

Research Article

Local Authority Waste Management Strategies, the Circular Economy and the Generation of Energy from Waste in England

Peter Jones ^{†, ‡}, Martin Wynn ^{†, ‡, *}University of Gloucestershire, Park Campus, Cheltenham, UK; E-Mails: PJones@glos.ac.uk;
MWynn@glos.ac.uk

‡ Current Affiliation: School of Business, Computing and Social Sciences, University of Gloucestershire

† These authors contributed equally to this work.

* **Correspondence:** Martin Wynn; E-Mail: MWynn@glos.ac.uk**Academic Editor:** Grigorios L. Kyriakopoulos**Special Issue:** [Renewable Energy and Circular Economy in Urban and Regional Developments](#)*Journal of Energy and Power Technology*
2024, volume 6, issue 2
doi:10.21926/jept.2402009**Received:** February 17, 2024**Accepted:** March 28, 2024**Published:** April 01, 2024

Abstract

The purpose of this article is to examine the approach to waste management of local authorities in England, to investigate their strategic objectives, and to ascertain to what extent sustainability and circular economy practices are in evidence in this context. A qualitative, inductive research method is used, based on an examination of secondary documentation in three local authorities in England in Birmingham, Bristol and Newcastle upon Tyne. The findings reveal considerable common ground within the three authorities – the importance of consumption across society in contributing to the generation of waste, the need for behavioural change, a focus on reducing waste (particularly food waste), maximising recycling and re-use, reducing carbon dioxide emissions, and actively involving the local community and businesses. The case studies also evidence clear support for moving towards a more circular economy, but a number of key challenges were identified whilst initiatives to increase “waste to energy” face a number of potential hurdles. These include the generation of pollution and



© 2024 by the author. This is an open access article distributed under the conditions of the [Creative Commons by Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium or format, provided the original work is correctly cited.

particulates by waste to energy plants, the destruction of useful materials, and the potential to disincentivize more sustainable waste management solutions. The article makes a small contribution to an existing gap in the academic literature and it is hoped these cases may act as a template for other research studies that could provide comparisons and contrasts in other local authority contexts.

Keywords

Waste management; local authorities; circular economy; waste to energy; sustainability; case studies

1. Introduction

The amount of waste generated globally has increased massively in recent decades. Statista [1] estimated that over two billion tons of municipal solid waste are generated worldwide each year, that this figure is expected to rise by 70% by 2050, and that the need for authorities to provide adequate waste treatment and disposal services becomes ever more important. Fitch-Roy et al. [2] suggested that the concept of the circular economy had been adopted by policy makers concerned with waste management, while Kumar and Samadder [3] argued that the generation of energy from waste - albeit at the very bottom of the waste hierarchy – is an important element in the circular economy and was not only a potentially important source of renewable energy, but could also ensure effective solid waste management.

Internationally, Sakai et al. [4] reported that national governments' and local authorities' responsibilities for waste management varied between jurisdictions. Within England, for example, both national government and individual local authorities have responsibilities for waste management. At the national level, the "Resources and waste strategy for England" [5], and the "Waste Management Plan for England" [6], are seen to embed "sustainable thinking around waste management", and to bring about "a real step change in how we consume resources, protecting the planet's natural capital for the benefit of us all – both now and in generations to come".

At the local authority level, county and unitary authorities "are responsible for producing waste local plans that cover the land use planning aspect of waste management for their areas" [6], and while local authorities are also generally responsible for municipal waste collections and disposal, this service may be contracted out to a private company. However, specific local authority's waste management policies have received limited attention in the academic literature (for an exception see Wang et al.'s study of Nottingham [7]) and this represents a gap in that literature. This exploratory paper looks to further contribute to filling that gap via three simple case studies of the ways in which the local authorities in Birmingham, Bristol and Newcastle upon Tyne have publicly set out their approach to waste management. Following this introduction, the following section provides an overview of the research method. Section 3 then discusses relevant literature relating to waste management, the circular economy and the generation of energy from waste, and two research questions are set out. In section 4, an exploratory review of the waste management policies in Birmingham, Bristol, and Newcastle upon Tyne is presented, and a discussion of some of the issues arising from the case studies follows in section 5, in which the two research questions are

addressed. Finally, section 6 contains a conclusion to the study, notes its limitations and briefly discusses possible future areas of research in this field.

2. Materials and Methods

The study adopts a qualitative, inductive approach using a scoping literature review and case studies of three local authorities in England. A scoping review involves a “broad scan of contextual literature” through which “topical relationships, research trends, and complementary capabilities can be discovered” [8], and provides “a means of gaining an initial impression” [9] of pertinent issues. Relevant publications and web sources were reviewed to establish the depth and breadth of current literature relating to the subject area. Internet surveys were conducted using Google as the search engine with appropriate search strings in January to February 2024. This was phase 1 of the research process which allowed the identification of a set of key issues and the development of research questions. These questions were then addressed with specific reference to the three case studies in phase 2 of the research process (Figure 1).

