Chapter 20
First Steps Towards Sustainable Waste Management

Øystein Peder Solevåg

Abstract Waste management started off as a public health issue. Today, the waste business is an important force in developing sustainable development and circular economy. New policies and regulations represent an opportunity for circularity, but there is still a long way to go in achieving a truly circular economy. The Circularity Gap Report 2020 indicated that the global economy is only 8,6 % circular. Industrial ecology and material flow analysis are important tools, not only for developing local and regional waste solutions, but also in the development of new global circular business models. In the Ålesund region, new sorting measures have increased recycling, from 32 % in 2017 to 45 % in 2019. New measures will be needed to reach national targets set for 2025. As the current global use of resources is unsustainable, and as current waste business models are insufficient to achieve circular economy, the next decade is likely to experience a rapid innovation of new business models challenging traditional waste management companies. This chapter presents data collected during a case study conducted in 2020.

20.1 Introduction: The Historical Development of Waste Management

Historically, waste management was introduced as a public health measure in larger cities. Removal of waste, which was mainly of organic origin, was necessary to reduce the risk of vector induced disease, e.g., through vermin or drinking water. Removed waste was either diluted in city waterways or reused as fertilizer in food production, inside and outside nearby cities (Torstenson 1997).

As industrial production developed, new materials, chemicals and other by-products where introduced, and with increased knowledge on the detrimental effects of pollution on human health and the environment, the need for more complex waste management solutions became apparent. During the twentieth century, waste

Ø. P. Solevåg (✉)
ARIM Company Ltd., Ålesund, Norway
e-mail: ops@arim.no

A. M. Fet (ed.), *Business Transitions: A Path to Sustainability*,
https://doi.org/10.1007/978-3-031-22245-0_20

management was developed as an economic service, the *Waste Business* was established. This newly established business organised collection and transportation of waste, surplus chemicals og other by-products, as well as establishing landfills and waste incineration plants. For a few materials, such as metals, recycling systems were established (Bodamer 2018). This development is mainly seen in Northern Europe. Globally, several countries have not moved forward in at the same pace. Several developing countries have only to a limited extent developed systematic waste collection and treatment. Marine littering is a major consequence of lack of such systems worldwide.

20.2 Waste Management and Circular Economy

In the twenty-first century, two global trends are setting a new standard for waste management. First, the global effects of waste and waste management are recognized as crucial for sustainability. The interlinkage between global resources and sustainability goals gives birth to the concept of circular economy (BH4S 2022). Circular economy can be described as a system "where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimized" (Merli 2018:705).

In the years between 1990 and 2010, cleaner production methods were applied to achieve process optimalisation in the waste management business. Towards 2010, life cycle assessment was applied as a planning and decision tool for the development of new recycling solutions (Michaud 2010). As the waste management sector was consolidating, environmental management systems were applied. Extended producer responsibility has also been implemented as a tool to organise and finance waste management (Kunz et al. 2018), as has eco-design (Demirel and Danisman 2019).

There are several methodologies and indicators used to describe the circularity of the economy. The Circularity Gap Reporting Initiative (CGRi) is an initiative of Circle Economy, an impact organisation dedicated to accelerating the transition to the circular economy (CGRi 2020). Using material flow analysis, this Initiative has published global and national reports on circularity. It describes several dimensions of the global material flow. Firstly, it describes the total amount of materials applied, based on material type (minerals, ores, fossil fuels and biomass). Then the material flow through the global economy (take, process, produce, provide, end of use) is described. The share of the global material flow between global business sectors (housing, communication, mobility, healthcare, services, consumables, and nutrition) is also described. Of the 100.6 Gt materials that enters the global economy annually, 31.0 Gt is added to stock, while only 8.6 Gt is recycled. (CGRi 2020).

In a world where the global economy is expanding, recycling of additional resources will not be sufficient to gain sustainability (Grosse 2010), and it is important to stress that circular economy is more than recycling of materials. Circular economy is expected to not merely recycle materials, but also to reduce waste og

improve resource productivity; thus, reducing environmental impacts from production and consumption. The International Resource Panel use the term *decoupling* as the necessary result of the circular economy: "The decoupling of natural resource use and environmental impacts from economic activity and human well-being is an essential element in the transition to a sustainable future" (IRP 2019:28).

