"It is all about consuming." "As Australia is living a consuming and wasteful society something has to give in, and to ensure a sustainable future, changes in the system need to be made" (P2)</i>
Investment and feasibility	<i>"Australia can either go through the same process or are we going to make the same mistakes" (P1)</i>

The reason that delivering waste to landfills is no longer a viable option for Australia is due to cost, resource availability and a growing population. Landfills cost money to maintain, waste is a valuable resource and the landfills that are located on the outskirts of cities will be reached by urban sprawl. This is a long-term issue that Australia needs to consider. The other factor about modern society is the consuming generation. Advanced manufacturing technologies generate greater quantities of produce that leads to greater profit, no matter the cost and impact that comes. The question that Councils should ask is whether investments into FOGO would solve this problem and whether there are other and better solutions for Australia.

A challenge for introducing a FOGO system is the technologies made available for collecting and treating. If it is not worthwhile for councils to fund two separate collecting trucks for garden and food waste, then the one truck for the mixing of food and garden waste (FOGO) is the better option. There are various benefits and disadvantages of a separate waste stream system and, although it is something that the waste industry wants, it may not be the best option for councils to utilise.

It will depend on what councils can and cannot do, and what they want to achieve from the system. FOGO is able to provide the ingredients required to create compost and energy. However, by having two separate bins for garden waste and food waste it provides the opportunity for treatment plants, like those for composting facilities, to mix the optimal ratio to generate the best product. Furthermore, if anaerobic digestion (AD) is the path that councils or compost facilities wish to move towards, then separate waste streams would be

better due to the sensitivity of the digesters. With FOGO and the mixing of food and garden waste, the treatment plants may need to separate to ensure that the right ratio is met.

4. Discussion

This study contributes to the body of knowledge with a Divergence of Attention Diagram and provides rich insights into FOGO collection systems, with a particular focus on levies and taxes, capital investment challenges, lack of capacity, contract inefficiencies, and separate waste streams.

4.1. Divergence of Attention

Drawing on the key findings, the authors developed a Divergence of Attention Diagram to represent goal differences between Technology and the Separate Waste Stream system (Figure 1). During interviews, it was identified that the stakeholders (33%) had an ideal vision for an effective waste collection and treatment system, that being the separate waste streams. On the other side of the diagram, policies and decision-makers are investing in technologies. There is an ideology in the modern world that technology can fix all problems. The situation is that, without an effective system for that technology to work, the technology cannot be utilised appropriately to its full capacity, which leads to a failed technological solution and mistrust for further funding.

