From Open to Closed-Cycle Fast Moving Consumer Goods (FMCG) Packaging Systems: An Overview of Potential Avenues for Progress

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1. Introduction

The twelfth UN Sustainable Development Goal ('4rfResponsible Consumption and Production'), calls for significant change in how we view both production and consumption norms (UNGA 2015). The production and consumption norm for fast moving consumer goods (FMCG) packaging, up to 2017, was to treat them as single-use disposable items. Large quantities of used packaging were sent to landfills. Some packaging was 'recycled', but much of this material was actually exported to third countries, where it persisted as a significant but largely invisible challenge (EEA 2019). Progress in glass, steel, aluminium and paper recycling was offset by a massive increase in the use plastics in packaging and landfilling/exporting of plastic waste (USEPA 2017). In developing economies, the direct move to plastics as the primary FMCG package component meant that the situation was rapidly deteriorating in these countries (Tisserant et al. 2017). Public discussion of waste was increasing prior to 2017, but not to the point of mass mobilisation.

This situation changed abruptly in many countries with the screening of a single TV series, 'Blue Planet II' by the British Broadcasting Corporation (BBC) in 2017, and specifically one episode, Our Blue Planet (Episode 7, 10 Dec.) that dealt with effectively indestructible plastic waste in the oceans. The 'Blue Planet Effect' (Gell 2019) has led to the elimination of single use plastic bags in many countries and their severe curtailment in many others (Taylor 2019). While these massive developments appear to be out of proportion to the seemingly minor triggering event, these 'marketing earthquakes' are quite common in marketing where, as in an earthquake, substantial movement to a new equilibrium occurs as an outcome of a small triggering event for the release of pre-existing market pressures (Hamlin et al. 2015). At the same time, many countries that had acted as a convenient destination for both unrecyclable and supposedly recyclable FMCG waste refused to accept any more imports from developed economies and started

to aggressively police these policies amid considerable publicity (Brooks et al. 2018; McNaughton and Nowakowski 2019).

These developments, along with the public revelation that the majority of 'recycling' in developed countries actually meant export dumping, have triggered a very rapid move to a much higher level of consumer awareness, sensitivity and scepticism towards FMCG packaging waste. Despite the passage of three years since 'Blue Planet II' screened, this awareness does not seem to be declining, and is thus becoming both a political and commercial issue (Webster 2019). Such rapid and irreversible movements between stable states in consumer awareness and sentiment are a feature of FMCG markets, where they are described as 'marketing earthquakes' (Hamlin et al. 2015). This appears to be a classical marketing earthquake, and the FMCG packaging environment is now a very different place to what it was three years ago. Anybody claiming in 2016 that single use supermarket plastic bags would be illegal in my home country of New Zealand by 2019 would have been met with disbelief. Yet, it is now so (Ministry for the Environment (NZ) 2019).

In this new environment it is now possible for the first time to consider a proposal that is core to any circular economy (Stahel 2016): How might a national-level system be set up to create a closed-cycle system for FMCG packaging manufacture, distribution, consumption and disposal in which 'at source' FMCG package design and standardisation is used alongside government regulation to reduce package waste to a small amount of unavoidable loss?

This chapter presents a commentary on how progress may be usefully made towards this end. It is a conceptual and pioneering discussion because almost no research has been published on such systems up to this point. Consequently, it is very difficult to fund and publish empirical research on any aspect of such systems due to the absence of any coherent conceptual basis. This chapter seeks to contribute to the creation of such a basis by providing an initial published platform for research in the area by starting with some basic definitions, and moving on to examine how the current situation might be usefully modified by national-level waste minimisation systems. A variety of approaches that might act as a basis for such a national level system are then described.

The discussion concludes that there appears to be no insurmountable technical barriers to the implementation of such a system. There is a considerable convergence between systems that are based on package recycling and those that depend upon package reuse when they are deployed on a national scale. The barriers to the establishment of any system are largely social and political. Any such system will require aggressive regulation to establish and maintain it. Such regulation will require

a high degree of consensus between the population, business and government if it is to be politically feasible. As a consequence, social, commercial and political matters have to be taken into account from the outset when designing such a system so that the necessary consensus/acquiescence can be achieved.

2. Definitions

The literature in this area has an issue with varying terminology. In order to avoid confusion, the three key terms that are used throughout this chapter are defined here:

Reuse:	A package is used and is then cleaned and otherwise prepared for reuse without any further transformation. It is then reused for its original purpose, e.g., returnable glass milk bottles.
Recycling:	A package is used and is then reprocessed into its original components. These are then used to remanufacture a package of an identical or similar type with equivalent value, e.g., aluminium cans reduced to aluminium, then remanufactured as aluminium cans.
Repurposing:	A package is used and is then reprocessed into a form where either it or its components may be used in a role of lower unit value, e.g., composting, remanufacturing PET bottles into a component of insulating cement building blocks, remanufacturing plastic bags into park benches.

3. The Current Situation in FMCG Packaging

The current situation in FMCG packaging in a developed economy is shown in Figure 1. In a developed economy such as the United States, the system is predominantly linear, with packaging inputs coming in at the top of the system, and proceeding through stages of manufacturing distribution, sale, consumption and disposal. Upon disposal, the majority of packaging ends up as waste in landfills, or exported to an uncertain destination and fate. A minority of packaging material may be repurposed, in which case the material is remanufactured and used for an alternative purpose rather than being returned to the system. Much smaller volumes are truly recycled, in that they are remanufactured and returned to the system at the same point from which they came. An equivalently small proportion are reused, a process in which they are returned to the system in their original form (USEPA 2017). In addition to revelations with regard to the degree to which 'recycled' materials quoted in these figures is actually exported and dumped (Dobush 2019), official figures of this type display some peculiarities. For example, (USEPA 2017) claims

that in 2017 c. 15% of all glass waste was burnt and its energy recovered. As glass is a non-flammable/exothermic material, this claim has some issues of credibility.

It should be noted that 'repurposing' is not recycling, although it is often described as such (e.g., Keramitsoglou and Tsagarakis 2018). While some materials such as elemental aluminium may be freely and repeatedly repurposed, most polymers and organic materials are complex compounds that are not as amenable to remanufacture, and the process consequently usually involves a degree of functional downgrading, which destroys the circularity that is the primary characteristic of recycling (Rahimi and García 2017). A good example of this repurposing is the common activity where soft plastics such as single-use supermarket carrier bags are 'recycled' into park benches (Righter 2019). As such, the bags are not truly recycled back into the packaging system, and presumably after a passage of a few years the faded and warped bench becomes a yet more intractable disposal problem. Similarly composting of 'organic' packaging is not recycling, but repurposing—the result cannot be reused for its original purpose.

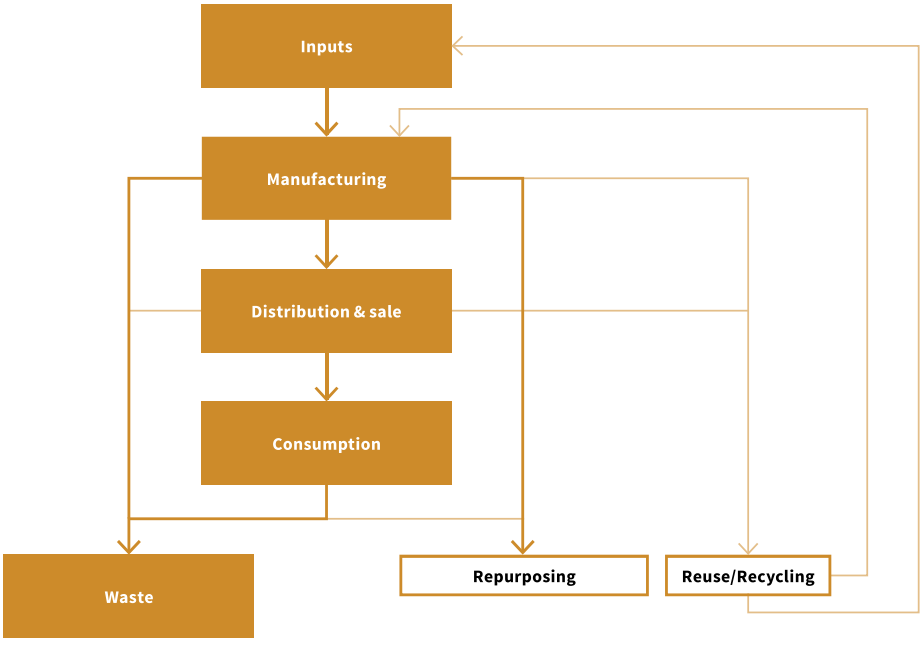

Figure 1. Linear 'open-cycle' fast moving consumer goods (FMCG) packaging system (the current situation).

