

University of Wales Trinity St David

Research Proposal

Assessing the impact of changes to the waste and recycling services on the recycling rates and residents' recycling behaviour in Pembrokeshire

Laura Davies (1905575)

Table of Contents

1. Introduction	3
2. Literature Review	6
2.1 Options for Waste and Recycling Management	6
2.2 Waste and Recycling Management in Wales	8
2.3 Factors Affecting Recycling Behaviour	8
2.4 The Waste Hierarchy and the limitations of Recycling	11
3. Methodology	14
4. Evaluation of Research	15
5. References	16

1.Introduction

The world is facing diminishing natural resources, plastic-choked oceans and rising global temperatures. Waste management processes are an opportunity to make more sustainable use of these limited resources, reduce the impact of plastic on our natural environment whilst at the same time reducing emissions of greenhouse gases.

In 2016, the waste management sector was responsible for 5% of global greenhouse gases, primarily in the form of methane released from the decomposition of biodegradable waste in landfill, approximately 1.6 billion tonnes of carbon dioxide-equivalent (CO₂-equivalent) were released into the atmosphere and the sector had to cope with the 242 million tonnes of plastic waste created across the globe, 12% of all municipal solid waste. (Kaza et al 2018)

It was estimated that an effective waste management and promotion of waste prevention could lead to a 10 to 20% reduction in global greenhouse gas emissions (UNEP, 2015).

The European Union (EU) has legislated to tackle the use of landfill, to reduce waste and increase recycling. The Waste Framework Directive 2008/98/EC (rWFD) (EU, 2008) requires member states to reuse and recycle at least 50% of their household waste by 2020. In the United Kingdom, local authorities have a legal duty under the Environmental Protection Act 1990 (Section II, Part 45) to collect household waste. Within its 2010 strategy document Towards Zero Waste, the Welsh Assembly Government set targets for the recycling of Welsh household waste and the Waste (Wales) Measure 2010 Act introduces financial penalties for councils that fail to meet these recycling targets. By 2020, Welsh councils must recycle of 64% of collected waste and 70% by 2025.

The Well-being of Future Generations (Wales) Act 2015, obliges public bodies such as local authorities to consider the long-term impacts of their decisions, ensure they are sustainable and contribute to the goals within the Act.

Sustainable waste management strategies contribute to 3 of the 7 goals of the Well-being of Future Generations (Wales) 2015 Act.

A prosperous Wales	An innovative, productive and low carbon society which recognises the limits of the global environment and therefore uses resources efficiently and proportionately (including acting on climate change); and which develops a skilled and well-educated population in an economy which generates wealth and provides employment opportunities, allowing people to take advantage of the wealth generated through securing decent work.
A resilient Wales	A nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change).
A globally responsible Wales	A nation which, when doing anything to improve the economic, social, environmental and cultural well-being of Wales, takes account of whether doing such a thing may make a positive contribution to global well-being.

2 of the 46 National Indicators of the Well-being of Future Generations (Wales) Act 2015 directly impacted by waste management strategies.

15. Amount of waste generated that is not recycled, per person.

41. Emissions of greenhouse gases within Wales.

Figure 1: Elements of Well-being of Future Generations (Wales) 2015 ACT impacted by waste management strategies.

In 2017 Pembrokeshire County Council(PCC) conducted a review of its existing waste and recycling services and concluded that significant change was unavoidable and as such the Council should seek to move towards a service that is as future-proof as possible, to avoid the risk of piecemeal and reactive change in future.(P.C.C. 2017) Whilst the council had so far met government recycling targets, recycling rates had plateaued over the last few years and it was not felt that the council would be able to meet increasingly challenging targets in the future with the current WRS set up. Through the Welsh Government's Collections Blueprint and Collaborative Change Programme (W.A.G. 2011) planning and financial support was available to enable county councils to make the changes necessary to meet current and future legislated targets.