20.3 Waste Policies and Regulations

Since the 1990s, the *waste hierarchy* as presented in Fig. 20.1 has provided a tool for developing waste policies and regulations. In Europe, the hierarchy has been implemented as a main part of the international waste legislation. Based on this waste hierarchy, several targets have been developed. An important target is that by 2035, 65% of all municipal waste should be re-used or recycled. Waste hierarchy provides a direction for the development of the circular economy. However, it is necessary to also include other elements from the CapSEM toolbox, such as design, labelling, supply chain management and monitoring. The 'Circular Economy Package', is an example of this (Stahel 2017).

20.4 Municipal Waste Management in the Ålesund Region

ÅRIM is a waste management company owned by seven municipalities in Norway. The company was established in 2010, and the main purpose of the company is to manage household waste from approximately 105,000 inhabitants. The collection system for household waste was originally based on a two-bin-system, with the collection of paper and plastic every month and collection of residual waste every week. Glass and metal packaging was not collected on a household level but had to

Fig. 20.1 Waste hierarchy

be transported to local recycling stations. ÅRIM carried out an analysis of waste production and composition from local households. The analysis was based on national waste regulations, and results from LCA and carbon footprint of products (CFP), for household waste in general (Raadal et al. 2009) and for food waste in particular (Modahl et al. 2016). ÅRIM on average (2017–2020) received 384 kg household waste per inhabitant per year, as shown in Table 20.1. In 2017, 32 % of the household waste managed by ÅRIM was re-used or recycled.

In 2018, the collection system for approximately 55 % of the households in the region was changed to a four-bin-system, with the collection of food waste and residual waste every second week. Paper and plastic are collected once a month, as before. In addition, glass and metal packaging is collected every second month. Food waste is used to produce biogas and fertilizer, paper, plastic, glass, and metal packaging are recycled while residual waste is incinerated, producing electricity and heat. The results of the change in collection system are shown in Table 20.2.

The change to the collection system has improved the sustainability of waste management from households in ÅRIM, as more waste is recycled and less is incinerated. In 2019, 45 % of the household waste managed by ÅRIM was re-used or recycled. From 2023, all households will have a four-bin collection system. However, further work is needed to identify any necessary circular strategies. This is a challenge for most Norwegian municipalities (Norwegian Environment Agency 2021). In its role as a waste management company ÅRIM is unlikely to achieve these goals on its own. A partnership between industry, waste management companies and regulatory authorities is necessary.

Table 20.1 Waste per inhabitant (measured in kg waste per inhabitant per year (average 2017–2020) (Annual reports published at *www.arim.no* and internal data)

Collected at household level (incl. glass and metal packaging)	230 kg
Brought to recycling stations (bulky and hazardous waste)	154 kg
Total waste production	384 kg

Table 20.2 Collected waste (Annual reports published at *www.arim.no* plus internal data)

Categories	Collected kg per inhabitant 2017	Collected kg per inhabitant 2019	Change kg per inhabitant
Food waste	0	35	**+ 36**
Paper waste	39	34	**- 5**
Plastic packaging	5	7	**+ 2**
Glass and metal packaging	10	14	**+ 4**
Residual waste	182	133	**- 49**
Total collected	**237**	**227**	**- 10**

20.5 Applying the CapSEM Model to Local Waste Management

The CapSEM Model is useful in many ways. For ÅRIM it can be used as a top-down framework for the waste collecting system ÅRIM is using, which is based upon international and national regulations. These regulations are based on the principles of sustainability and circular economy (change on the system level is defined as Level 4 in the CapSEM Model). The regulations are implemented through environmental management systems and reporting systems in ÅRIM (change on the organizational level is defined as Level 3), established for providing all interested parties (such as authorities, owners, customers, and neighbours) with necessary information. In order to achieve recycling targets, ÅRIM must inform consumers in the regions about how to recycle, and also about how to buy products that are more durable, can be repaired or recycled (change on the product level is defined as Level 2). Finally, ÅRIM also needs to implement measures on our own waste management facilities to comply with existing and new environmental legislation, preventing emissions to water, air and soil (change on the production level is defined as Level 1).