A further aspect of the current situation that cannot be expressed in Figure 1 is the degree of fragmentation within the system. Given that any individual supermarket has around 30,000 products on its shelves and a large hardware store around the same number, any developed economy has hundreds of thousands of individual FMCG products, and tens of thousands of unique packages containing thousands of unique and discrete constituents. These constituents are combined and recombined as they pass through multiple participants at the various stages of the process, and they arrive at their eventual destination after disposal via an equally wide variety of routes. As a result, their eventual destinations are unknown to any consumer or statutory authority, which reduces motivation to change (Barnes 2019).

A good example of this is the coffee capsules popularised by Nespresso®. The capsules are now sold worldwide via an enormous variety of outlets (Brem et al. 2016). They are also manufactured by a large number of companies using a wide variety of materials (de Oliveira and Rodrigues 2015). The original Nespresso® capsules are aluminium; others are made from combinations of various plastics, biodegradable polymers and organic materials. While many have the advertised potential to be repurposed, and Nescafe and others aggressively promote their products on this basis (Fox 2019), the degree to which they actually achieve this status is impossible to ascertain.

The same can be said about the FMCG packaging system in its current fragmented situation. While it can be stated with some confidence that the amount of packaging that is repurposed, recycled or reused is only a minority of the total (Hoornweg et al. 2015), the exact size of that proportion, and whether that proportion is increasing, static or decreasing, is not known.

4. The Aspirational Situation for FMCG Packaging

An aspirational situation for FMCG packaging in a developed economy is shown in Figure 2. This design, specifically for FMCG packaging, is derived from the closed-cycle system developed by Meherishi et al. (2019), which encompasses all activity within an economy. The linear structure from manufacture to consumption from Figure 1 remains, but there are now feedback loops at each stage that return packaging material to the manufacturing process. This feedback can be via recycling, reuse, or a combination of the two, but repurposing has no role in the process unless the component in question is a renewable resource.

This position on repurposing is not compatible with Meherishi et al.'s (2019) concept of circular supply chain management (CSCM) where repurposed material can be moved between industries, but the example given by these authors shows

the issue of functional and value downgrading that is implicit with repurposing within CSCM:

> "In practice, CSCM endeavor [sic] to produce zero waste through system-wide innovations to recover value from what was traditionally called 'waste'. For example, recycled PET bottles may be used for construction; light concrete is added to the bottles, creating isolated walls for houses." (Meherishi et al. 2019, p. 885)

The issue with this example is that the PET/concrete block will also come to the end of its useful life, at which point the large lumps of concrete/PET combination are likely to represent a completely economically intractable repurposing/recovery problem. They will then become open-cycle waste—like the 'recycled' benches mentioned earlier. In most cases repurposing merely kicks the open-cycle 'can' down the road. If it is kicked far enough, then it may perhaps become invisible to the original user, but this does not mean that it has disappeared!

Figure 2 shows that an input into the system remains, but at a greatly reduced level that is balanced by unavoidable loss at the other end of the process. Even an aspirational situation has to accept that some loss will occur. This also departs from the aspiration outlined by Meherishi et al. (2019). This loss may come about by actual physical loss, dispersion, permanent retention by the consumer, destruction or defilement beyond the capacity to recycle or manufacture and the minority of situations where a closed-cycle system cannot be sensibly applied to either a package or a functional component of it.

A good example of unavoidable loss is the colorants used as a component of inks and dyes in packaging. Colorants are present in tiny quantities that are often fully integrated with an individual package. As a consequence, these are rarely if ever recovered, even though when measured on a system wide scale, this loss of colorant by irreversible dispersion may be significant. This loss is not an issue if the colorant is either a biological product or is synthesised from common elements that cycle within the biosphere, but it is an issue if the colorant incorporates a rare element derived from mining of finite deposits that have been concentrated over a geological time period (e.g., copper) (Sverdrup et al. 2019).

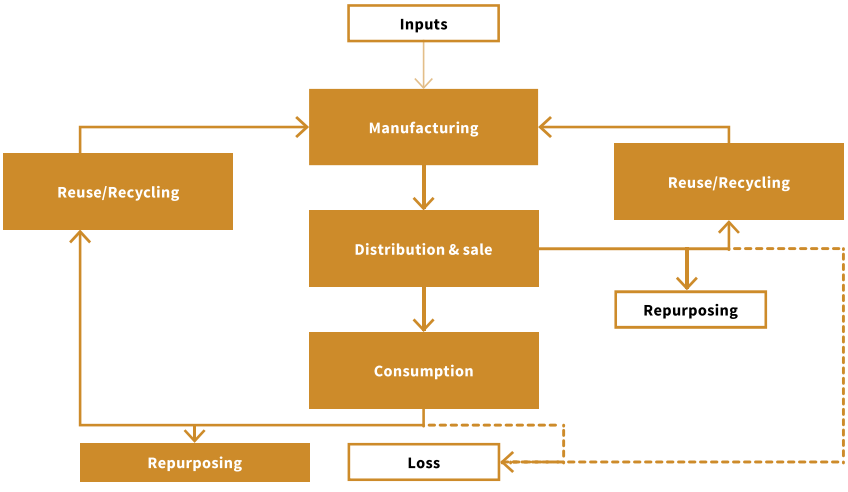

Figure 2. Circular 'closed-cycle' FMCG packaging system (aspirational situation).

Clearly the system shown in Figure 2 represents a radical departure from that shown in Figure 1. Can this situation be achieved or even approached within the political, commercial and social parameters of a developed society? The global closed-cycle system developed by Meherishi et al. (2019) encompasses an entire economy and it represents such a massively complex scenario that it is hard to envision how a single strategy could be developed to achieve it. This is not the case in the situation under discussion here. FMCG packaging is a substantial industry; however, it is only a small, consistent component of any economy with a well delimited waste stream. It does therefore represent an environment within which a coherent national level strategy and plan for moving towards an aspirational scenario could be developed.

5. Current Developments towards Closed-Cycle FMCG Packaging Systems

5.1. Overview

The reviews by Meherishi et al. (2019) and Nemat et al. (2019) represent a comprehensive overview of academic research in closed-cycle FMCG packaging. The vast majority of studies on current closed-cycle FMCG packaging initiatives reported by these reviews are restricted to single products or single companies, and as such reflect the high degree of fragmentation that exists within the field.

Closed-cycle initiatives based on packaging reuse are heavily concentrated in the manufacturing and distribution steps of the FMCG packaging systems, primarily secondary and tertiary packaging (e.g., Battini et al. 2016; Baruffaldi et al. 2019).[1] Many studies have reported significant cost advantages for the reusable systems studied (e.g., Silva et al. (2013)), but the majority of secondary and tertiary packaging is still either disposed of or repurposed at the present time (Chung et al. 2018).

5.2. Reusable Systems

Those initiatives that involve reusable primary packaging are predominantly single companies, such as small independent dairy product manufacturers, that offer reusable glass milk bottles (Levitt 2019). In some cases, these individual initiatives are sufficiently similar and sufficiently numerous that they represent significant industry-scale movements. One example of such a movement would include the move to allowing reusable coffee cups by a wide number of foodservice providers (Romeo 2018; Winter 2019b), although this particular example has not been without its problems and public relations disasters (Gabbitas 2018). Nevertheless, the majority of retail coffee cups remain single-use items with a structure that predetermines that they go to landfill (Poortinga and Whitaker 2018).

While not a package in the strict use of the term, the movement towards reusable supermarket shopping bags has had a far greater impact on behaviour in many countries than many other initiatives (Parker 2019). In many cases this movement has been backed by legislation (Nielsen et al. 2019), with legislators reacting to and leveraging the rapid development of a strong market sentiment (Knoblauch et al. 2018). The outcome has been that, in many countries, a product that was once produced and discarded by the billions has been massively reduced. This was the case in the UK, for instance, within a very short time period (Woodcock 2019). This offers an encouraging illustration that mass changes in consumer sentiment and behaviour towards packaging are possible—given the right social conditions.