Welsh Assembly Government programmes for the support of local authority waste and recycling services (WRS)	
Municipal Sector Plan Part 1 Collections Blueprint. March 2011.	The Collections Blueprint sets out the Welsh Government's recommended service profile for the collection of waste from households. The Blueprint relies on the collection of recyclable resources that are presented part-segregated by residents. Those resources are then further sorted by operatives as they are collected. The Collections Blueprint provides councils with one way of complying with the legislation on kerbside collection.
Collaborative Change Programme 2011	Strategic funding and technical support to help local authorities develop and deliver detailed plans to achieve the outcomes of the Wales Waste Strategy - Towards Zero Waste. Administered by WRAP (Waste and Resources Action Programme)

Figure 2: Welsh Government support programmes for developing WRS

The Council estimated that its fines would be circa £140,000 for every single percentage point below the target under the Waste (Wales) Measure 2010 Act. The target of 64% could lead to a potential fine of £840,000 in 2019. (WWG PCC 2018)

In addition, the council had identified targeted savings of £510K (2019-20) and £241K (2020-21) from increased recycle income and a reduction in disposal gate rates. (P.C.C. 2018)

In 2019, under the WAG's Collaborative Change Programme, PCC received £720,730 to transform its waste and recycling collection to a kerbside sort system with specialised multi-compartmentalised collection lorries.

Pembrokeshire County Council's new Waste and Recycling Service (WRS)	
June 2019	Introduction of residual waste checks at all waste and recycling centres (civic amenity sites). Residual waste bags automatically opened and checked for potential recyclable contents.
September 2019	Fortnightly absorbent hygiene products collections from registered properties.
November 2019	Introduction of a three-weekly residual waste collection. Restricted to three supplied transparent grey bags per property. (Equivalent to one bag per week).
November 2019	Roll-out of new weekly kerbside sort collection.

Figure 3: Timescale of WRS rollout

The purpose of this research is to assess the ability of the new scheme to meet future recycling targets; to analyse which elements of the scheme or interventions by the council had most impact on householder waste management behaviour and to identify if householders feel there was any behavioural spill-over from the scheme, such as changing their purchasing habits to reduce waste and increase recycling. Introducing a new waste and recycling service to meeting increasingly challenging targets is costly, at a time when councils are under huge financial pressure and ultimately requires huge cooperation and ‘buy-in’ from householders to be successful. My research will address whether this scheme has been successful and which elements did householders feel were most effective in enabling them to increase the amount of their household’s recycling and reduce the amount of residual waste, in order to establish if the approach of Pembrokeshire County Council is one that should be replicated across other local authorities in Wales and beyond.

Original waste collection scheme



Weekly co-mingled recycling



Weekly food waste



Fortnightly glass



Fortnightly unlimited residual waste

New Kerb-sort scheme from November 2019



3 weekly residual waste



Weekly Food waste



Weekly Glass



Weekly Cardboard



Weekly Plastics and metals



Weekly Paper



Also optional fortnightly Absorbent Hygiene Products (AHPs)

Figure 4: Changes to the WRS at Pembrokeshire County Council.

2. Literature Review

2.1 Options for Waste and Recycling Management

The arrival of municipal waste as we know it today is a relatively recent phenomenon. It evolved in developed countries out of the post-war prosperity, expansion of the petrochemical industry (and the development of new plastics) and the resulting boom in the development of short and long-lived consumer products in the 1950s and 60s. The management of waste only came onto the political agenda in the late 60s driven by its impact on society and the emerging need for environmental protection. (Cimpan et al 2015)

Across the UK, Europe and beyond there are as many schemes as there are municipal authorities. Since the introduction of waste management techniques in the second half of the 20th century, there have been two main methods for the recovery of recyclable materials; through source separation in the household followed by separate collection schemes or through the centralised mechanical processing of mixed waste.

Centralised processing of mixed waste or mixed recyclates rely on specialist technology to be able to separate materials into separate streams for reuse. In the early 1990s, many areas in the United States developed mixed waste recovery plants but this led to low recovery rates and economic and operational challenges leading to this system being largely abandoned. (Cimpan et al 2015)

In Europe in the 70s early attempts at extracting resources such as compost and other recyclable materials from mixed waste through physical processes built on agricultural and mining processes struggled to produce material of sufficient quality and free from contaminants. (Pretz 2000) This led to a focus on source separation and collection as being regarded as more feasible across mainland Europe and remains the case today.