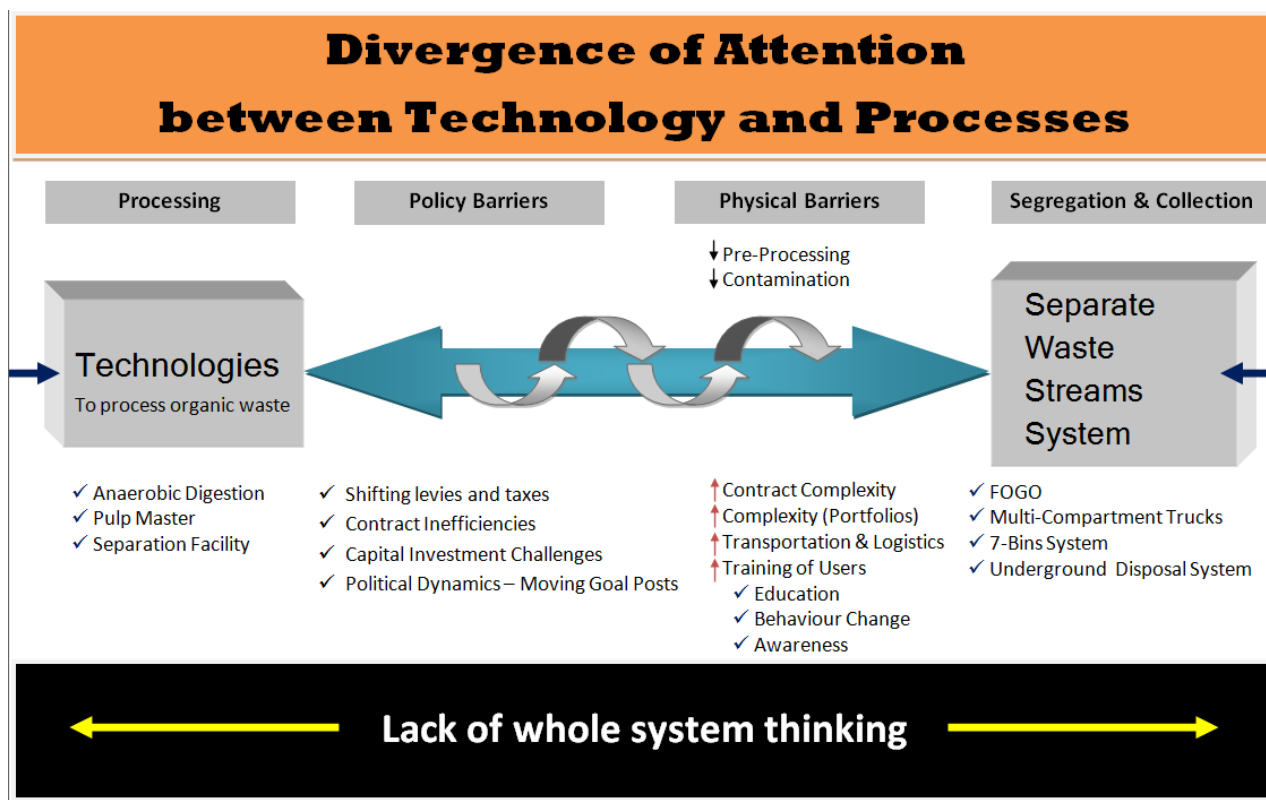


Figure 1. Divergence of Attention Diagram.

What should be well noted in Figure 1 is that technology and separate waste streams come in one package. The ideal system needs an effective and clear-cut policy for the separate waste stream system to exist but, without technology, the new system would not be able to work. Technologies that evolve around the collection and treatment stage of waste would require advanced multi-compartment trucks, multi-compartment bins and anaerobic digestion treatment facilities.

In the direction of Separate Waste Streams there is the “Messy Complex” where this new strategy is trying to fit into the Australian system and ideology. With the Separate

Waste Streams comes an increase in contract complexity and complexity with paperwork (portfolios). There is also an increase in transportation and logistics and a need to train users through education, awareness programs and behaviour change. Without sufficient funding for effective long-term education, the Separate Waste Streams system will not be able to function long term. As a positive, there will be a decrease in pre-processing and contamination.

On the other side of the diagram, moving towards advance technologies means that, if the waste industry is going to move forward, it will need to battle with shifting levies and taxes and to deal with contract inefficiencies and capital investment challenges. To make things more difficult, Australian politics are constantly moving and changing. The dynamic of Australian politics is that legislations, goals and targets are easily eradicated when a new party is elected; if it is not in the agenda of the new government, it is scrapped, no matter how good or efficient the goal proves to be.

Standing in the middle of the Divergence of Attention Diagram there is a fork of dividing ideologies and goals. As a result, 'There is No Focus' and 'Nothing Sticks' in Australian politics when it comes to waste. The interesting aspect about the Divergence of Attention is that technologies cannot be utilised within an effective and clear policy system; meanwhile, Separate Waste Streams require technologies in order for the system to be implemented and to operate. When the two ideologies are put together it forms the ideal system. For example, Anaerobic Digestion as a technology requires a Separate Waste Stream system for it to work efficiently. The government can place as much funding into technologies as they wish but, without an appropriate policy and plan developed beside it, the strategy will fail, resulting in uncertainty and mistrust from investors and stakeholders in providing funding for utilising an advanced waste management system.

4.2. Challenges and Barriers for Implementing FOGO Systems

One of the issues that is recognised Australia-wide is the fact that each state has their own policies and agendas when making political decisions, and this is one of the major factors that seems to be hindering Australia's advancements. If Australia does not have a clear policy decision-making body, how can the appropriate decisions be made and maintained in order to advance the waste industry technologically. With the absence of a waste levy in Queensland, the National Waste Policy 2018 was released. With this policy, the Queensland government had identified the benefits of a circular system, but what seems to be missing was the strategic plan for achieving this foresight. The next step for the Queensland government is for the Waste Levy 2019 to be identified in greater depth. For now, it is a start, and is a step-by-step strategic guide to achieve the circular economy goal.