One interesting development, which involves an attempt to consolidate FMCG reusability among multiple suppliers, is the Loop® concept, in which reusable

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[1] Primary packaging is the packaging that is bought with the product and forms part of an integrated 'offer' (e.g., the wrapper on a bar of chocolate). Secondary packaging is present at the point of sale (POS) and is used to present the package to the consumer (e.g., the open-top box in which the chocolate products are presented to the consumer in the shop). Tertiary packaging is rarely present at the POS, and is used to transport the product (e.g., the cardboard carton containing several open-top boxes of chocolate and the pallet on which a number of cartons may be transported by sea or land).

packages with an expected life of 100 cycles are supplied by major FMCG companies via a privately held Internet platform (Cheng 2019). Loop is only available in restricted areas of North America and Europe at the present time. The system has garnered considerable publicity, but reviews of the system have been equivocal with regard to price (Bratskeir 2019). Whether this price reflects a high margin, or simply the cost of manufacturing and refilling a portfolio of unique branded packages, has yet to be established, as has the fate of the packages if they reach their end of use point.

One reusable closed-cycle FMCG packaging system that has been fully operational in the soft drinks category worldwide for over 50 years is the system pioneered by Sodastream®. This system relies upon a consumer owned carbonation machine with reusable bottles for both carbonating gas and the water that is carbonated. Concentrated syrups for flavour are available in a standard single-use pack. Despite its undoubted effectiveness as a package reduction system and its clear economic advantages to consumers, this system has had little impact upon the vast quantities of soda that are sold in single-use PET bottles each year (Osland and Luo 2019).

This lack of impact appears to be an outcome of hostility to the system within distribution channels for soft drinks. It must be remembered that a packaging innovation that is economically advantageous to consumers may be economically disadvantageous to those who supply them. The author was employed by an American investor in the late 1980s to examine the feasibility of introducing a similar system into the United States. After considerable investigation, the conclusion reached was that the level of hostility among established suppliers of soft drinks meant that the only large-scale point of access to the market was via chain retail outlets (hardware stores) that were not at present selling soft drinks.

Thirty years later in my home town of Dunedin, New Zealand, this situation does not seem to have changed. The local hardware multiple does not sell soft drinks, but it does have a very large and prominent display of Sodastream® machines along with a wide range of good quality syrups and gas bottles. None of this is available via the mainstream supermarkets. One striking feature is the complete absence of branded after-market syrups for this system. This is in contrast to the coffee capsule markets where nearly all the major coffee brands have multiple coffee capsule products available in supermarkets. The point to be made by this example is that the attitude of channels to any proposed package reduction innovation, and the reasons for that attitude, must form a component of any research related to the development of that innovation if it is to have any hope of large-scale success.

5.3. Repurposing and Recycling Systems

Repurposing and recycling, with the former often described as the latter, have a very much larger presence in both the academic literature and in practice (Han et al. 2018). Unlike reuse, repurposing initiatives include large-scale (public) systems that encompass an entire FMCG package waste stream. Large scale repurposing systems (usually described as recycling) now have a strong presence in many developed economies (Khandelwal et al. 2019). Many systems of refuse sorting are now established at a civic collection level with organic waste, paper, glass, plastics and aluminium all identified as separate repurposing streams (Keramitsoglou and Tsagarakis 2018).

Of these only that for aluminium seems to be largely problem free with a strong commercially viable market for the stream and no issues with repurposing to the same level, thus establishing a true recycling scenario (Dando 2019). The other three streams, plastic in particular, all have serious issues with identifying an end use for the repurposed product, and establishing a commercially viable market/logistics system to access that end use (Brooks et al. 2018).

Contamination remains a serious issue, not only with foodstuffs and other items that are foreign to that particular stream, but also with 'paper' and 'plastic' packages that are not repurposable because they are not entirely as they seem. This can be because either they are not made from a repurposable material or because the package consists of a variety of intimately incorporated components which cannot be separated for repurposing (Schmidt 2018). Tetra-pacs and multi-layer plastic bottles are examples of this multi-component package issue (Ma 2018). Complex 'hi-tec' packages of any sort that are developed to address specific problems higher up the distribution chain can present serious issues when it comes to repurposing them after final use (Kaiser et al. 2018). As there is considerable investment and activity in the development of such 'hi-tec' FMCG packages (e.g., Idumah et al. 2019), this 'designed in' unrecyclability problem is likely to become more significant in the future.

Glass, while seemingly an easily repurposable commodity, suffers from the fact that there are many types of glass, and it only takes a small amount of contamination of an inappropriate but very similar looking glass (e.g., lead crystal), or anything else for that matter, to make an entire batch of food-grade glass unfit for recycling back to its original purpose. As a consequence, most glass packages that are not reused in the existing form are either landfilled or repurposed (Majdinasab and Yuan 2019).

These issues with repurposing have recently led to a number of unfortunate and high-profile incidents. These very public failures, and the undertones of deceit

that have coloured many of them, have led to a certain loss of public confidence in large scale repurposing initiatives despite the significant achievements that can be attributed to them (Laville 2018).

5.4. Reduction Systems

The predominant reduction system at present is the bulk or 'bin' product retail format, which eliminates retail packaging altogether as consumers bring and fill their own containers (Beitzen-Heineke et al. 2017). Bin retailers are usually smaller independent retailers, although recently, larger retailers have started to offer restricted services in this area (Flaws 2019). Bin retailing certainly eliminates packaging, and thus closes the cycle. However, it faces considerable challenges in transitioning to a mainstream format because of issues with food contamination, difficulty in handling some foods, and potential liability in jurisdictions where tort is an active legal sector (Vanne 2019).

Bin retailing also represents a major challenge to large FMCG manufacturers and retailers due to the loss of brand intellectual property (IP) and capital value as the majority of these brands communicate with the consumer via the package at the point of sale in FMCG markets (Hamlin 2010). It also creates major issues with apportionment and pricing, which are both key marketing tools in this industry (Ellickson and Misra 2008). As a consequence, major FMCG companies are likely to actively resist any significant expansion of this format. Given the resources available to them, this resistance is likely to be effective.

5.5. Progress towards a Closed-Cycle

It is not currently possible to state with any confidence if progress is being made with moving to a closed-cycle for FMCG packaging. Progress in new closed-cycle packaging formats is matched by 'progress' in new FMCG packaging formats and technologies that are incorrigibly open-cycle and single use.

Perhaps no example expresses this situation better than the 'coffee pod' market cited previously. This market relies upon a consumer owned machine that takes single-use pre filled coffee pods—one for each drink. The disposable pods are small and attractively styled items—each an FMCG package in its own right—that may be made of either metal or plastic. Coffee pods have grown to be a global industry in the last twenty years. The pioneering brand Nespresso® still dominates the market, and has made very high-profile attempts to ameliorate the obvious 'throw away' aspect of this product via stressing the use of aluminium as a key component in the pods, and a series of high-profile re-purposing exercises for the aluminium.

Nevertheless, the small size of the pod and consumer habit dictates that, even though repurposing opportunities exist, the majority of pods end up being flicked into the consumer's kitchen bin, and from thence to landfill. The exact proportion of coffee pods that make this particular journey is unknown.

The situation is aggravated by the large number of competing after-market pods that are now available. These use an enormous variety of alternatives to aluminium, including plastic and compostable versions. All these of course require their own dedicated repurposing systems, thus losing any opportunities for economies of scale and consumer communication.

It is not disputed by any manufacturer that pods create more direct waste than the coffee making systems that they have displaced. The counter argument put forward by these companies and others is that the environmental impact of this waste is offset by the reduced requirement for coffee, and a concomitant reduction in the environmental impact of this crop globally (Gunther 2015). This may be so, but one possibility that is not widely discussed is the potential for reusable pods to capture this desirable efficiency without generating the undesirable waste stream. Reusable pods are readily obtainable on the Internet, but not from the major players (e.g., Coffee Lovers New Zealand 2019)—which indicates that there is no particular barrier to the wider scale deployment of reusable pods or the design of a reusable pod chamber into the machine in the first place.

The reason for the lack of enthusiasm for reusable or 'designed in' pods among the market incumbents may well be related to commercial imperatives similar to those that oppose the Sodastream®. A coffee pod system comprises a machine and a dedicated consumable product, the pod. As with colour printers and ink cartridges the bulk of the lifetime profit of such a system is in the large number of consumable pods, not the single durable machine, which may be sold at or below cost in order to establish the consumable purchase stream (Dhebar 2016). In the case of Nescafe Nespresso® pods, the coffee in them is priced at NZ$124 per kilogram in my local supermarket. This scale of value added, compared to other retail presentation formats such as packaged ground coffee, generates an understandable reluctance to introduce anything to the market that might interfere with the continued consumer take up of the consumable pod product.[2]

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[2] Countdown, Mosgiel, New Zealand, 20/12/19. A sixteen-capsule box of Nescafe pods, $9.99. Assuming 5 g/capsule (Caffeininformer.com 2019) gives a value of $124/kg for the coffee. Nescafe Instant 100 g $7.00, assuming an extraction yield from beans of 1:3 (Pfluger 1975) gives a value of $25/kg for the coffee. Package ground coffee (Hummingbird) 200 g $7.00 gives value of $35/kg for the coffee.