“Separate collection of individual waste fractions is seen as a pre-condition for fostering high quality recycling and high recycling rates” (BiPRO/CRI 2015) and European legislation such as the Article 10 of the Waste Framework Directive stipulates a requirement for source separation, focussing on the priority waste streams of metal, plastic, glass, paper/card and food/compostable waste. Even with such focussed legislation in Europe, a wide range of different systems have been developed from co-mingled bags of recyclables, separate containers for each stream to drop off centres for glass. In its study of the 28 capital cities across Europe, as a way to compare waste and recycling management in European countries, BiPRO/CRI 2015 inevitably misses the different approaches taken within the devolved nations, including Wales, and therefore probably misses other regional variations within each country.

The BiPRO/CRI report recommends strict separate collection (one recyclable in one bin) because the quality of the collected material is better and rejection rate is lower. The co-mingled approach can work, but the collected material can only be sorted to produce clean fractions if there is very little unwanted contamination - reducing contamination/ “sorting mistakes” in the co-mingled bin and during transportation is the largest challenge. The trend in recyclate markets is likely to be towards requiring higher quality materials particularly as China followed by other far east countries are now refusing to accept plastic for recycling coming out of the West.

However, the Environment Agency concluded that ‘co-mingled collections are the main collection method in England and are likely to remain so’ (Environment Agency 2016), despite the fact that England in 2018 had not reached 45% recycling of household waste (DEFRA 2018b) nor was likely to reach the EU 50% target by 2020 according to the Environment, Food and Rural Affairs (Efra) Committee (Parliament, 2014).

Legislation for mandatory separate food waste collections in England is not due until 2023 subject to consultation. (DEFRA 2018a)

There is a financial cost to co-mingling; UK Resource Associations asserted that “Co-mingled waste collection coupled with poor sorting at many UK Material Recovery Facilities (MRFs) are responsible for high contamination rates of materials destined for recycling, costing the UK recycling industry in excess of 50 million pounds annually (UK Association 2012).

Reduce, reuse and recycle are the basic principles of Japan’s waste management and recycling policy. It inaugurated a policy programme entitled ‘Sound Material–Cycle Society’ to facilitate recycling and waste reduction at national and local levels (‘Basic Law for Establishing Sound Material Cycle Society’; 2000).

Collection type	Paper	Glass	Plastic	Metal	Bio-waste
Door-to-door (single fraction) 	AT, BE, BG, CY, DE, DK, FI, HU, IT, LU, LV, NL, SI, UK	BG, FI, LU, LV, NL, SI, MT	AT, LV, NL, DK	FI, NL, DK	AT, BE, CZ, DE, FI, EE, IT, HU, LU, NL, SI, SE, IE, UK
Co-mingled ...plastic + metal 			BE, BG, CY, DE, FR, IT, HU, LU, SI		
...3 fractions	RO, MT: paper, plastic, metal UK: plastic, metal, glass				
...all in one bin	EL, IE: paper, glass, plastic, metal				
Bring points 	CZ, EE, ES, FR, HR, LT, PT, PL, SE, SK	AT, BE, DK, CY, CZ, DE, EE, ES, FR, HR, IT, HU, LT, PT, PL, RO, SE, SK	SE	AT, EE, SE	ES
			ES, HR, LT, PT, PL (all plastic/metal in one container)		
Civic amenity sites 	Primary collection: CZ (metal waste), SK (metal and bio-waste), LV (metal) Addition collection of all waste streams: all countries PL: rare distribution of civic amenity sites				

Figure 5: Overview of collection systems in place in the 28 EU countries from BiPRO/CRI 2015

2.2 Waste and Recycling Management in Wales

Since 1999 Wales has increased its household recycling rate from 5.2% to 60.7% making Wales the third highest household recyclers in the world. (Eunomia 2017)

It has reduced household food waste by 12% between 2009 and 2015 by legislating for mandatory separate food collection and is now set to increase its recycling target to 80% in 2034-35 pending consultation. (WRAP 2015)

Wales has demonstrated innovation in the items collected for recycling including mattresses and hygiene products such as nappies but the government acknowledges that half of the household residual waste that remains can still be recycled, with half of that being food waste (Beyond Recycling 2019)

Currently 13 out of 22 local authorities have adopted Welsh Government's Collections Blueprint for a kerbside sort system.