Within these themes, the reasons for these problems existing are due to a lack of education, a broken system and ineffective leadership. The Divergence of Attention Diagram (Figure 1) shows the caveats in the system, and the different direction policies and leadership are facing. The lack of understanding and capacity to provide solutions to problems needs to be changed.

According to the stakeholder interviews, there is a varied understanding of the FOGO system. Something that remains in common is that FOGO is a strategy that can be used as a stepping stone towards more advanced policies and technologies in the waste industry. Australia needs to mature into a waste-free society; it is not a change that will occur over night. *"We have the ideas and the plans to do it"* (P3). The ideas for utilising certain technologies are available, but it is the mindset of people and policies that need to change. Australians consider the environment as a resource that can be packaged and sold for profit. There are no guidelines for replenishing the source from which the resource comes, and this is where the major changes need to be made. The downside to this is that funding is needed to make significant changes.

Only one stakeholder from the interviews is against the FOGO system, *"I'd like to bypass it but I think we are going to go through with it."* (P1) Within the waste industry, the composting facilities and treatment facilities are the ones that have the most difficulty

with the food waste they receive from FOGO due to contamination. These facilities have customers for whom they need to produce good-quality products, *“We are not a waste facility, we are a compost facility, and farmers wouldn’t want plastic in their compost. They want clean genuine product.”* (P1) If the quality of the compost is not up to standard, the farmers and other clients will not want to buy it. As a result, the treatment facilities at composting facilities would want a system that is effective and reliable, and one that would not create more or different problems that limit the quality of products.

The other question that needs to be considered is whether FOGO should be commercially or residentially focused. The majority chose the commercial sector for the FOGO system. Places like hotels, restaurants and shopping districts certainly do waste a lot of food in food that is not sold, that has reached the expiry date or did not meet standards. In the USA alone, 50% of food produced never reaches consumers and customers [20]. With the statistics of having food waste directed towards the FOGO system for the commercial industry, it would save a significant amount of diversion from landfill. Furthermore, it is easier to reduce contamination levels commercially as it would be within their legally binding contract. Residents cannot be made to follow a contract; they would either mistakenly throw waste in the wrong bin or not care. There is indeed a *“political fix”* (P5) over residents, but if it is a system that the people are not craving then they will not want to utilise the system correctly.

The other factor that needs to be considered is contracts. Contracts should not be written in a way that prohibit future change, and instead should provide enough certainty for investors to make investments. Because of the lack of integrity for policy it makes the situation tricky and constitutes a difficult barrier to overcome. It should be ensured that legislation does not place those barriers to organic waste collection targets or reduce options for companies in the waste industry to adapt and evolve.

Closing the loop to ‘use food to make and grow more food’ was mostly important for the six interviewed stakeholders, and they supported the idea of implementing FOGO to reduce food waste going to landfill, and have it directed towards a sustainable system.

The following sections discuss the key findings with a focus on the political landscape, education, sustaining the FOGO system and a top-down approach.

4.3. Australian Politics (State Power)

Differing policies and legislations between states are hindering advancement for Australia’s economy and society. The waste industry among one of the important industries is suffering from the lack of effective policy and legislation, particularly Queensland with no waste levy to fund and support the advancements.

To support the waste industry without a waste levy, the National Waste Policy 2018 *“Responds to the challenges facing waste management and resource recovery in Australia”* and *“Provides a framework for businesses to embrace innovation and develop technologies that create new opportunities”* [9].

This strategy is clearly indicating that its focus is on ‘providing a framework that embraces innovation and technologies. In theory, this is a good step towards an effective system, but, in practice, it was found during the interviews that the frameworks need to be evaluated and re-evaluated to become innovative, as it is intended for technologies. The contracts, for example, were identified as the main barriers towards technological innovation as part of a faulty system and framework that lacks innovation.