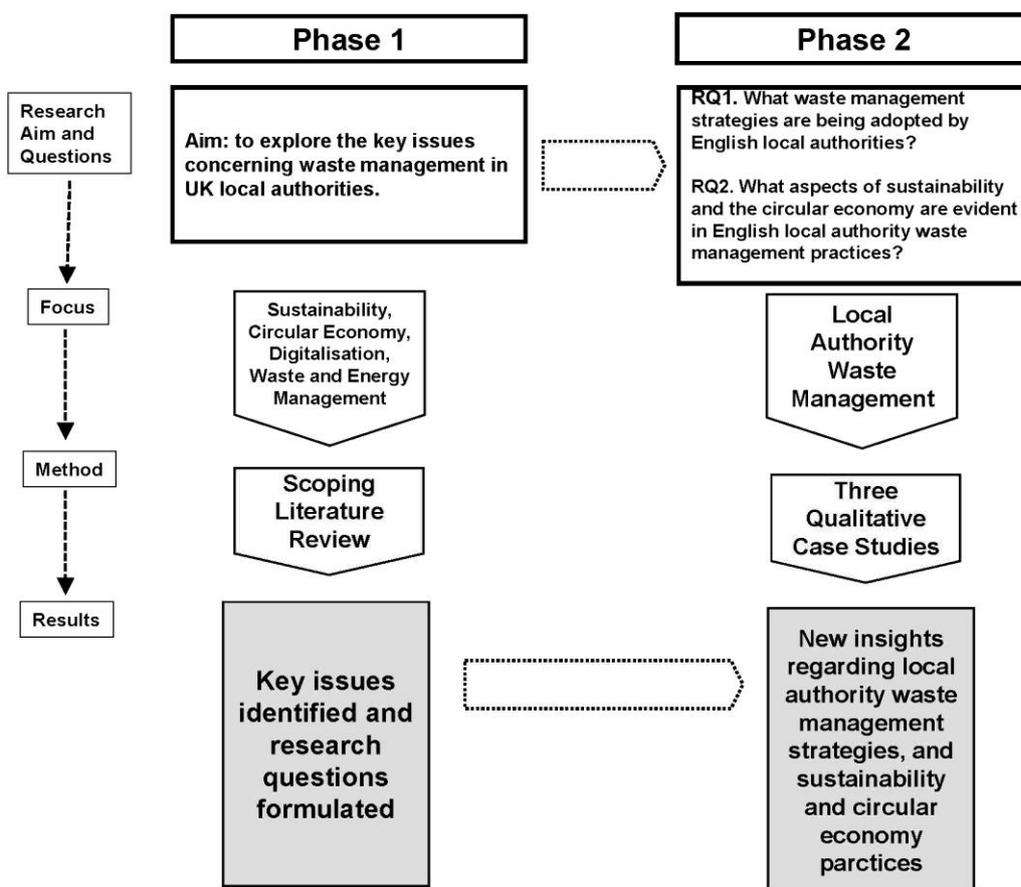


Figure 1 The two phases of the research process.

The validity of generalizing from case studies has been much discussed in the literature with differing views [10]. Here it is suggested that the case study could be used as a vehicle for comparison and contrast with waste management strategies and related issues in other local authority contexts (Figure 2).

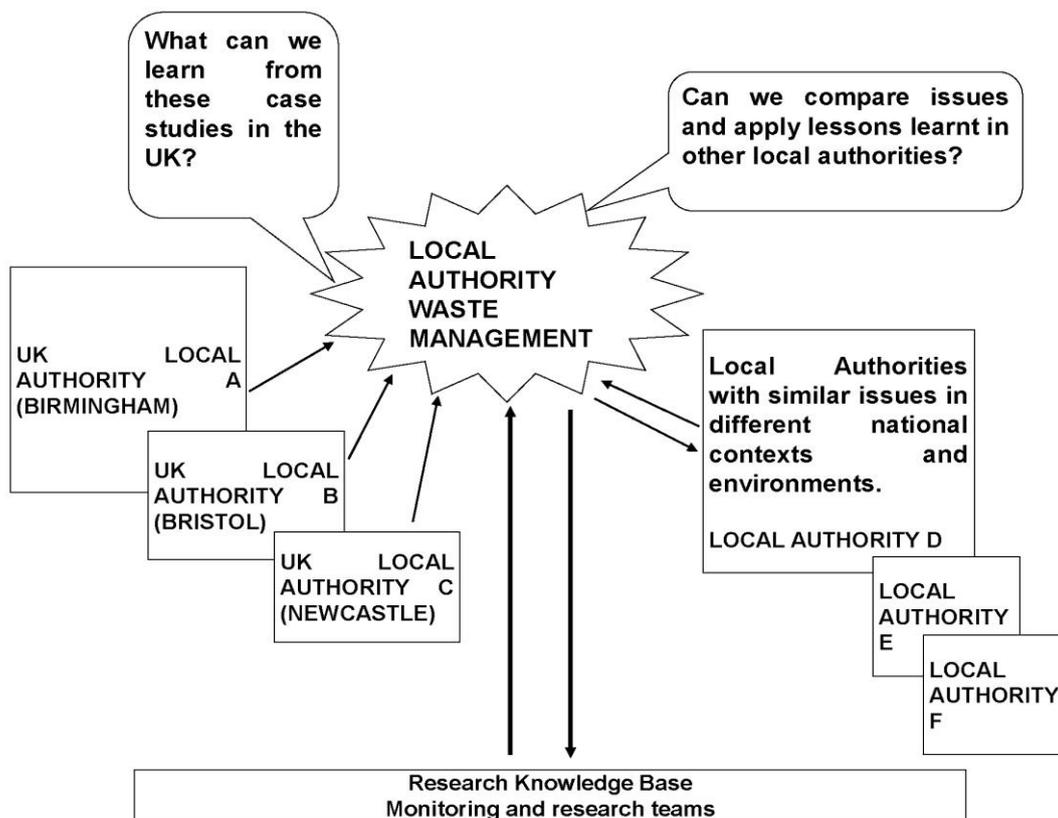


Figure 2 Comparing and contrasting local authority case studies.

The Internet search used the names of eight large provincial cities in England, namely Birmingham, Bradford, Bristol, Leeds, Liverpool, Manchester, Newcastle upon Tyne, Sheffield and the phrase “municipal waste policies and strategies” as the key terms in the Google search engine. The search revealed that three of the city councils - Birmingham, Bristol, and Newcastle upon Tyne - had posted details of their current waste management strategies and policies. These were Birmingham City Council’s “Waste Strategy 2017-2040” [11], Bristol City Council’s “Towards A Zero Waste Bristol: Waste and Resource Management Strategy” [12], and Newcastle City Council’s “Waste Strategy” [13], and it these documents that provide the source material for the case studies.

The documents were well structured and clearly signposted, and the authors took the considered view that a detailed content analysis would be unnecessary in an exploratory study. Rather, a close reading of the source material was undertaken and a number of major themes were identified. As the reports are in the public domain, on the selected companies’ websites, the authors felt that it was unnecessary to seek formal permission to use them. At times, the authors explicitly draw quotations from the selected local authority documents, with the aim of providing authenticity in answering the research questions by exploring how the selected local authorities publicly outlined their strategies and related issues.