Collection method ¹	Number of councils using method in 2011-12	Number of councils using method in 2016-17
Collections Blueprint ²	3	11
Kerbside sorted (but not fully Collections Blueprint in other areas of service) ³	5	1
Twin-stream	5	3
Multi-stream	2	1
Co-mingled	7	6

Notes:

- 1 Data is for the system predominantly used by each council during the year.
- 2 In practice, not all councils categorised as 'blueprint' operated all aspects set out in the Welsh Government's service configuration for the Collections Blueprint. For example, on collection crew level, charging for garden waste collection, free provision of food caddy liners or promotion of home composting.
- 3 The Council still shown as kerbside sorted but not fully Collections Blueprint is Torfaen County Borough Council. The Council began to move towards the Collections Blueprint in 2015-16 but has yet to change its recycling collection vehicles to those preferred in the Blueprint. The Welsh Government considers that the Council should not yet be regarded as having adopted the Blueprint for the purpose of comparison.

Figure 6: Comparison of the methods that Welsh councils used to collect recyclable resources from Wales Audit Office 2019

2.3 Factors Affecting Recycling Behaviour

What is the best approach to take with householders when it comes to implementing a new household waste system? What behaviours, incentives or even penalties are most likely to improve recycling rates? Knowing how individual behaviours can be influenced is vital for the planning and roll-out of new waste services aimed at increasing recycling rates.

Dai, Gordon, Ye, Xu, Lin et al. (2015) suggest that for recycling to become successfully established it is necessary to have processing facilities, demand for products, commercial possibilities, collection infrastructure and appropriate legislation and enforcement and even these are not sufficient without the engagement and cooperation of residents.

The participation of households is key to the high recovery of good quality recyclables without the need for further sorting. (Carreno and Suarez 2010). The more streams that can be efficiently separated without the need for additional sorting and correction at collection centres the cheaper the recycling process can be made.