5.6. The Case for a National Level Approach to Closed-Cycle FMCG Packaging

There appears to be little dispute that an open-cycle FMCG packaging system is not viable in the long term. However, it cannot be stated that any significant net progress is being made towards closing the cycle in this sector. At present, the majority of closed-cycle initiatives based on reuse and recycling are too small, isolated, symbolic and/or ephemeral to make a significant difference. The same can be said of reduction systems based on the elimination of consumer packaging at the point of sale. Large-scale initiatives based on repurposing of FMCG packaging waste do not close the cycle in the required manner, and the outwards channels for repurposing captured waste streams have proven to be very difficult to establish and maintain, leading to a series of damaging high-profile scandals.

It would appear that the only avenue to progress towards a closed system in this area is the consideration of national level closed-cycle systems that are able to capture economies of strategic coherence, design, scale and communication. Such systems are unlikely to consist of a single solution, and will only succeed if they have a high degree of consumer support with complete government commitment, along with a degree of commercial incumbent acquiescence within the FMCG industry itself.

6. Developing Closed-Cycle FMCG Packaging Systems on a National Scale

6.1. The Advantages of National Level Systems

To this point no country has attempted to introduce a closed-cycle system of FMCG packaging at a national level. This is perhaps not surprising as the political and fiscal obstacles do appear to be daunting, and any such system requires definitive regulation on a level that has not been fashionable in developed economies since the 1970s (Bloom 2017). Nevertheless, national level systems that are set up as such from the outset do offer advantages over the current process of undirected development via a series of unconnected micro-initiatives.

The most obvious of these advantages is scale. A closed-cycle packaging process that may not be economically or technically viable on the scale of a local or individual channel participant level may be perfectly viable when applied on a national scale.

The second major advantage is that regulation can be more easily applied on a national scale, thereby achieving compliance and uniformity across an economy.

Compliance is a necessity for any closed system initiative to succeed. Humans are notoriously unwilling to accept constraints upon their behaviour, even when it is in their interests to do so. A good example of this is the issue of non-compliance with the European Union's ban on incandescent lightbulbs, despite the fact that LED

lightbulbs are not only a collective environmental benefit but also an individual economic benefit given their much lower lifetime costs—even for the most fiscally constrained citizens (United Nations Environment 2017). Nevertheless, loopholes were actively identified and developed that allowed incandescent light bulbs to be imported into the EU, and they were then (perversely) purchased on a large scale (Schießl 2012). These loopholes had to be aggressively 'shut down' by the authorities (Hickman 2012). It is possible that certain sectors of society and industry would react in a similar manner to any closed-cycle packaging initiative.

Uniformity is also a necessity if advantages of scale are to be fully realised. Once again, uniformity is not a feature of unrestrained societies, even if it is advantageous. As a result, uniformity can only be achieved in the majority of cases by regulation. The coffee pod industry cited earlier is a good example of this type of perverse behaviour and the need for regulation to suppress it. The principle drawback of the coffee pod is its manifest wastefulness. It would be in the individual interests of the industry participants to standardise certain aspects of the pods so that a standardised waste disposal solution could be applied to this undesirable aspect of the product. This has not happened. There are now a wide variety of pods that each require their own system to deal with them, none of which really have the scale to be viable. It is an undesirable situation that appears to be getting worse rather than better as new 'solutions' enter the market.

The third advantage of a national scale initiative is the capacity for the deployment of social investment. Any closed-cycle system is likely to require a considerable up-front investment. There are barriers to this investment coming from the private sector. Firstly, the return from any such system may take a considerable time to materialise. Secondly, the returns and benefits may not accrue to the same area/investor as where the investment was made, and they may not be a single bottom line return either (Walker et al. 2008). While triple bottom line accounting has been around for several decades (Slaper and Hall 2011), there are no examples of private investors embracing it on the scale that would be required here. There is also an issue with the incompatibility of private investment in a regulated environment, and the capacity for monopolistic behaviours as has been seen in privatised water (Lobina 2019).

6.2. The Convergence between Reuse and Recycling in National Scale Systems

Up to this point in the literature reuse and recycling have been normally considered to be discrete alternative approaches to the developing closed-cycle systems for FMCG packaging. However, when applied to national level systems, the

difference between the two approaches converge, and the differences between them become much more nuanced. In a closed-cycle system run on a national scale that is based on reusable FMCG packages, it is important that a reusable package also has the capacity to be recycled to the same level of functionality. A reusable package may be reusable, but it will have a more or less precisely predictable life. For example, glass milk bottles have a theoretically indefinite lifespan; but in practice, they have a very specific life expectancy (WRAP 2010). If a reusable package does not have the capacity for recyclability then once again it is simply a slower-burning repurposing exercise, and it is not a closed-cycle system.

The difference between a national level recyclable system and a national level reusable system is thus merely how many cycles the package will make though the system before it is recycled. This is a logistic rather than a paradigmatic level of difference.

6.3. The Role of 'Upstream' and 'at Source' Design and National-Scale Standardisation

One of the main reasons why existing large-scale FMCG packaging repurposing systems have run into such difficulties is that they have employed the 'ambulance at the bottom of the cliff' approach to treating this particular environmental ailment, and the role of upfront design has only recently become a focus of research (Rezaei et al. 2019). It is impossible to say how many unique FMCG packages exist in a developed economy, but the number certainly runs into the millions, and the specific material component and technology types run into the thousands. These material components and technologies are also frequently intimately incorporated with each other in a single package. Every week, more packaging innovations of ever more complex types join this population (Wyrwa and Barska 2017). All of this variety then has to be sorted into a small number of 'waste streams'—creating an insoluble technical and logistic nightmare.

If a closed-cycle system is to be successfully applied to FMCG packaging, then the FMCG packaging will have to be designed from the outset to fit the closed-cycle system and not the other way around. If it is deployed on a national scale, 'the system' is also a singular not a plural entity, and all FMCG packaging will have to be designed from the outset to fit the requirements of this single system. The coffee pod example noted earlier indicates that such compliance is only likely to be achieved by regulation.

The level of design standardisation imposed by such regulation could vary quite significantly. At a minimum, packages might be restricted to a set number of non-combined components with proven recyclability, and the most extreme level of the entire FMCG sector could be restricted to a minimum number of fully standardised

packages. Preliminary design studies undertaken by this writer have indicated that the 20,000 food items found in the average supermarket in New Zealand could be presented with less than 20 standard reusable package types incorporating less than four technologies.

6.4. The Requirements and Role of the Consumer

Any closed-cycle FMCG packaging system has to conform to the requirements of its constituents, who also each have a specific role to play in its implementation. The retail consumer will have legitimate expectations of any such system. These include core functions of economic efficiency, ease of decision/purchase, containment, protection, transportability and (reasonable) preservation. However, it is extremely unlikely that a closed-cycle packaging system will match the existing open-cycle system in all regards. This may create some local and specific problems, but such consumer problems are also commercial opportunities. For example, coffee pod consumers are likely to be denied coffee pods in their current form as part of any closed-cycle scenario, but this represents an opportunity to the first company to create an equivalent system that does comply with the system's parameters. It is important to note that a closed-cycle system defined by regulation will not necessarily suppress innovation in the manner assumed by much of the literature (e.g., Trubnikov 2017), and that a proactive regulatory system may well act as a disruptive innovation in its own right, thus increasing rather than decreasing the overall rate of innovation in a market, as has been the case with domestic lighting.

6.5. The Requirements and Role of Business

The primary requirement that business has of any closed-cycle system is that it will permit them to continue to operate in a manner that allows an adequate return on the capital invested in them. How this occurs will vary in accordance with the position of the business within the system. Clearly some specialist packaging businesses that are heavily invested in non-compliant plants and technologies may face particular issues in this regard, and some form of compensation for irrevocably committed capital may be the only redress.

For many manufacturers and retailers, their capital issues may relate more strongly to intangible capital assets, mainly brand IP, which in many cases represents the dominant portion of the capital value of any FMCG company (Winter 2019a). No research exercises on alternative FMCG packaging systems have touched on this key issue. Any system that significantly interferes with the effectiveness of FMCG brand assets is likely to encounter well-funded and highly organised resistance from

industry players. As consumers form relationships with brands and also rely on them to assist with their decision making, this resistance may well also strike a significant chord with them (Elbedweihy et al. 2016).