Birmingham is a major city in the West Midlands region of England and it has a population of c. 1.15 million and covers over 250 square kilometres. It was one of the early centres of the Industrial Revolution, but the city’s modern economy is now dominated by the service sector, even though it still has a significant manufacturing sector. Bristol is the major city in the south west of England, it has a population of c. 479,000 and covers an area of 110 square kilometres. Once a major port, Bristol’s modern economy is built on the creative media, electronics and aerospace industries, and

the former docks in the city centre have been redeveloped as centres of heritage and culture. Newcastle upon Tyne is a city in the north east of England, has a population of some 300,000 people, and covers 155 square kilometres. In the nineteenth century, the city was a centre for coalmining, manufacturing and ship building, but in more recent times, it has developed a diverse economic base.

3. Literature Review

The literature on how the circular economy and the generation of energy from waste can contribute to waste management embraces a wide range of themes. These include a focus on the transition from a linear to a circular business model, barriers to, and to a much lesser extent, drivers of, the implementation of a more circular economy, the role of digital and robotic technologies, and the drivers of, and challenges for, the generation of energy from waste. The aim here is to highlight these themes rather than to offer a comprehensive review.

For the Ellen McArthur Foundation “a circular economy is a systemic approach to economic development designed to benefit businesses, society, and the environment. In contrast to the take-make-waste linear model, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources” [14]. As such, the concept of the circular economy is often contrasted with the traditional linear economy, which turns raw materials into waste in the production process, and which is seen to lead to environmental pollution and the build-up of waste, and the removal of natural capital. Essentially, the concept of the circular economy embraces all stages of the product life cycle from product design and production, through marketing and consumption to waste management, recycling, and re-use.

A number of technologies can be employed to generate usable forms of energy (electricity, heat and transport fuels) from waste, including combustion, gasification, pyrolysis, anaerobic digestion, and landfill gas recovery. In the combustion process, for example, the waste is burnt, releasing heat, which turns water into steam, which in turn drives a turbine generator to produce electricity. This is perhaps the most widely used of the technologies, but it releases a range of environmental pollutants, which require the installation of pollution control systems or further treatment. Gasification is a chemical process, in which waste is heated in a low oxygen environment, until it is broken down into its constituent molecules. One of the main products from this process can be used directly for electricity generation.

Romero-Hernandez and Romero [15] put forward a framework to guide companies on their journey from a linear consumption pattern to a holistic, circular approach, and concluded that waste management practices can offer both cost-saving and revenue-generating opportunities, which create new value streams from materials previously discarded. More generally, the authors emphasised the importance of improved design and production practices, central to the circular economy, which eliminated the waste and repurposed resources from products at the end of their life cycle back as raw material inputs to create new products. The role of circular economy business models in the implementation of the sustainable development goals in the waste management sector was researched by Puntillo [16]. The research drew upon a case study of a company that developed a business model to recycle wastes into recyclable materials under a circular economy approach. The author suggested that the findings from the case study could stimulate further research into how circular economy models could help societies to change from the mentality of

linear business models to the integrated circular economy models that seeks to emulate nature's cyclical systems.

In the wider context of the European Union, Neves and Marques [17] sought to identify both drivers of, and barriers to, the development of the circular economy within waste management, using data from 19 European Union countries, and focusing on social, economic and environmental factors. One of the main findings was that education had a positive, and highly significant, effect in that people with a higher level of education were more inclined to buy products containing recycled components and/or to separate their waste for recycling. In examining the effect of the population age distribution, the findings revealed that older people are less concerned with transitioning to a circular economy than their younger counterparts. This suggests policies specifically targeting older people and the less educated are needed to promote an effective transition to a circular economy. Municipal waste management practices in 10 European countries were studied by Malinauskaite et al. [18], who looked to assess the extent to which waste to energy technologies play a role in waste management within these countries. The authors argued that waste to energy technologies should be given more attention in the circular economy, due to their capacity to bridge and enhance resource and energy efficiency improvements. More generally, their findings suggested that in most European countries, waste is regarded as a nuisance rather than a resource, and that political will is a key driver for change, with greater cooperation being required between waste management authorities and those government departments responsible for energy, waste management and the environment, if the full potential of waste to energy technologies is to be realised.

The relevance of consumer behaviour and digital ecosystem efficiency on plastic waste in 8 countries in the European Union were studied by Khatami et al. [19]. The authors proposed an elaborate practical framework which included a reduction in waste generation, recycling in waste circulation, recovery in waste valorisation, and efficiency in resource consumption by the digitalisation of design technology, and education in consumer behaviour. Looking to the future, there was a need for research to measure both consumption behaviour and digitalisation in the circular economy in the management of plastic waste in particular.

In a cross-industry study of the challenges to the more circular use of materials, Salmenpera et al. [20] argued that the current ways of managing waste required revision if material circularity was to increase, and looked to increase understanding of the critical barriers faced by practitioners in the transition towards a more circular economy. Their study of 25 pilots promoting waste prevention in various industries suggested that practitioners did not share a similar vision of the barriers towards transition, but that a more widespread shared awareness of barriers would promote the retention of material value in product life cycles. The findings of the study revealed that illustrating the economic benefits of a circular economy, better sharing of waste-related data, and increasing the dialogue and co-operation between key players could help to increase shared awareness. More generally, the study highlighted that overcoming barriers required recognition of the interlinkages in the product lifecycle.

Recent literature has examined the links between digitalisation and the circular economy [21], and more specifically Sarc et al. [22] explored the use of digitalisation and robotic technologies in waste management. Their focus was on systems that could be used in waste management plants or machines in the future to increase the efficiency of waste management. They examined the sorting of waste via robotic technologies and methods for digital image analysis, and they presented the results of a market survey of online waste companies focusing on their digital readiness. In

conclusion, the authors noted that if the waste management industry was to successfully implement digital technologies and robotics, then waste management systems will need to be co-ordinated with industrial companies and their suppliers.