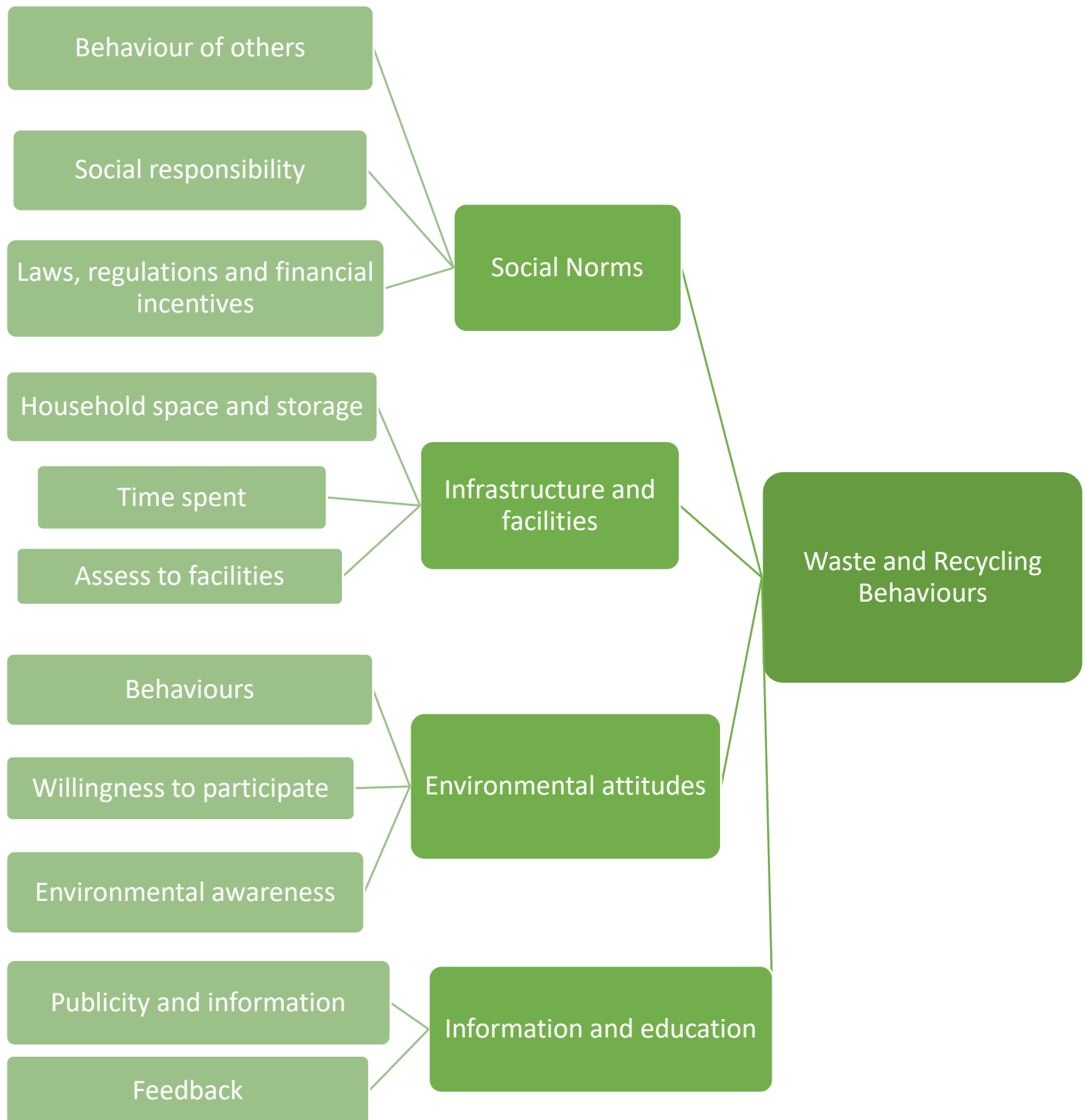


Figure 7: Factors impacting individual recycling behaviour adapted from Meng et al (2019)

Environmental Awareness

Garcés et al. 2002 found that residents with “personal environmental awareness and knowledge of the environmental damage caused by urban waste will better prompt them towards waste recycling behaviour” however, many behavioural studies do not pay special attention to the discrepancy between intention and actual behaviour around waste sorting. (Zhang et al 2019)

Despite China’s historic role as a depository for much of the West’s recycling material it has so far not managed to tackle its own lack of recycling. As recently as 2015, only 2% of solid waste was sorted and

recycled, with 78% going to landfill (Chen et al 2015). In research carried out in Tai'an City one of the first pilot cities for waste sorting in China, Zhang et al (2019) found that personal attitudes (personal norm) such as an awareness of environmental issues was much more important than the attitudes and influence of others (subjective norm) with regard of their intention to recycle but even though many residents intended to participate in waste sorting, many still fell short. Their results suggest that to move from intention to action was dependent on facility accessibility and stimulus such as advertising and that even having strong intentions towards sorting waste was not enough to overcome lack of access to facilities and even those with no intention to sort their waste did so if faced with good facilities at the kerbside.

Practical aspects of the scheme

As the Pembrokeshire scheme is a kerbside collection all residents will have the same opportunity to take part however what impact will the change in frequency of the collection of both the residual and recycled waste have? Gellynck et al (2011) found that changing from weekly to fortnightly collection of residual waste and separate kerbside collection of organic waste increased a municipality's change of increasing recycling rates.

However, factors that might impact on success include the practicalities for different groups of householders regarding the number and size of sorting receptacles and home storage space. "If a recycling bin is full, many residents will simply throw their excess recyclables away with their garbage". (Lane and Wagner, 2013) Adequate space for temporary storage of sorted materials can be another aspect of accessibility that can increase the rate of waste sorting and recycling behaviour (Ando and Gosselin, 2005). Will the scheme work as well for urban householders with a lack of outdoor space as rural householders with ample space? Williams and Kelly (2003) suggest "There is no single, ideal design and the characteristics and needs of the community should dictate the scheme's design (Williams and Kelly, 2003).