Generally it could be expected that large incumbent FMCG businesses would resist any closed-cycle system as it represents a change to a status-quo that is currently highly advantageous to them. Medium and smaller companies may well take an opposite viewpoint, in that anything that significantly disrupts the status-quo is potentially to their advantage (Christensen et al. 2015).

The role of business is fairly straightforward: to comply with the closed-cycle system, and to invest, operate and innovate within its spirit and parameters. Whether this happens will depend upon the degree to which any proposed closed-cycle system meets the requirements outlined above. Not everybody in the FMCG industry will be comfortable with any proposed closed-cycle system, but it is essential to its success that a critical mass of them are. Collectively businesses within the FMCG industry have considerable fiscal resources and a high level of skill in public communication. If the FMCG industry were to reach a consensus to actively deploy these capacities against any proposed system in a free-market democracy, it would greatly reduce the chances of that system coming into operation, whatever its benefits might be. The case of Sodastream® demonstrates this capacity clearly, even when applied at a passive level.

6.6. The Requirements and Role of Government

The principle requirement for government at all levels is to reduce the amount of waste going to landfill, which is both a major communal cost and a politically troublesome issue. However, this has to be achieved in a manner that is consistent with public health, social sensibilities and economic well-being. Public waste disposal was initially motived by public health rather than private convenience. It dates back to 1750 in London, and for the first 150 years the process was self-funding as the communal waste streams largely consisted of ash, urine, dung and organic waste, all of which had value and an accessible repurposing market (Velis et al. 2009). Only since 1900 has the increasingly large and diverse stream of private household consumer waste become a net communal cost, which has been exploited by the FMCG industry among others. Governments would very much like to return to the pre-1900 position!

The principal role for national government in this situation is one of leadership. Perhaps the most important aspect of this is to make the communal cost of open-cycle FMCG items more publicly apparent, and to then act accordingly and with public

support. The private profitability of open-cycle FMCG packaging goods relies upon the partial or complete socialisation and apparent dispersal of the cost/impact of their disposal. Disposable nappies, while not strictly a package, are a good example of this exploitation of public waste streams. Disposable nappies are a very high percentage all nappies used. Used disposable nappies are a particularly undesirable landfill input, and they represent a considerable proportion of waste going to landfill (Mendoza et al. 2019).

Reusable nappy systems that offer good performance are now available, and at an economically very advantageous cost to the consumer compared to disposables. They will never be quite as convenient to the individual as the disposable version, but the disposable nappy is a highly destructive and expensive item in a communal landfill, and even minor changes brought about by incentives to use reusables have generated significant communal savings (Warner et al. 2015). Disposable nappies, like coffee capsules, are very easy to use and profitable to manufacture and sell, and disposable nappy systems still dominate retail displays and public advertising. It is thus very unlikely that their use will cease unless government either taxes them to properly reflect the social cost of disposal, prohibits their sale or ceases to allow them to enter the communal waste stream at any point. The perverse importation and purchase of incandescent lightbulbs in Europe in the face of regulation indicates that only the second two more drastic options, requiring great political courage, would be likely to succeed.

It is likely that no closed-cycle system for FMCG packaging will ever be established without such leadership by government. That leadership will have to come via justified regulation if we continue with the disposable nappy example. If the management of one of the major disposable nappy manufacturers unilaterally chose to sacrifice their position in the disposable market by moving towards reusables, they could quite justifiably be accused of destroying shareholder value, especially as their competitors predictably moved to exploit their loss of position in the disposable nappy market. It is very likely that the management in question would be removed and the initiative reversed. Any executive that was interested in their own self-preservation is therefore very unlikely to do this, and the same will apply to the management of any other FMCG company that operates in a market where the communal cost of open-cycle FMCG packaging is not properly recognised.

If, by contrast, the government told all nappy manufacturers that sale of disposables would be prohibited after three years as an outcome of the costs that they represent to the government, no market position or capital is lost to that company through that ruling relative to its competitors. It would only be lost if the company

failed to innovate in response to that ruling as effectively as its competitors over the following three years.

Thus, the primary role of government is leadership by regulation, but regulation that is the minimum to achieve the objective, fully justified and judiciously developed and applied in order to avoid the generation of a critical degree of resistance within the FMCG industry and the consuming public.

6.7. The Requirements and Role of Trans-National Organisations and Treaties

A wide variety of trans-national organisations exist to improve environmental outcomes, and such organisations play a part encouraging governments to take a leadership role, and assisting them when they choose to do so. Thus, the acquisition and dissemination of experience and information relating to best practice in closed-system FMCG packaging systems is an obvious role for such organisations so that such best practices are consistently applied.

A rather less obvious but equally important role for trans-national organisations is the mitigation of the negative effects of trans-national treaties in the development of closed-cycle FMCG packaging systems. Many free trade agreements that are coming into force go well beyond free trade and significantly constrain national governments in their policy development if a company or nation can demonstrate that such regulations will affect their property rights. The legal platforms on which such cases may be made by third parties against local laws and regulations are in many cases set up within the treaty itself and they can fall well short of what would be considered a satisfactory legal platform for governments to defend their position (Kelsey 2019).

Just how these can impact on government FMCG packaging policy can be clearly demonstrated by the experience of Australia's attempts to ban branding on retail cigarette packages. This policy was challenged by the international tobacco companies on the basis of loss of intellectual property rights under just such an international treaty, a case that the Australian government eventually won (O'Dowd 2018). However, the potential for such international treaties to allow commercial interests to strike down domestic government policy on FMCG packages, especially in smaller countries that are committed to treaties in which redress can be pursued by third parties in treaty pseudo-courts, was clearly demonstrated. A role therefore exists for trans-national organisations to oppose treaties that, either by accident or design, give third parties the power to overrule regulations put in place by democratically elected governments.

6.8. Potential Structures for a National Scale Closed-Cycle FMCG Packaging System

Any closed-cycle system for FMCG packaging will have to satisfy the requirements of the constituents identified above, and it will also rely upon them to fulfill their roles if it is to have any chance of long-term success at a national level. The development of such a system will require a considerable amount of negotiation and compromise between these stakeholders, coupled with consistent leadership from government. It is likely that the system that would emerge from the end of these negotiations would differ significantly from the one that the constituents had individually in mind when they started out. This process will require that participants not become overly committed to any specific technical platform as it is the outcomes, not the means towards those outcomes, that will determine the eventual success or failure of a system. It is also possible that a single national system may consist of a small number of discrete solutions.

With this caveat in mind, the three approaches outlined below, all of which require point of origin design, may represent viable starting points for this process.

Restricted component recycling: The current efforts at recycling rarely achieve recycling to the same level, with repurposing at varying levels of success being the normal outcome. A national level system that aims to achieve a closed-cycle system based on recycling is unlikely to succeed unless packaging manufacture is regulated so that only component materials that can be recycled to the same level indefinitely are used, and that these component materials are easy to identify and separate from each other (Figure 3).

This system has the advantage that it is closest to the present open-ended arrangements from all stakeholders' points of view. In addition, many of the components that might be used have existing recycling codes, such as PET (Polyethylene Terephthalate) = 1 (EC 1997). Industry participants would be free to do as they pleased within the parameters of the component content regulation. Current consumer and government arrangements would remain largely unchanged. The drawback of this system is that the requirement for the indefinite recycling to the same level is an extremely demanding one if packages remain single use. Almost the only material that could meet this requirement at present is aluminium.

Consumer controlled reusable packaging: The rise of bin retailers, where consumers bring their own packaging to be filled from bulk containers, was discussed earlier (Figure 4). These retail formats still have a small market share in most developed economies, but they are growing fast. The principal drawbacks of these systems relate to food safety and cross-contamination at retail and in the home,

and handling at retail. Loss of retailer and manufacturing IP along with control of the package are also significant issues for industry stakeholders.