Zhang et al. [23] also argued that smart technologies could help to bring about a transition to a circular economy in waste management practices. The authors noted, however that such a transformation faced many barriers, particularly at the operational level, and identified, and prioritised, 12 of these barriers. Based on interviews with experienced practitioners, their findings identified three causal barriers: a lack of regulatory pressures; a lack of both environmental education and a culture of environmental protection; and a lack of market pressures and demands. The authors also looked to develop a greater understanding of how the key barriers interacted, and emphasised the importance of involving all stakeholders to facilitate an effective transition to more ecologically, economically and ethically sound waste management systems. Rather similar findings were reported by Aycin and Kaya [24], who employed a literature review and solicited the views of some 20 engineers, principally drawn from waste co-ordinators working for various municipalities, to identify barriers to the development of zero waste management in Turkey. A total of 12 barriers were identified, including deficiencies in the legislation and standards on waste; lack of co-operation between stakeholders; insufficient areas for waste collection and separation; inadequate awareness about the environment; and inadequate recycling techniques. However, the two key causal barriers affecting Turkey's approach to zero waste management were seen to be uncertainty of the goals and tactics relevant to the circular economy and lack of financial and economic aid.

Recent policies adopted by both developed and developing countries on waste-to-energy technologies were reviewed by Rezanian et al. [25]. The authors identified the most successful waste-to-energy technologies, including incineration, landfill, anaerobic digestion, and composting, and summarised both the challenges and barriers for moving towards a circular economy. Their paper suggested that the main challenges facing developed countries were changing consumer behaviour, innovation in business practices, creating opportunities through international cooperation, transitioning towards a circular economy by government support, and the use of renewable materials in the production cycle. In developing countries, some of the main challenges included the need for circularity programs for public awareness, inclusive investment by government agencies, and technology transfer and knowledge sharing from developed countries.

In light of the range of issues raised in the scoping review of relevant literature above, the case study research addresses the following research questions (RQs):

RQ1. What waste management strategies are being adopted by English local authorities?

RQ2. What aspects of sustainability and the circular economy are evident in English local authority waste management practices?

4. Case Study Findings

The case studies presented in this section are drawn from three large cities in different parts of England. Each of the case studies has its own distinctive characteristics, which reflects the approach to waste management adopted by the three city councils. They provide some valuable insights into local authority thinking about, and strategy on, waste management within England.

4.1 Birmingham City Council

Birmingham City Council's waste strategy [11] looks to reduce waste wherever possible; to maximise recycling and re-use, and realise the value of waste; to maximise recovery, where waste cannot be prevented, re-used or recycled, through energy regeneration; to eliminate waste going to landfill; and to ensure that the city's residents play their part in sharing the environmental, economic and social benefits of viewing waste, and utilising it, as a resource.

More specifically, in order to underpin its strategy and to deliver reduction, re-use and recycling, and to inform the design of waste management services, the city council established eight aims and objectives, as set out below:

- To reduce the amount of waste that is created, reusing and recycling where possible, and recovering energy from any remaining waste.
- To recycle 70% of all household and municipal waste by 2040.
- To reduce the amount of waste generated by 10%, compared to the 2014/2015 baseline, by 2025.
- To eliminate waste from landfill by 2040.
- To manage the city's household and municipal waste in a more sustainable way to make a positive contribution to climate change and to help reduce carbon emissions.
- To develop ways of prioritising the collection of recycling (noting that the composition, and types, of waste collected, change over time).
- To improve the city council's services, reduce costs, and use the most appropriate technologies, to manage waste.
- To increase the range of materials collected separately from other waste, and thus to achieve recycling targets and to eliminate waste sent to landfill.

In translating these aims and objectives into action, Birmingham City Council developed a waste plan, guided by four principles, namely a focus on prevention; the creation of a circular economy; working in partnership to reduce and re-use waste; and a focus on maximising recycling and re-use. That said, the city council's detailed appraisal process also identified the important continuing role that energy from waste can to play in helping deliver a waste strategy. In looking to recover energy from waste, the Tyseley Energy Recovery Facility, which is to the south east of the city centre, and whose working lifespan is expected to run until at least 2034, takes some 350,000 tonnes of waste and burns it to produce electricity, the majority of which is fed into the National Grid, is seen to have a key role to play in the overall waste strategy.

In looking to harness community involvement, the city council emphasised the importance of behavioural change, and a waste prevention plan was seen to be an important tool in evidencing how local communities can directly inform best practice, with a programme to target a reduction in food waste being seen as a key priority. At the same time, the city council reported that a range of strong partnership arrangements, including work with large retail and manufacturing companies to reduce packaging, and the development of relationships with local enterprise partnerships to ensure that local companies play a more direct role in the waste management, were already in place within the city. In addressing urban design, the city council will use planning policy to encourage the more sustainable management of waste, and will look to work with developers to identify innovative underground waste storage schemes, and to ensure that adequate access is provided for waste and recycling vehicles.

4.2 Bristol City Council

In outlining its vision for the city's waste strategy, Bristol City Council claimed "we want Bristol to be a city where resource use is minimised, waste production is minimal and that repair and re-use is maximised. We want a city where there is a clean, green, safe and sustainable streetscene for residents and for visitors to Bristol" [12]. More specifically, a zero-waste Bristol was seen to be one where the local authority and businesses recognised waste as a valuable resource; where the focus was on maximising waste prevention, waste reduction, re-use and recycling; and where the local authority would look to actively promote its vision through information, education, and where necessary, enforcement action. For the delivery of this vision, a number of objectives were identified, namely support for the circular economy; the reduction of carbon emissions and the protection of natural resources; increasing public understanding of, and engagement with, waste issues; and maintaining and enhancing the city's streets and neighbourhoods.