Information and Education

The success of the Pembrokeshire scheme will depend on how well it engages with residents and through what channels. While people may be aware that recycling programs exist, those that lack information typically do not seek it out (Andersson and Borgstede, 2010). They further state that leaflets or environmental newsletters are the most effective print forms for encouraging recycling.

A Dutch information strategy called '100-100-100' (with aim of getting 100 households to live 100% waste free for 100 days) which included residents signing up to a programme, an information evening, being given assignments, challenges and tips to reduce household waste and increase amount of recycling was shown to be effective at increasing waste prevention behaviour, reducing the overall amount of residual waste produced and the amount of incorrectly sorted waste was reduced. (Van der Werff et al 2019)

In their study of the waste reduction and recycling initiatives of Yokohama and Kamakura it was found that the public awareness campaign for source separation which involved face-to-face meetings between city officials and the public, as well as inclusion in school curricula, was the key to raising and maintaining high recycling rates. (Hotta and Aoki-Suzuki 2014)

Social Norms

During their review, for the European Commission, of European capitals BiPRO/CRI 2015 found that the implementation of a Pay-As-You-Throw (PAYT) for residual waste collection is one of the main success factors for reducing the amount of residual waste by increasing the sorting of recyclates by householders. Whilst Pembrokeshire County Council has limited the households to three bags of household waste to be collected every three weeks, it does not currently limit residual waste taken to waste and recycling centres, which benefits vehicle owners. Maybe to further encourage residents to extract the maximum amount of recycling out of household waste to reach future targets, there will be a charge for household waste at WRCs.

However as recently as 2019 Defra reiterated the law with regard to English local authorities charging for the use of WRC, in response to a number of local authorities expanding the items they charge for at civic amenity sites, that disposing of household waste, including waste from DIY home improvement projects, should be free of charge.” The Local Authorities (Prohibition of Charging Residents to Deposit Household Waste) Order 2015 prohibits English local authorities from charging residents to enter or exit a WRC or from depositing household waste. As the legal frameworks of the devolved nations continues to move apart it may be that schemes that are successful in one municipality are not transferrable because of the different policy barriers and laws. (Husaini et al 2007)

In 2017, the Welsh Government consulted on new powers to use fixed penalty notices, and extended producer responsibility, to increase recycling and is committed to supporting councils to use existing powers in section 46 of the Environmental Protection Act 1990 to sanction those who put recyclable materials in residual waste containers or contaminate containers intended for recyclable materials. The use of these powers for this purpose has not yet been tested in the courts. (W.A.G 2017)

Financial motivation also can play a part in changing behaviour. A study of Wales’s Single Use Carrier Bag Charge(SUCBC) introduced in 2011 showed that whilst this caused an immediate increase in the use of shoppers’ own bags, with 74% of respondents always taking their own bag (a 25% increase against no change in England and Scotland), this didn’t lead to a significant behavioural spill-over with only small increases into other pro-environmental behaviours that were weaker than the increases in England and Scotland where there was no SUCBC. (Thomas et al 2016)

The Welsh Government is also proposing to work with other governments in the UK to develop legislation for a Deposit Return Scheme (DRS) for drinks containers. Single use drink containers are often purchased and disposed of whilst people are out and about and less likely to end up in household recycling than other plastics. (Beyond Recycling 2019)

2.4 Waste Hierarchy and the limitations of recycling

“Wales has transformed from a nation which recycled less than 5% of its municipal waste, to become an international leader that recycles 63%. Put simply, it’s what we do.” (Beyond Recycling 2019)

Wales being regarded as the 3rd leading nation in the world for recycling household waste has arguably become one of the Welsh Assembly Government’s most repeated statements to demonstrate the benefits of devolution in a political landscape where it seeks to broaden its powers over aspects of decision-making

still controlled from Westminster. It has undoubtedly been successful but the recent launch of the Beyond Recycling consultation is an acknowledgement that there are consequences to focusing solely on weight-based recycling targets at the expense of waste reduction and reuse which are higher up on the waste hierarchy. The language of Beyond Recycling is about moving towards a circular economy which prioritises waste reduction and reuse.