The problem is that governments or councils invest in technologies, and then when it fails due to ineffective innovative strategies with a rigid framework, no goals are achieved. If appropriate technologies are to be implemented, the appropriate policies need to be put into place. A system cannot run without the effective guidelines to guide it. The Divergence of Attention Diagram (Figure 1) represents this ineffectiveness; on one side, there is technology with the support of investments and policies, while the stakeholders in the waste industry are facing and dreaming of a system that is operational, clean and cost-effective—the separate waste stream system. What no one realises is that the separate waste

stream system, as a policy, and technological advancements work together. Without the effective and appropriate technologies, such as AD and separate bin collection systems, the separate waste stream strategy cannot work. Both technological and policy advancements need to be made and this can only start “from the top” where funding and investments influence and affect the change needed.

4.4. Role of Education

It has been pointed out by the interviewed stakeholders that public awareness and the education of communities and the next generation are critical to a successful FOGO system.

Councils need to develop initiatives for increasing education and awareness. However, it is questionable whether these methods will work. *“With education you do really need to push if you want to get hold of it, for the long run and getting the information out there.”* (P3)

The education and awareness programs for residents need to be carefully crafted to provide consistent information through local media, so that they can become normalised in community practice.

To normalise community practice, common definitions, standards, and objectives about waste need to be incorporated statewide. Waste as a topic can be introduced into the education curriculum of primary and secondary schools, in subjects like science and geography. The curriculum includes definitions and concepts of waste, waste cycle, RRR (Reduce, Reuse, Recycle), and case studies of countries facing environmental, social and economic issues with waste going to landfills, whilst proposing solutions for a sustainable, zero-waste future society and appropriate action plans in incorporating behaviours to reach such a future. These behaviours can be promoted with rewards, such as funding going to schools who have the most sustainable practice, those following the United Nations Sustainable Development Goals and those that have the best understanding of the definitions and facts of the most recent National Waste Report, something which can be showcased in school competitions. Zero-waste sustainability events in schools can invite parents to join in fun activities, like competitions, and have news media broadcast the events statewide.

Zero-waste propaganda can further move beyond schools and into public and private organisations such as local councils and universities, setting the example. This can occur by adding waste into health and safety training and practices, so that staff know how to handle the various waste types and ensuring appropriate multiple colour-coded bins and that the handling of the waste is set as standard within the organisations. With normalised sustainable behaviours in schools and workplaces, communities will begin using it in their personal lives as well. Such knowledge and awareness can then continue spreading into public spaces, such as markets and stalls in parks and town centres where second-hand and re-created products are sold. This will provide people the opportunity to see the creativity of living in a zero-waste society. An example of a growing sustainable group in Queensland, ‘Boomerang Bags’ are estimated to divert 62,000 kg of material from landfill every year [21]. Such groups can visit schools and teach them about reusing, reducing and recycling waste.

4.5. Monitoring the Introduction of and On-Going FOGO System

The following method is recommended when FOGO has been introduced and the success rate is being monitored and evaluated by local councils. A major issue that treatment facilities face is the contamination levels hindering the ability for reusable materials to be recycled, because treatment facilities are not able to separate the mixed waste. As a result, waste that has been collected for the purpose of recycling ends up going to landfill. The operation for recycling facilities is costly and, if they are not being used for the purpose of their intended operations, then what is the point of having recycling collection and treatment facilities. To illustrate a failing example for recycling with the currently used yellow-lidded bins, Ipswich City Council was having contamination issues; because of the lack of education, residents were throwing their waste into the inappropriate bins, and valuable resources kept going landfill [20]. Educated volunteers in FOGO check the FOGO

bins for contamination. After checking, the volunteer fills a two copied pre-filled report directed to the owner of the household. One copy is placed into the mailbox and the other copy is collected by the council for statistical purposes.

Those homeowners who deliberately contaminate their FOGO bin are notified by Council and a warning with an education kit is provided. If, by the third time, the homeowner continues to disregard the instructions, they receive a fine for not participating in a green program, a program that aims to save the environment and benefit the local economy and community. With FOGO being introduced in this manner people will become accustomed to the habit of using FOGO properly, and treatment facilities will not have to pay extra costs and attention to contamination.

4.6. Top-Down Approach

To ensure an effective circular economy all sectors and reasons for waste being created need to be evaluated. Thus far, there has been great focus on the consumers. The National Waste Policy 2018 reminds Australians to “*Avoid purchasing products with excessive or unnecessary packaging; repair or reuse items rather than throwing them away; purchase products that can be used multiple times and that are long-lived*” [9].