Support for the circular economy, for example, was focused on a number of elements. Leading and enabling behavioural change, through a combination of measures that increased both the opportunity and the motivation to prevent, repair, re-use and recycle waste, with a key focus on food waste was seen as a key element. At the same time, the local authority emphasised the importance of developing local markets, encouraging the development of secondary material industries, facilitating the establishment of local repair and re-use schemes, particularly those with employment and training opportunities, and supporting local businesses to reduce, re-use, recycle, or recover energy from waste.

Reducing carbon dioxide emissions and protecting natural resources was also seen as a key objective of the zero-waste strategy. Here three elements were identified. Firstly, reducing the carbon footprint of waste management solutions and services. Secondly, to manage waste in a way that protects human health and the environment, minimising both risks to water, air, soil, flora and fauna and to townscapes, the countryside, and places of special landscape and historical interest. Thirdly, building flexibility into future waste contracts, to provide, where appropriate, waste material to the city council's energy company to generate local energy.

Bristol City Council reported exploring other methods of treating waste, such as energy recovery, and that the potential of recovering energy from waste has grown considerably since the opening of a Mechanical Biological Treatment plant in Avonmouth in 2011. The Avonmouth facility produces a fuel from waste which is then used to power a co-located energy facility that applies methods such as gasification and pyrolysis technologies, and some 25% of Bristol's waste is now converted to energy through these methods.

In looking to deliver its zero-waste strategy, Bristol City Council [12] set a number of what it described as "challenging targets". These were to:

- Produce the lowest amount of residual household waste per person per annum, and to aim for a target of below 130 kilogram of waste per annum by 2025.
- Recycle and prepare for the re-use (including composting) of 50% of waste by 2020 and 70% of waste by 2025.
- Reduce the amount of food waste going in household bins to 10% by 2025.

Ultimately, Bristol City Council recognised that while it had a responsibility to encourage more sustainable behaviour, all the city's residents and businesses have a role to play in waste management. Perhaps more fundamentally, the city council emphasised that "we live in a consumer

led society and we need to learn how to make better choices in what we buy, especially in consideration of choosing low packaging and wasting less food”, that “we can all contribute to implementing this strategy, just by modifying aspects of our behaviour”, and that “if everyone repaired, re-used or recycled an extra item every day, or picked up one piece of litter, this would make a huge impact on waste reduction” [12].

4.3 Newcastle City Council

The vision for Newcastle City Council’s waste strategy is “we want our Newcastle to be a clean, green and sustainable city that wastes less and recycles more” [13]. In developing its approach to waste management, the city council [13] acknowledged its statutory duty to consider the “waste hierarchy”, which lists management options running down from reduction, re-use, and recycling, to recovery to landfill, which is the least preferred option.

More specifically, the city council’s ambitions included:

- Changing the way people, businesses and organisations think about waste
- Building communities where excess waste and litter are socially unacceptable
- Reducing the production of waste
- Maximising the quality and the quantity of re-use and recycling
- Minimising the amount of waste sent to landfill
- Encouraging community and commercial opportunities to use waste as a resource

The city’s vision and ambitions reflected a number of strategic drivers that impact on waste management, including the growth in the city’s population and number of its businesses; growing public awareness in the importance of environmental issues; sustainability and carbon dioxide reduction ambitions; changes in national and local policies; and increasing cost pressures.

The city’s waste strategy has been developed around a number of themes, including behavioural change and education; waste prevention; recycling and composting; planning; recovering value; and public and private partnerships. In focusing upon behavioural change and education, for example, the city council emphasised the development of a number of behavioural change programmes and initiatives that would encourage residents to reduce, re-use and recycle their waste for the long-term benefit of the community. At the same time, the city council introduced a campaign to increase civic pride and to reduce litter and fly-tipping. In addressing waste prevention, the city council claimed that it would lead by example to reduce packaging and the use of single-use plastic, and encourage other organisations to follow suite. More generally, the city council included its preferred options for waste and recycling for new housing and business development in its Planning Guidance.

As part of its waste strategy, the city council outlined its commitment to moving towards a more circular economy, and to its work in generating energy from waste. The city council emphasised that this commitment would not only reduce waste, but also create new opportunities for growth, drive greater resource productivity, deliver a more competitive economy, better address emerging resource security/scarcity issues in the future, and help to reduce the impact of production and consumption. While recovery is low down on the waste hierarchy, Newcastle City Council identified the recovery technologies that would contribute to its waste strategy. The technologies included incineration, anaerobic digestion, gasification and pyrolysis, and all can produce fuels, heat and power.

In 2018, the city council looked to elicit public views, via two questionnaire surveys, on what was, at that time, the local authority’s proposed waste strategy. Though the response to the questionnaires was small, covering less than 0.02% of the city’s population, a variety of opinions and views emerged. The city council and the packaging industry were seen to bear the major responsibility for ensuring recycling. In addressing household waste, the most common themes were that people should buy only what they needed, and that reducing food waste was of particular significance. There was also a strong feeling that the city’s planning authorities should work with developers to try to ensure that new developments should have a target to recycle some 65% of their waste.

5. Discussion

This section draws upon the case study findings to specifically address the two research questions noted in section 3 above, and discusses related themes, which are depicted in Figure 3.