“A weight-based target provides no direct measure of sustainability and does not specifically prioritise the recycling of wastes that have the most effect in reducing Wales’ carbon footprint. In addition, a weight-based recycling target does not prioritise recycling of resources that are valuable because they are particularly scarce, and these targets can even have the opposite effect.” (Wales Audit Office 2018)

Can the new set-up in Pembrokeshire adapt if there is a shift away from the focus on weight-based targets? Ricardo Energy & Environment have noted that high recycling levels do not determine overall carbon performance and that weight-based measurement has encouraged councils to ‘chase’ certain heavier waste materials, in particular garden waste, despite arguably marginal environmental benefits.

“The strong promotion of kerbside garden waste collection in response to the need to raise recycling performance has meant that, in our experience since 2012, councils now give less prominence to home composting.” (Wales Audit Office 2018)

Most favoured option

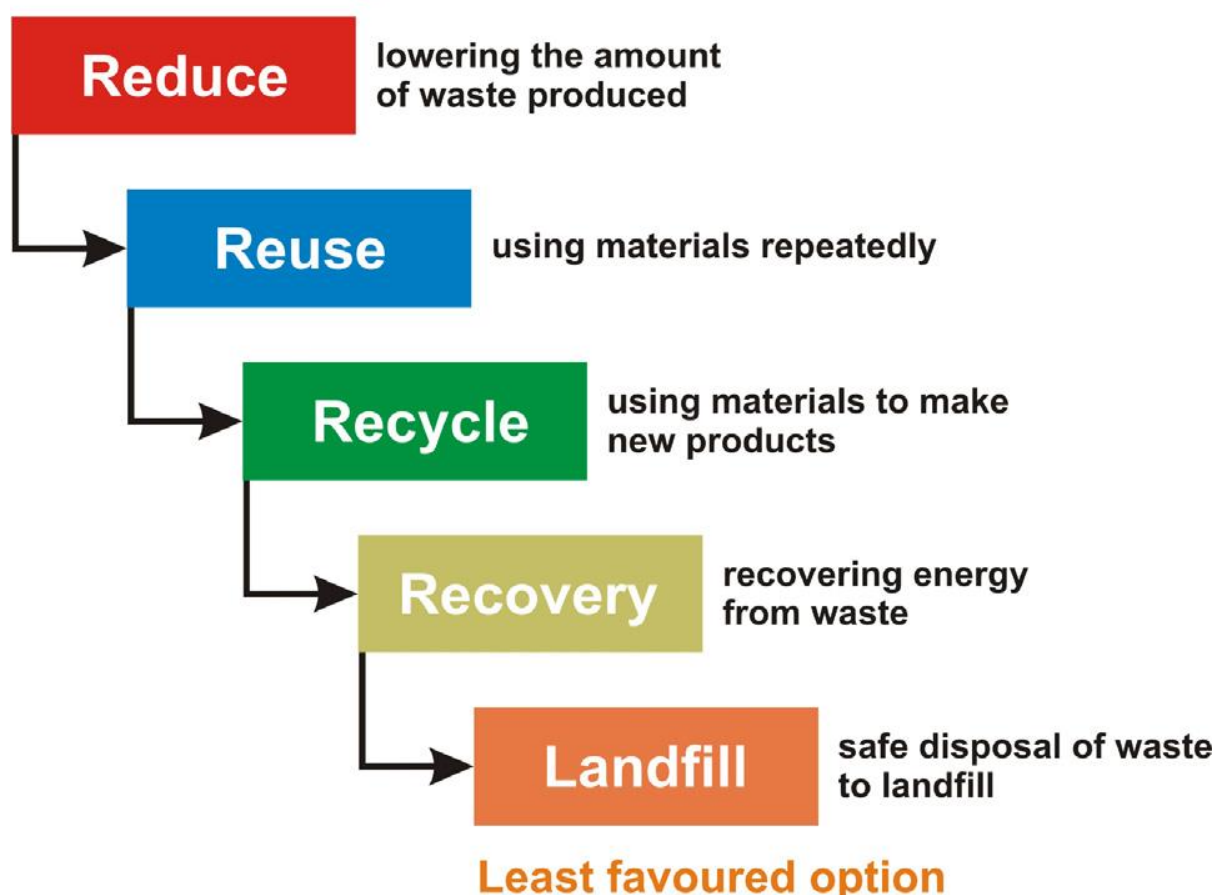


Figure 8: The Waste Hierarchy (EU Waste Framework Directive, 2008)