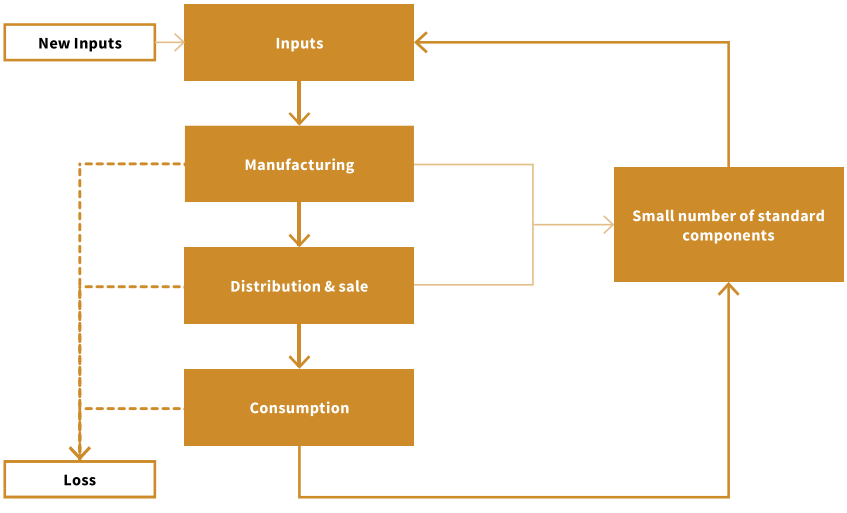

Figure 3. Restricted component recycling.

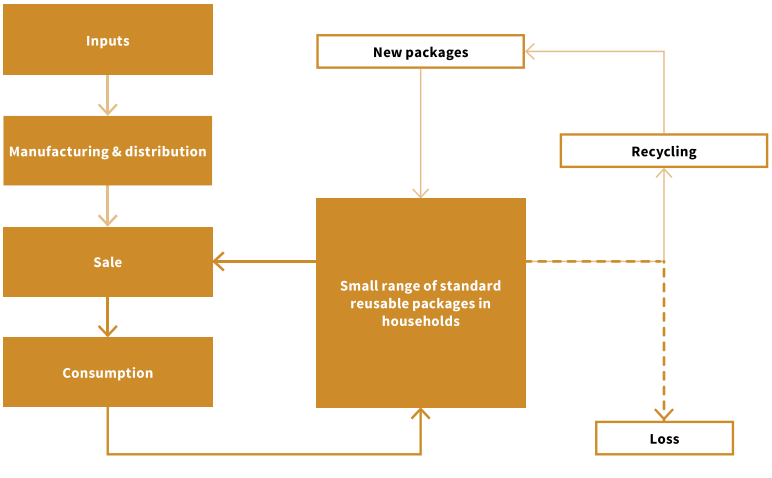

Figure 4. Consumer controlled reusable packaging.

Many of the handling and safety issues can be addressed by mandating the use of a restricted range of recyclable 'approved' containers to purchase retail items. The containers would remain the property and responsibility of the consumer. Such regulations have precedent with the use of approved containers for purchasing petrol. Even with careful design, it is unlikely that systems of this type represent a wide-ranging solution for closed system FMCG packaging. A variant of this, where the retailer rather than the consumer owns the package, may work in such circumstances, but smaller retailers may be systemically disadvantaged by such a system.

Third party controlled reusable packaging: In a third party reusable system a small range of standard reusable packages is also used, but this time they are controlled by a third party that processes them for reuse, and recycles them at the end of the useful reusable life of the package, on a national scale (Figure 5). In this system a package would be purchased from the third party by a manufacturer, who would then use it to send their product down the channel to retail. The consumer would then purchase the product, consume it and return the package to the third party by a regular domestic bin pick up. The third party would then reprocess the package and sell it out for reuse. Thus a package may go from city 'A' to city 'B' full of beer, be reprocessed and return from city 'B' to city 'A' full of milk, to then be sent to city 'C' full of tomato ketchup.

This approach has a number of advantages for most stakeholders. Apart from the use of a more restricted range of packages, the normal patterns remain unchanged for the consumer. They buy the items packed and dispose of them in a bin that can be collected in a similar manner to current weekly bin pickups. As industry controls the containers through manufacturing, distribution and sale, most of their safety, apportionment, pricing, handling and IP issues can also be mitigated. The exceptions to this are the packaging manufacturers who lose heavily if this system is introduced. This would need to be factored into the politics of any such initiative. A government that successfully deployed such a system would achieve its objective of reducing FMCG packaging waste to landfill, and if they control the third-party reuse/recycling process, then the system could be self-funding or even profitable. The regulatory monopoly issues that are inherent to this system would make any private ownership or control of this part of the system an extremely risky proposition.

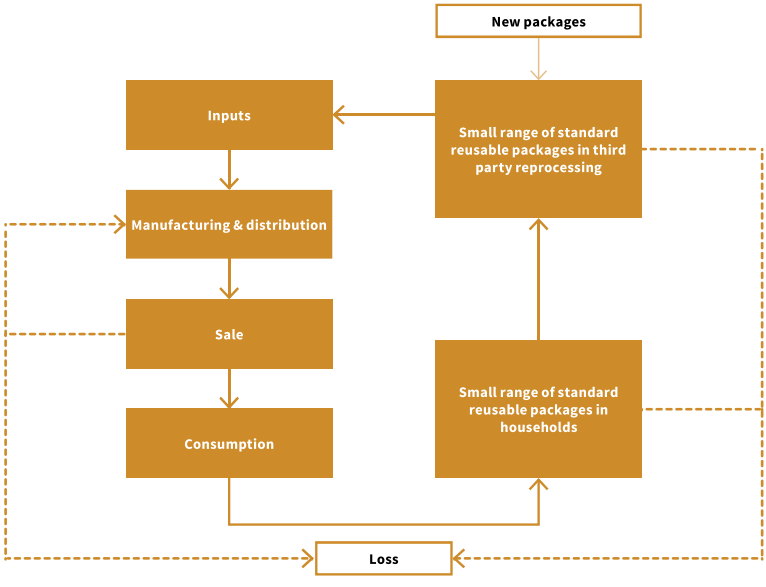

Figure 5. Third party controlled reusable packaging.

7. Progressing to a Closed-Cycle FMCG System: Future Steps

Achieving a closed-cycle FMCG packaging system on a national scale appears to be a depressingly enormous task. Yet, given widely known issues of pollution and resource depletion, achieving it also appears to be obligatory. The discussion presented here is by no means a comprehensive one, and the three approaches outlined above are only preliminary concepts.

The research team of which I am a member favours third party controlled reusable packaging as an initial avenue for development as it appears to have the capacity to meet all stakeholder requirements. The first step appears to be to develop the concept to the point where it can be presented as a service blueprint for large-format retailers via the following steps:

(1) Identify the minimum range (number) of packages that are necessary to present all packaged products in a large format retailer.
(2) Create a set of consumer performance specifications for each package type.
(3) Create a set of industry performance specifications for each package type.
(4) Identify which existing technologies (if any) would be able to meet these consolidated performance specifications in addition to being fully recyclable.

(5) Develop a computer logistics programme to model flows of the packaging though a third-party reprocessing and remanufacturing system.

The outcome of this work, which in our estimation will take a minimum of three years and cost in excess of three million New Zealand dollars, will be a basic service blueprint for the system that would form a starting point for preliminary evaluation and negotiation between the stakeholders noted previously.

The main objective of any national scale closed-cycle system is reduction by 'before the event' design and supporting regulation. This requires very careful research to inform design that addresses the interests and concerns of all stakeholders, but particularly those of business. The capacity of business to bless or blight an initiative, independently of its merits to consumers, government and the environment, is amply demonstrated by the differential trajectories of Sodastream® and Nespresso® in our FMCG markets.

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References

Barnes, Stuart J. 2019. Out of sight, out of mind: Plastic waste exports, psychological distance and consumer plastic purchasing. *Global Environmental Change* 58: 101943. [CrossRef]

Baruffaldi, Giulia, Riccardo Accorsi, Luca Volpe, Riccardo Manzini, and Fredrik Nilsson. 2019. Sustainable operations in reusable food packaging networks. In *Sustainable Food Supply Chains*. Cambridge: Academic Press, pp. 293–304.

Battini, Daria, Martina Calzavara, Alessandro Persona, and Fabio Sgarbossa. 2016. Sustainable packaging development for fresh food supply chains. *Packaging Technology and Science* 29: 25–43. [CrossRef]

Beitzen-Heineke, Elisa F., Nazmiye Balta-Ozkan, and Hendrik Reefke. 2017. The prospects of zero-packaging grocery stores to improve the social and environmental impacts of the food supply chain. *Journal of Cleaner Production* 140: 1528–41. [CrossRef]

Bloom, Peter. 2017. *The Ethics of Neoliberalism: The Business of Making Capitalism Moral*. Abingdon: Routledge.

Bratskeir, Kate. 2019. Loop Review: A Waste-Free Packaging Service for Returning Containers. *Huffpost*, October 28. Available online: https://www.huffpost.com/entry/loop-review-plastic-free-delivery_n_5db35e42e4b006d4916e7f79 (accessed on 21 April 2020).