The interviewed stakeholders mention that funding should be placed into education so that the ‘right choices’ can be made. There is great importance in creating an effective policy for manufacturers to follow. If products are made in a way that does not require throwing packaging away, then there is no waste to begin with.

The National Waste Policy 2018 for Strategy 10: Plastics and Packaging, and Strategy 13: Data and Reporting [9] (pp. 15, 16), mention support towards manufacturers regarding making informed decisions and making improvements to manufacturing appropriate goods and produces. Although this document does not go into great detail, the future document released by the Australian government needs to mention effective strategies that will be directed towards the manufacturing companies and packaging industries.

The change needs to happen from the top down. If changes are expected from the bottom, then it will never work. Changes made at the top have significantly higher influence and that ensure that change cascades down to the lowest level. People will change because they are forced to change. The ban on plastic bags was a good example of this step when the legislation *Waste Reduction and Recycling Amendment Act 2017* was released. The Queensland government [22] aimed to reduce the plastic pollution affecting the natural environment and marine ecosystems. The legislation targeted retailers as the main source for plastic bags being used by citizens, and alternative bags were recommended [22].

The *Brisbane Times* released an article about the effects that the ban on plastic bags had on Australian citizens, six months after the legislation was put into action [22]. The article talks about the fact that an anti-plastic revolution was in motion, as plastic bags in retailing dropped by 80%, and other behaviour changes, such as an increase in kitchen and backyard composting, were growing [21]. This is evidence that changes can indeed happen, but they need to occur from higher up.

5. Conclusions

This study aimed to explore the role of FOGO systems in managing food waste in Australia. It is a ‘closing the loop’ system that identifies organic waste ‘as a wrong time and place resource’ that is valuable to the environment, economy and communities. Nothing is wasted as unwanted organic matter is re-used to grow food and rehabilitate degraded and degrading sites. Through six stakeholder interviews, a range of issues were identified. The issues the industry face are levies and taxes, capital investment challenges, a lack of capacity, and contract inefficiencies that hinder the smooth introduction and success of a closed loop sustainable system. Two participants highlighted that alternative solutions, like the Separate Waste Streams (only food waste) method, can resolve the contamination issue composting facilities are having with the FOGO system. What is required for its success is to ensure that the technological changes occur simultaneously with the waste

policies, with sufficient and innovative regulations that ensure the development towards a social-economic system that favours a non-wasteful and sustainable future.

The Divergence of Attention Diagram illustrated this concept, as two scenarios leading to a technological solution and the separate waste stream system. Technology is as effective as the policies and guidelines provided with it and within which the technology is operating. Policies and technologies come hand in hand, and if the two are not used appropriately together there is a limited expectation that the waste industry will advance in the future.

FOGO is happening all over Australia and is an initiative that is growing. Queensland has a long way to go, but with the Waste Levy released in June 2019, it may encourage that push and funding to boost the waste industry's efficiency and resource reusability.

Governments should not only look to organisations in the waste industry and to Australian's shopping habits, but focus on the manufacturers and leading companies who are producing the waste. Indeed, this would involve a global change, as the market system allows the freedom for goods and services to be bought on an international level, but on a local basis, Australia can start creating and manufacturing products that will result in minimum waste.

To ensure that FOGO is successfully introduced and maintained, short- and long-term plans need to be put into place. While work is being completed on long-term plans, the short-term solutions can be activated and will act as a stepping stone towards long-term methods and technologies for the waste industry. To achieve a successful FOGO system, the legal barriers needs to be re-innovated or removed, allowing short- and long-term solutions to be initiated.

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Appendix A. Questionnaire for Interviews

1. Could you please give an introduction to your firm/government body and your role in it?
2. What does the term FOGO mean to you? Are you in favour of it as a strategy?
3. What challenges have you experienced in implementing/planning FOGO initiatives?
4. What are the best practices Australia can learn from European countries?
5. How do you see FOGO as a future application? What other forms of application can you expect to be introduced?
6. What are the next steps towards achieving an efficient waste management system? Are there other advanced methods that could take over FOGO? Additional Questions:
7. What kind of future policies are in the making and how do you propose future steps are taken to reduce landfill? What kind of future best practices would you recommend?

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