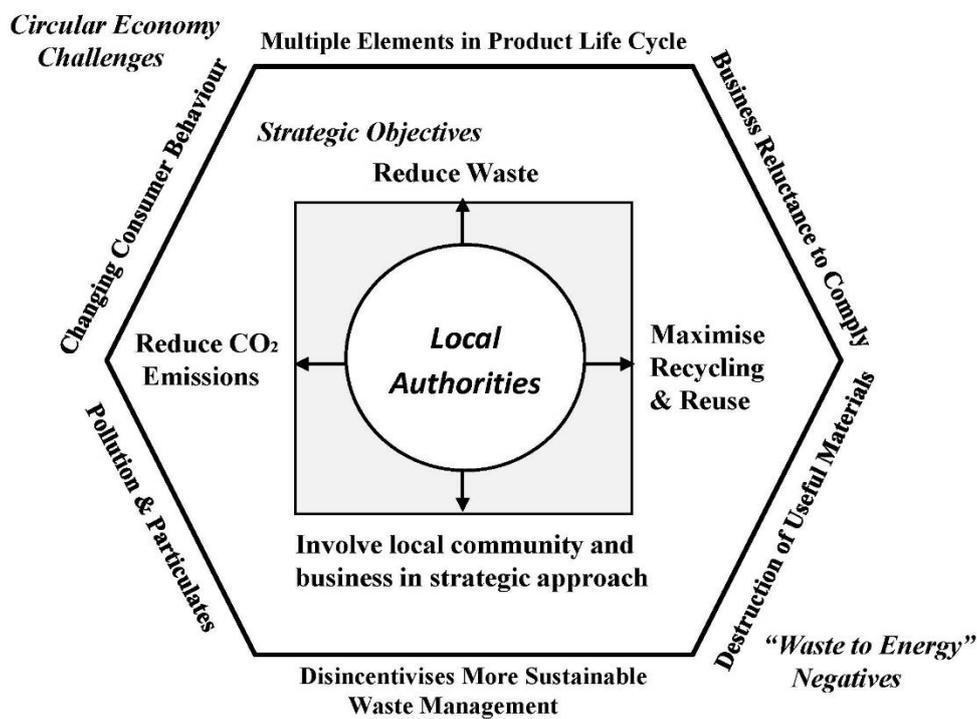


Figure 3 Local authority waste management: objectives and challenges.

5.1 RQ1. What Waste Management Strategies Are Being Adopted by English Local Authorities?

The three case studies focus on very different cities, though many of their waste management problems are the same. While some strategies emphasised distinctive perspectives, there was, perhaps not unsurprisingly, also considerable common ground. On the one hand, Bristol City Council, for example, explicitly recognised the importance of consumption across society in contributing to the generation of waste, and that behavioural change was the key to the city’s waste management problems. They noted in their report, for example, that “if everyone repaired, re-used or recycled an extra item every day, or picked up one piece of litter, this would make a huge impact on waste reduction” [12].

On the other hand, in terms of commonality, there is focus on looking to reduce waste, particularly food waste, to maximise recycling and re-use, to reduce carbon dioxide emissions, and to involving the community and businesses in approaches to waste management. On this last point, for example, Birmingham City Council's strategy includes a number of mechanisms, namely community involvement, partnership working, and urban design, for ensuring that sustainable waste management is embedded in the behaviour of individuals and businesses. Interestingly, there is relatively little reference to the use of digital and other technologies as part of a waste management strategy, although Newcastle City Council do note that technologies (e.g., anaerobic digestion, gasification and pyrolysis) will play a part in generating energy from waste.

At the same time, the three case studies also revealed, albeit in different measure, the city councils' thinking on the role of the circular economy and the generation of energy from waste, in their waste management strategies. As such this reflects some of the literature cited earlier. The circular economy and the generation of energy from waste pose challenges for waste management strategies, and these challenges are outlined below in response to RQ2.

5.2 RQ2. What Aspects of Sustainability and the Circular Economy Are Evident in English Local Authority Waste Management Practices?

For many local authorities, while there is undoubted enthusiasm for moving towards a more circular economy, as epitomised by the case studies, in theory the concept embraces much more than waste management, as waste is but one element in the product life cycle. As such, the circular economy spans all stages of the product life cycle from the design and production process, through marketing and consumption, to waste management cycling and possible recycling and re-use. So defined, it is important to recognise that a transition to a comprehensive circular economy must extend way beyond local authorities. On the one hand, local authorities may possibly be able to bring some influence to bear on local businesses to adopt more circular business models, but such local businesses may be unwilling to jettison their traditional business models in favour of what might be perceived by some as the wider common good. On the other hand, much of the waste that local authorities have to manage was generated from goods produced by businesses with an international, and in many cases a global, reach. Individual local authorities in England have little power to persuade such businesses to adopt a more circular business model. More generally, Dagilienė and Varaniute [26] argued "that organisations transitioning to a circular business model usually face multiple tensions arising from the paradoxical relationship between achieving circularity and creating economic value".

Generating energy from waste also poses a number of challenges. A decade ago, the UK's Department for Environment, Food and Rural Affairs [27] argued that the "visual impact of energy from waste is increasingly recognised as an important issue, and there is a tendency to move away from the big sheds and tall chimney approach towards innovative designs, more in keeping with the local environment" and that "transport links are a key concern for local residents and it is an issue which needs very careful consideration" in that one of the greatest impacts of any waste management site is "the truck movements required to get the waste to the site".

More generally, Guberman [28] has summarised some of the disadvantages of schemes to generate energy from waste, including pollution and the particulates it generates, the destruction of useful materials, and the potential to disincentivize more sustainable waste management

solutions and renewable energy sources". The Tyseley Energy Recovery Facility in Birmingham is reported to be the largest emitter of carbon dioxide in the city. Friends of the Earth Birmingham [29], for example, argued that "energy from waste is the problem and it is not going to become the solution". More generally, pollution and carbon dioxide emissions from waste to energy plants are certainly a cause of public concern, and looking to the future, developing new waste to energy facilities may well only intensify such concerns.

More widely, waste management is intimately bound up with sustainable consumption. England is, as Bristol City Council emphasised, very much a consumer led society, and if major reductions are to be achieved in the waste generated in English cities then radical changes in consumer behaviour, and more particularly in the level of goods and services consumed, will be necessary. At the same time, there are academic concerns about tensions between research agendas about sustainable consumption and the circular economy. Thus, while Welch et al. [30] recognised that many scholars in economic sociology, ecological economics and the degrowth community had looked to reframe sustainable consumption in terms of the circular economy, this in effect meant that many insights into the very nature of consumption had not been pursued.