Brem, Alexander, Maximilian Maier, and Christine Wimschneider. 2016. Competitive advantage through innovation: The case of Nespresso. *European Journal of Innovation Management* 19: 133–48. [CrossRef]

Brooks, Amy L., Shunli Wang, and Jenna R. Jambeck. 2018. The Chinese import ban and its impact on global plastic waste trade. *Science Advances* 4: eaat0131. [CrossRef]

Caffeininformer.com. 2019. Nespresso Original Line Caffeine, "Each Standard Arabica Capsule Contains 5 grams of Coffee". Available online: https://www.caffeineinformer.com/caffeine-content/nespresso-coffee-capsules (accessed on 23 December 2019).

Cheng, Karen. 2019. Sustainable Packaging Approaches for Current Waste Challenges. Ph.D. dissertation, Massachusetts Institute of Technology, Cambridge, MA, USA.

Christensen, Clayton M., Michael E. Raynor, and Rory McDonald. 2015. What is disruptive innovation? *Harvard Business Review* 93: 44–53.

Chung, Sai Ho, Hoi Lam Ma, and Hing Kai Chan. 2018. Maximizing recyclability and reuse of tertiary packaging in production and distribution network. *Resources, Conservation and Recycling* 128: 259–66. [CrossRef]

Coffee Lovers New Zealand. 2019. Retail Description of Reusable Nespresso Pod. Available online: https://www.coffeelovers.co.nz/products/nespresso-stainless-steel-refillable-coffee-capsule-coffee-tamper-reusable-coffee-podC (accessed on 23 December 2019).

Dando, Tansy. 2019. European Aluminium Can Recycling Rate Reaches 74.5 per cent. *Resource.co*, October 15. Available online: https://resource.co/article/european-aluminium-can-recycling-rate-reaches-745-cent (accessed on 21 April 2020).

de Oliveira, Elizabeth Real, and Paula Rodrigues. 2015. The importance of corporate social responsibility in the brand image–The "Nespresso" case study. *International Journal of Engineering and Industrial Management* 4: 77–87.

Dhebar, Anirudh. 2016. Razor-and-Blades pricing revisited. *Business Horizons* 59: 303–10. [CrossRef]

Dobush, Grace. 2019. The brutal reality of being the World's 'best' recycler. *Huffington Post*, July 19. Available online: https://www.huffpost.com/entry/germany-recycling-reality_n_5d30fccbe4b004b6adad52f8 (accessed on 21 April 2020).

European Community (EC). 1997. Commission Decision of 8 January 1997 Establishing the identification system for packaging materials pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste. *Official Journal of the European Communities*, L50/28. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31997D0129&from=EN (accessed on 19 February 2020).

EEA (European Environment Agency). 2019. The Plastic Waste Trade in the Circular Economy (Briefing). October 28. Available online: https://www.eea.europa.eu/themes/waste/resource-efficiency/the-plastic-waste-trade-in (accessed on 21 April 2020).

Elbedweihy, Alaa M., Chanaka Jayawardhena, Mohamed H. Elsharnouby, and Tamer H. Elsharnouby. 2016. Customer relationship building: The role of brand attractiveness and consumer–brand identification. *Journal of Business Research* 69: 2901–10. [CrossRef]

Ellickson, Paul B., and Sanjog Misra. 2008. Supermarket pricing strategies. *Marketing Science* 27: 811–28. [CrossRef]

Flaws, Bonnie. 2019. Countdown's BYO container scheme goes nationwide. *Stuff*, July 29. Available online: https://www.stuff.co.nz/business/114556623/countdowns-byo-container-scheme-goes-nationwide (accessed on 23 December 2019).

Fox, Hannah. 2019. Which Coffee Pod Brands Are the Most Eco-Friendly? *Which*, April 22. Available online: https://www.which.co.uk/news/2019/04/which-coffee-pod-brands-are-the-most-eco-friendly/ (accessed on 21 April 2020).

Gabbitas, Josh. 2018. Campaigners Call for Starbucks to Honour Pledge to Bring in '100% Recyclable' Cup. *The Independent*, March 6. Available online: https://www.independent.co.uk/news/business/news/starbucks-recyclable-coffee-cup-pledge-disposable-campaigners-call-late-levy-a8237246.html (accessed on 21 April 2020).

Gell, Fiona. 2019. The Blue Planet effect: The plastics revolution is just the start. *The Guardian*, March 29. Available online: https://www.theguardian.com/commentisfree/2019/mar/25/plastics-revolution-marine-life (accessed on 21 April 2020).

Gunther, Marc. 2015. The good, the bad and the ugly: Sustainability at Nespresso. *The Guardian*, May 27. Available online: https://www.theguardian.com/sustainable-business/2015/may/27/nespresso-sustainability-transparency-recycling-coffee-pods-values-aluminum (accessed on 21 April 2020).

Hamlin, Robert P. 2010. Cue-based decision making. A new framework for understanding the uninvolved food consumer. *Appetite* 55: 89–98. [CrossRef]

Hamlin, Robert P., David Bishop, and Damien W. Mather. 2015. 'Marketing earthquakes' A process of brand and market evolution by punctuated equilibrium. *Marketing Theory* 15: 299–320. [CrossRef]

Han, Jia-Wei, Luis Ruiz-Garcia, Jian-Ping Qian, and Xin-Ting Yang. 2018. Food packaging: A comprehensive review and future trends. *Comprehensive Reviews in Food Science and Food Safety* 17: 860–77. [CrossRef]

Hickman, Leo. 2012. Light goes out for incandescent bulbs. *The Guardian*, August 31. Available online: https://www.theguardian.com/environment/2012/aug/31/lightbulbs-incandescent-europe (accessed on 21 April 2020).

Hoornweg, Daniel, Perinaz Bhada-Tata, and Christopher Kennedy. 2015. Peak waste: When is it likely to occur? *Journal of Industrial Ecology* 19: 117–28. [CrossRef]

Idumah, C. I., M. Zurina, J. Ogbu, J. U. Ndem, and E. C. Igba. 2019. A review on innovations in polymeric nanocomposite packaging materials and electrical sensors for food and agriculture. *Composite Interfaces* 27: 1–72. [CrossRef]

Kaiser, Katharina, Markus Schmid, and Martin Schlummer. 2018. Recycling of polymer-based multilayer packaging: A review. *Recycling* 3: 1. [CrossRef]

Kelsey, Jane. 2019. The Trans-Pacific Partnership Agreement and the Regional Comprehensive Economic Partnership: A Battleground for Competing Hegemons? In *Free Trade Agreements*. Singapore: Springer, pp. 11–34.

Keramitsoglou, Kiriaki M., and Konstantinos P. Tsagarakis. 2018. Public participation in designing the recycling bins to encourage recycling. *Sustainability* 10: 1240. [CrossRef]

Khandelwal, Harshit, Hiya Dhar, Arun Kumar Thalla, and Sunil Kumar. 2019. Application of life cycle assessment in municipal solid waste management: A worldwide critical review. *Journal of Cleaner Production* 209: 630–54. [CrossRef]

Knoblauch, Doris, Linda Mederake, and Ulf Stein. 2018. Developing countries in the lead—What drives the diffusion of plastic bag policies? *Sustainability* 10: 1994. [CrossRef]

Laville, Sandra. 2018. UK plastics recycling industry under investigation for fraud and corruption. *The Guardian*, October 19. Available online: https://www.theguardian.com/environment/2018/oct/18/uk-recycling-industry-under-investigation-for-and-corruption (accessed on 21 April 2020).

Levitt, Tom. 2019. Cut the wrap! UK dairy farm aims to be first to go single-use plastic-free. *The Guardian*, November 28. Available online: https://www.theguardian.com/environment/2019/nov/28/scottish-dairy-farm-aims-to-become-uks-first-to-go-single-use-plastic-free-mossgiel-ayrshire (accessed on 21 April 2020).

Lobina, Emanuale. 2019. UK: Strong and Weak Lock-in of Water Governance Outcomes in England. In *Facing the Challenges of Water Governance*. Cham: Palgrave Macmillan, pp. 155–88.

Ma, Yuhui. 2018. Changing Tetra Pak: From waste to resource. *Science Progress* 101: 161–70. [CrossRef]

Majdinasab, Alireza, and Qiuyan Yuan. 2019. Post-consumer cullet and potential engineering applications in North America. *Resources, Conservation and Recycling* 147: 1–9. [CrossRef]

McNaughton, Sean, and Kelsey Nowakowski. 2019. How China's plastic waste ban forced a global recycling reckoning. *National Geographic*, June. Available online: https://www.nationalgeographic.com/magazine/2019/06/china-plastic-waste-ban-impacting-countries-worldwide/ (accessed on 21 April 2020).