20.6 Concluding Remarks

The types of changes in global systems needed to reach UN Sustainability Development Goals requires a fundamental shift in the purpose of business and almost every aspect of how it is conducted. There is a need for innovation of more sustainable business models (Bocken et al. 2014). Sustainable business model innovation might be described as an important link between Level 3 and Level 4 in the CapSEM model. Business model innovation is necessary to achieve system change, but it also represents a threat to organisations which are unable to adapt. As the current use of resources is unsustainable, and as the current waste business models are insufficient for achieving a circular economy, the next decade is likely to experience a rapid innovation of new business models challenging the traditional waste management companies.

References

BH4S (2022) Circular economy business models. Available via: https://bh4s.no/sustainable-business-model-archetypes/circular-economy-business-models. Accessed 29 June 2022

Bocken NM, Short SW, Rana P, Evans S (2014) A literature and practice review to develop sustainable business model archetypes. J Cleaner Production 65:42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Bodamer D (2018) A timeline of the modern solid waste industry. Available via Waste 360: https://www.waste360.com/print/40069. Accessed 14 September 2022

CGRi (2020) Circularity gap report 2020. Available via: https://www.circularity-gap.world/2020. Accessed 29 Jun 2022

Demirel P, Danisman GO (2019) Eco-innovation and firm growth in the circular economy: evidence from European small-and medium-sized enterprises. Bus Strateg Environ 28(8):1608–1618. https://doi.org/10.1002/bse.2336

Grosse F (2010) Is recycling "part of the solution"? The role of recycling in an expanding society and a world of finite resources. Surveys Perspect Integrat Environ Soc 3(1):1–17. http://journals.openedition.org/sapiens/906

IRP (2019) Global Resources Outlook 2019: Natural Resources for the Future We Want. Report for the International Resource Panel. Summary for Policymakers. Nairobi: United Nations Environment Programme pp. 160. Available via https://www.resourcepanel.org/reports/global-resources-outlook. Accessed 29 Jun 2022

Kunz N, Mayers K, Van Wassenhove LN (2018) Stakeholder views on extended producer responsibility and the circular economy. Calif Manag Rev 60(3):45–70. https://doi.org/10.1177/0008125617752694

Merli R, Preziosi M, Acampora A (2018) How do scholars approach the circular economy? A systematic literature review. J Cleaner Production 178:703–722. https://doi.org/10.1016/j.jclepro.2017.12.112

Michaud JC, Farrant L, Jan O, Birgitte Kjær B, Bakas I (2010) Environmental benefits of recycling: 2010 update. Available via: https://wraporguk/resources/report/environmental-benefits-recycling-2010-update Accessed 29 Jun 2022

Modahl IS, Lyng K-A, Stensgård A, Saxegård, S, Hanssen O, Møller H, Arnøy S, Morken J, Briseid T, Sørby I (2016) Biogassproduksjon fra matavfall og møkk fra ku, gris og fjørfe. Status 2016 (fase IV) for miljønytte for den norske biogassmodellen. Available via: https://norsus.no/wp-content/uploads/or-3416-bvc-biogassmodell-fase-iv-2016-versjon-3-aapen.pdf. Accessed 29 Jun 2022 [Norwegian]

Norwegian Environment Agency (2021) Analyse av tiltak og virkemidler for økt forberedelse til ombruk og materialgjenvinning av husholdningsavfall og lignende næringsavfall. Available via: https://www.miljodirektoratet.no/publikasjoner/2021/april-2021/m2021.pdf/. Accessed 29 Jun 2022 [Norwegian]

Raadal HL, Modahl IS, Lyng KA (2009) Klimaregnskap for avfallshåndtering. Fase I og II. Available via: https://norsus.no/wp-content/uploads/1809.pdf. Accessed 29 Jun 2022 [Norwegian]

Stahel WR (2017) Analysis of the structure and values of the European Commission's circular economy package. In Procee Instit Civil Eng Waste Res Manag 170(1):41–44. https://doi.org/10.1680/jwarm.17.00009

Torstenson I (1997) *Fra nattmann til renholdsverk: avfall og renovasjon i Oslo gjennom tusen år.* Oslo: ProArk. Available via : https://www.nb.no/items/URN:NBN:no-nb_digibok_2017091207132. Accessed 29 Jun 2022 [Norwegian]