However, the focus on consumption goes beyond the continuing acquisition of goods per se, in that the purchase and possession of a seemingly ever more sophisticated range of goods is seen to be an important part of the consumer's social values. Thus, an individual's identity may, in part, be forged, for example, by the cars they drive, the regular acquisition of new computing capabilities, furniture, home entertainment and television facilities, and kitchens and bathroom suites. This may, in turn, make it difficult for large numbers of consumers to make fundamental changes to their consumption behaviour. More generally, it remains to be seen how enthusiastically consumers will embrace radical changes in both the frequency and levels of their consumption, not least because it could be seen as a reversal of progress towards a better life, namely one that involves "a sacrifice of our current, tangible needs and desires, in the name of a better but uncertain future" [31].

6. Conclusion

This short exploratory paper offers three case studies of the waste management strategies of large city councils in England. Although there are some studies of waste and biomass energy generation in rural environments [32], there are relatively few of this ilk in urban settings. The case studies add value to existing studies of local authority waste management strategies in that they offer a more extensive picture than Wang et al.'s [7] study, cited earlier, which was based on just one city, namely Nottingham. The findings from the case studies revealed a number of common elements within their waste management strategies, including looking to reduce waste, to maximise recycling and re-use, to reduce carbon dioxide emissions, and to involving the community and businesses in approaches to waste management. At the same time, the case studies also revealed the city councils' commitments to the circular economy, and to the generation of energy from waste. The identification of these common elements serves to strengthen the significance of the case studies in highlighting the contribution local authorities in England are making both to the "Resources and Waste Strategy for England" [5] and to the "Waste Management Plan for England" [6]. As such, the paper makes a small contribution to helping to fill the gap in the academic literature on local authority approaches to waste management identified earlier, and to locating individual local authority waste management strategies into the wider national picture.

While this study is focused on three large city councils in England, it does have wider implications that extend beyond the current study. On the one hand, the three case studies generally reinforce many of the findings from the literature cited earlier. Here, for example, there is empirical support for growing awareness of the importance of the circular economy, and of consumer education, though there is little empirical evidence in the case studies that local authorities are using digital technologies in their waste management operations. More generally, the findings of the case studies can be seen to be linked to the more fundamental issues of sustainable consumption and sustainability, and as such are part of the wider picture of the transition to a sustainable future. Further, while the case studies in this paper are unashamedly empirical, the authors follow Ridder et al. [33] in believing that the findings of the case studies in this paper have the potential to extend and refine theory.

The authors are aware that this paper has a number of limitations. The source material on waste management strategies in Birmingham, Bristol and Newcastle upon Tyne draws exclusively on Internet searches, and there is no attempt to undertake primary empirical research amongst the local authorities' executive officers or their waste management operations staff, or to review documentation that was not posted on the Internet, or to survey residents' consumption behaviour or their views on waste prevention or proximity to energy from waste generation plants. At the same time, the selection of material from the source material was made by the authors. However, the authors believe this is an appropriate approach in what is an exploratory paper. As such, it might also be seen to provide a platform for future research agendas into local authority waste management strategies, that may encompass contrasts and comparisons with other local authority case studies, as depicted in Figure 2. This could entail more detailed empirical research on the waste management strategies being pursued by a larger sample of local authorities in the UK and the European Union, research into the environmental, economic, social, and technological barriers and challenges local authorities face in pursuing such strategies, and how local authorities look to work with their resident populations and with local businesses in developing waste management strategies. There is also scope for further research into the relationship between sustainable consumption and the circular economy, particularly as it relates to waste management strategies, into the potential role of digital technologies in supporting waste management strategies and operations, and to extend and refine theory as suggested above.

Author Contributions

Conceptualization, P.J. and M.W.; methodology, P.J. and M.W.; secondary research, P.J.; formal analysis, P.J. and M.W.; writing—original draft preparation, P.J.; writing—review and editing, P.J. and M.W.; project administration, M.W. All authors have read and agreed to the published version of the manuscript.

Funding

This project received no funding.

Competing Interests

The authors have declared that no competing interests exist.

Data Availability Statement

All data sources are referenced in the text of the article.

References

1. Alves B. Global waste generation - statistics and facts [Internet]. New York, NY: Statista; 2023. Available from: <https://www.statista.com/topics/4983/waste-generation-worldwide/#topicOverview>.
2. Fitch-Roy O, Benson D, Monciardini D. All around the world: Assessing optimality in comparative circular economy policy packages. *J Clean Prod.* 2021; 286: 125493.
3. Kumar A, Samadder SR. A review on technological options of waste to energy for effective management of municipal solid waste. *Waste Manag.* 2017; 69: 407-422.
4. Sakai SI, Yoshida H, Hirai Y, Asari M, Takigami H, Takahashi S, et al. International comparative study of 3R and waste management policy developments. *J Mater Cycles Waste Manage.* 2011; 13: 86-102.
5. Department for Environment, Food and Rural Affairs. Resources and waste strategy: At a glance [Internet]. London, UK: Department for Environment, Food and Rural Affairs; 2018. Available from: <https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england/resources-and-waste-strategy-at-a-glance>.
6. Department for Environment, Food and Rural Affairs. Waste management plan for England [Internet]. London, UK: Department for Environment, Food and Rural Affairs; 2021. Available from: <https://assets.publishing.service.gov.uk/media/60103f71d3bf7f05bc42d294/waste-management-plan-for-england-2021.pdf>.
7. Wang D, He J, Tang YT, Higgitt D, Robinson D. Life cycle assessment of municipal solid waste management in Nottingham, England: Past and future perspectives. *J Clean Prod.* 2020; 251: 119636.
8. Porter AL, Kongthon A, Lu JC. Research profiling: Improving the literature review. *Scientometrics.* 2002; 53: 351-370.
9. Bell E, Bryman A, Harley B. *Business research methods.* Oxford, UK: Oxford University Press; 2018.
10. Gray D. *Doing research in the business world.* London, UK: SAGE Publications Ltd.; 2016.
11. Birmingham City Council. Waste strategy 2017-2040 [Internet]. Birmingham, UK: Birmingham City Council; 2017. Available from: <https://birmingham.cmis.uk.com/Birmingham/Document.ashx?czJKcaeAi5tUFL1DTL2UE4zNRBcoShgo=mLfwA7lajWLupRk5yAHtrTaj5Sa7wvjgdx9zIjwMDiqHdQs7lu%2bXzg%3d%3d&rUzWRPf%2bZ3zd4E7lkn8Lyw%3d%3d=pwRE6AGJFLDNlh225F5QMaQWCtPHwdhUfCZ%2fLUQzgA2uL5jNRG4jdQ%3d%3d&mCTIbCubSFfxsDGW9IXnlG%3d%3d=hFfIUdN3100%3d&kCx1AnS9%2fpWZQ40DXFvdEw%3d%3d=hFfIUdN3100%3d&uJovDxwdjMPoYv%2bAJvYtyA%3d%3d=ctNJfF55vVA%3d&FgPIIEJYlotS%2bYGoBi5olA%3d%3d=NHDURQburHA%3d&d9Qjj0ag1Pd993jsyOJqFvmyB7X0CSQK=ctNJfF55vVA%3d&WGewmoAfeNR9xqBux0r1Q8Za60lavYmz=ctNJfF55vVA%3d&WGewmoAfeNQ16B2MHuCPMRKZMwaG1PaO=ctNJfF55vVA%3d>.
12. Bristol City Council. Towards a zero waste Bristol: Towards a waste and resource management strategy [Internet]. Bristol, UK: Bristol City Council; 2016. Available from:

<https://www.bristol.gov.uk/files/documents/820-towards-a-zero-waste-bristol-waste-and-resource-management-strategy/file>.

13. Newcastle City Council. Waste strategy [Internet]. London, UK: Newcastle City Council; 2019. Available from: <https://www.newcastle.gov.uk/sites/default/files/your-services/Waste%20and%20recycling/Newcastle%20City%20Council%20WASTE%20STRATEGY%202019.pdf>.
14. Ellen McArthur Foundation. The circular economy in detail [Internet]. Cowes, UK: Ellen McArthur Foundation. Available from: <https://www.ellenmacarthurfoundation.org/the-circular-economy-in-detail-deep-dive>.
15. Romero-Hernández O, Romero S. Maximizing the value of waste: From waste management to the circular economy. *Thunderbird Int Bus Rev.* 2018; 60: 757-764.
16. Puntillo P. Circular economy business models: Towards achieving sustainable development goals in the waste management sector—Empirical evidence and theoretical implication. *Corp Soc Responsib Environ Manag.* 2022; 30: 941-949.
17. Neves SA, Marques AC. Drivers and barriers in the transition from a linear economy to a circular economy. *J Clean Prod.* 2022; 341: 130865.
18. Malinauskaitė J, Jouhara H, Czajczyńska D, Stanchev P, Katsou E, Rostkowski P, et al. Municipal solid waste management and waste-to-energy in the context of a circular economy and energy recycling in Europe. *Energy.* 2017; 141: 2013-2044.
19. Khatami F, Vilamová Š, Cagno E, De Bernardi P, Neri A, Cantino V. Efficiency of consumer behaviour and digital ecosystem in the generation of the plastic waste toward the circular economy. *J Environ Manage.* 2023; 325: 116555.
20. Salmenperä H, Pitkänen K, Kautto P, Saikku L. Critical factors for enhancing the circular economy in waste management. *J Clean Prod.* 2021; 280: 124339.
21. Wynn M, Jones P. Digital technology deployment and the circular economy. *Sustainability.* 2022; 14: 9077.
22. Sarc R, Curtis A, Kandlbauer L, Khodier K, Lorber KE, Pomberger R. Digitalisation and intelligent robotics in value chain of circular economy-oriented waste management - A review. *Waste Manag.* 2019; 95: 476-492.
23. Zhang A, Venkatesh VG, Liu Y, Wan M, Qu T, Huisingh D. Barriers to smart waste management for a circular economy in China. *J Clean Prod.* 2019; 240: 118198.
24. Aycin E, Kaya SK. Towards the circular economy: Analysis of barriers to implementation of Turkey's zero waste management using fuzzy DEMANTEL method. *Waste Manag Res.* 2021; 39: 1078-1089.
25. Rezania S, Oryani B, Nasrollahi VR, Darajeh N, Lotfi Ghahroud M, Mehranzamir K. Review on waste-to-energy approaches toward a circular economy in developed and developing countries. *Processes.* 2023; 11: 2566.
26. Dagilienė L, Varaniūtė V. Transitioning to a circular economy: Paradoxical tensions of the circular business model. *Organ Environ.* 2023; 36: 559-589.
27. Department for Environment, Food and Rural Affairs. Energy from waste: A guide to the debate [Internet]. London, UK: Department for Environment, Food and Rural Affairs; 2014. Available from: <https://assets.publishing.service.gov.uk/media/5a7c77ade5274a559005a113/pb14130-energy-waste-201402.pdf>.

28. Guberman R. What is waste-to-energy? [Internet]. New York, NY: RTS; 2021. Available from: <https://www.rts.com/blog/what-is-waste-to-energy/>.
29. Friends of the Earth Birmingham. Why waste incineration is not the future for Birmingham [Internet]. Birmingham, UK: Friends of the Earth Birmingham; 2021. Available from: <https://www.birminghamfoe.org.uk/wp-content/uploads/Why-waste-incineration-has-no-future-in-Birmingham-1.pdf>.
30. Welch D, Sahakian S, Wahlen S. Consumption and society in the 21st century. *Consump Soc.* 2022; 1: 3-10.
31. European Commission. Policies to encourage sustainable consumption [Internet]. Luxembourg: Publications Office of the European Union; 2012. Available from: <https://op.europa.eu/en/publication-detail/-/publication/b1a0f465-c37e-4440-8302-151140bd818d>.
32. Yin S, Zhao Z. Energy development in rural China toward a clean energy system: Utilisation status, co-benefit mechanism, and counter measures. *Front Energy Res.* 2023; 11: 1283407.
33. Ridder H-G, Hoon C, McCandless A. The contribution of case study research to the field of strategy and management. In: *Research methodology in strategy and management (Vol. 5)*. Leeds, UK: Emerald Group Publishing Limited; 2009. pp. 137-175.