Meherishi, Lavanya, Sushmita A. Narayana, and K. S. Ranjani. 2019. Sustainable packaging for supply chain management in the circular economy: A review. *Journal of Cleaner Production* 237: 117582. [CrossRef]

Mendoza, Joan Manuel F., Francesco D'Aponte, Diego Gualtieri, and Adisa Azapagic. 2019. Disposable baby diapers: Life cycle costs, eco-efficiency and circular economy. *Journal of Cleaner Production* 211: 455–67. [CrossRef]

Ministry for the Environment (NZ). 2019. Phase out of Single-Use Plastic Shopping Bags. Available online: https://www.mfe.govt.nz/consultation/plasticshoppingbags (accessed on 21 April 2020).

Nemat, Babak, Mohammad Razzaghi, Kim Bolton, and Kamran Rousta. 2019. The role of food packaging design in consumer recycling behavior—A literature review. *Sustainability* 11: 435. [CrossRef]

Nielsen, Tobias Dan, Karl Holmberg, and Johannes Stripple. 2019. Need a bag? A review of public policies on plastic carrier bags–Where, how and to what effect? *Waste Management* 87: 428–40. [CrossRef]

O'Dowd, Adrian. 2018. Latest legal challenge to tobacco plain packaging is rejected by the World Trade Organization. *BMJ: British Medical Journal (Online)* 361: k2878. [CrossRef]

Osland, Asbjørn, and Lori Luo. 2019. *Environmental Sustainability, Sugar Consumption, and Sodastream*. Thousand Oaks: SAGE Publications.

Parker, Laura. 2019. Plastic bag bans are spreading. But are they truly effective? *National Geographic*, April. Available online: https://www.nationalgeographic.com/environment/2019/04/plastic-bag-bans-kenya-to-us-reduce-pollution/ (accessed on 21 April 2020).

Pfluger, Richard. A. 1975. Soluble coffee processing. In *Solid Wastes: Origin, Collection, Processing, and Disposal*. Edited by Charles. L. Mantell. New York: Wiley.

Poortinga, Wouter, and Louise Whitaker. 2018. Promoting the use of reusable coffee cups through environmental messaging, the provision of alternatives and financial incentives. *Sustainability* 10: 873. [CrossRef]

Rahimi, AliReza, and Jeannette M. García. 2017. Chemical recycling of waste plastics for new materials production. *Nature Reviews Chemistry* 1: 0046. [CrossRef]

Rezaei, Jafar, Athanasios Papakonstantinou, Lori Tavasszy, Udo Pesch, and Austin Kana. 2019. Sustainable product-package design in a food supply chain: A multi-criteria life cycle approach. *Packaging Technology and Science* 32: 85–101. [CrossRef]

Righter, Catalina. 2019. Green seats: Benches made from recycled bags debut at South Carroll High. *Carroll County Times*, June 18. Available online: https://www.baltimoresun.com/maryland/carroll/news/cc-bags-to-benches-20190617-story.html (accessed on 21 April 2020).

Romeo, Peter. 2018. Restaurants rethink the disposable coffee cup. *Restaurant Business*, December 13. Available online: https://www.restaurantbusinessonline.com/beverage/restaurants-rethink-disposable-coffee-cup (accessed on 2 July 2020).

Schießl, Michaela. 2012. Dictatorship of the Bureaucrats' Light-Bulb Ban Casts Shadow over EU Democracy. *Spiegel Online*, August 31. Available online: https://www.spiegel.de/international/europe/eu-light-bulb-ban-illuminates-power-struggle-in-brussels-a-852931.html (accessed on 21 April 2020).

Schmidt, Anthony T. 2018. Keep it Simple: Making it easy is the key to recycling success. *Waste+ Water Management Australia* 45: 2.

Silva, Diogo Aparecido Lopes, Gece Wallace Santos Reno, Gustavo Sevegnani, Tacila Berkenbrock Sevegnani, and Oswaldo Mário Serra Truzzi. 2013. Comparison of disposable and returnable packaging: A case study of reverse logistics in Brazil. *Journal of Cleaner Production* 47: 377–87. [CrossRef]

Slaper, Timothy F., and Tanya J. Hall. 2011. The triple bottom line: What is it and how does it work. *Indiana Business Review* 86: 4–8.

Stahel, Walter R. 2016. The circular economy. *Nature* 531: 435–38. [CrossRef]

Sverdrup, Harald Ulrik, Anna Hulda Olafsdottir, and Kristin Vala Ragnarsdottir. 2019. On the long-term sustainability of copper, zinc and lead supply, using a system dynamics model. *Resources, Conservation and Recycling* X: 100007.

Taylor, Rebecca L. C. 2019. Bag leakage: The effect of disposable carryout bag regulations on unregulated bags. *Journal of Environmental Economics and Management* 93: 254–71. [CrossRef]

Tisserant, Alexandre, Stefan Pauliuk, Stefano Merciai, Jannick Schmidt, Jacob Fry, Richard Wood, and Arnold Tukker. 2017. Solid waste and the circular economy: A global analysis of waste treatment and waste footprints. *Journal of Industrial Ecology* 21: 628–40. [CrossRef]

Trubnikov, Dmitrii. 2017. Analysing the impact of regulation on disruptive innovations: The case of wireless technology. *Journal of Industry, Competition and Trade* 17: 399–420. [CrossRef]

United Nations General Assembly (UNGA). 2015. *Transforming Our World: The 2030 Agenda for Sustainable Development*. A/RES/70/1. New York: UNGA. Available online: https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1andLang=E (accessed on 21 April 2020).

United Nations Environment. 2017. *Accelerating the Global Adoption of Energy Efficient Lighting*. Paris: United Nations Environment.

USEPA (United States Environmental Protection Agency). 2017. Containers and Packaging: Product-Specific Data. USEPA. Available online: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/containers-and-packaging-product-specific-data (accessed on 21 April 2020).

Vanne, Karine. 2019. The problem with America's bulk food bins. *Eater*, October. Available online: https://www.eater.com/2019/10/29/20938213/bulk-food-grocery-store-supermarket-environmental-impact-plastic-packaging (accessed on 21 April 2020).

Velis, Costas A., David C. Wilson, and Christopher R. Cheeseman. 2009. 19th century London dust-yards: A case study in closed-loop resource efficiency. *Waste Management* 29: 1282–90. [CrossRef]

Walker, Helen, Lucio Di Sisto, and Darian McBain. 2008. Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors. *Journal of Purchasing and Supply Management* 14: 69–85. [CrossRef]

Warner, Charles, Hilary Vick, Paul Phillips, and Andrew Lappage. 2015. The 'Real Nappies for London' Scheme 2007–2012: Key findings to drive a future waste prevention agenda through landfill reduction. *The Journal of Solid Waste Technology and Management* 41: 28–40. [CrossRef]

Webster, Ben. 2019. Britain sends plastic waste to countries with heavily polluted rivers. *The Times*, December 13. Available online: https://www.thetimes.co.uk/article/rivers-of-waste-plastic-created-by-britains-exported-rubbish-7r2wlxbf8 (accessed on 21 April 2020).

Winter, Daniel. 2019a. Top 100 global brands 2019: The full ranking. *Financial Times*, June 11. Available online: https://www.ft.com/content/3a3419f4-78b1-11e9-be7d-6d846537acab (accessed on 21 April 2020).

Winter, Lydia. 2019b. 10 best reusable coffee cups. *The Independent*, February 7. Available online: https://www.independent.co.uk/extras/indybest/house-garden/coffee/best-reusable-coffee-cup-a7510606html (accessed on 21 April 2020).

Woodcock, Andrew. 2019. Plastic bag usage in supermarkets down 90 per cent since introduction of 5p charge in 2015. *The Independent*, July 31. Available online: https://www.independent.co.uk/news/uk/politics/plastic-bag-charge-supermarkets-figures-reduction-a9029996.html (accessed on 21 April 2020).

WRAP (Waste and Resources Action Programme). 2010. *Life Cycle Assessment of Example Packaging Systems for Milk*. Banbury: WRAP.

Wyrwa, Joanna, and Anetta Barska. 2017. Innovations in the food packaging market: Active packaging. *European Food Research and Technology* 243: 1681–92. [CrossRef]