The percentage of household waste recycled in Wales (2018-2019) that is organic waste ranges from 15.1% in Ceredigion to 27.8% on Anglesey (Pembrokeshire 21.3%). (Welsh Government 2020) Welsh Government

applies the same recycling target to all councils, but until 2017-18 the combined recycling rate across rural areas had been consistently higher than for valleys areas and urban areas. Rural councils have the opportunity to collect larger quantities of garden waste because their householders are more likely to have gardens whereas arguably councils should be encouraging home composting as much as possible.

The Welsh Government has set targets for annual waste reduction of 1.2% per year which councils are currently meeting but the UK has been undergoing a decade of relatively low economic growth following the recession of 2008. Traven et al (2018) demonstrated that waste generation is strongly correlated with Gross Domestic Product (GDP). It may be that the challenging targets that have been set for councils have been achieved because households have simply not been generating the level of waste, due to constrained household finances caused by low wage growth and freezes and cuts to benefit payments, that may be generated during a time of strong economic growth. The Welsh Assembly Government states that we need to break the link between waste generation and economic growth. Since 2009/10 household arisings have been reduced by 1.8% per year but how much of this is a symptom of economic activity and how much due to improvements in waste management and household behaviour? In a thriving economy will the changes Pembrokeshire have made be sufficient to achieve the recycling targets.

Between October 2015 and September 2018, the Welsh Government gave £13 million to three not-for-profits with objectives that include, but not limited, to waste prevention. This amount is dwarfed by the nearly £1billion it has spent on recycling infrastructure. (Wales Audit Office 2019)

Most studies test if intervention strategies promote waste reduction do so by testing if the strategy increases the amount of recycled materials or the number of participants in a recycling scheme (Varotto and Spagnolli, 2017) concentrating on recycling at the expense of waste reduction and reuse which are further up the waste hierarchy so it is not just political leaders who have focused on recycling but researchers too and for a similar reason. It is easier to quantify approaches that volume recycling weight than impacts on waste reduction and reuse.

Methodology

Survey of Householders

I will produce a questionnaire of approximately 10 - 15 questions to assess what elements of the scheme or communication of the scheme householders believed most impacted on their waste management and recycling behaviour using a Likert scale. I will look at the impact of the ease of use, the limiting of residual waste bags, the introduction of checks at waste and recycling centres, clarity of council information and communication streams, use of new household recycling receptacles, increased participation, use of waste and recycling centres and whether householders feel the new system has changed their buying habits or attitude to recycling or reuse and any reduction in residual waste compared to prior the scheme.

I intend to target between 100 and 150 households by doing a mix of town centre face-to-face surveys, at a variety of times to target a range of demographics and if necessary by going door-to-door in a mix of addresses across rural and urban settings. There is also the option of surveying users one of the waste and recycling centre to target the impact of changes there.

All surveys will be anonymous and no personal data will be recorded.

I will then apply an exploratory factor analysis (EFA) in order to merge behaviour items and identify common factors.

Qualitative Assessment of new Waste and Recycling Scheme

Council figures are available quarterly to assess the volumes of recycled material and residual waste. These will demonstrate whether there are any variations in the recycling rates of the different recycling streams.

A PESTLE (political, economic, social, technological, legal and environmental) analysis will be carried out to critique and evaluate the scheme as a case study which will provide a framework to assess the ability of the scheme (or elements of) to be transferred to other local authorities. I will evaluate its use of new technology and any demonstration of innovation, the quality and methods of communication and feedback, incentives or penalties, use of demonstrations or social-modelling, impact on waste and recycling targets and opportunities for pro-environmental behavioural spill-over of residents.

Evaluation of Research

Limitations

Whereas a Likert scale questionnaire is straightforward to carry out, there is an issue with inaccuracy inherent in self-reporting. The effects of time and memory, lack of understanding and willingness to be honest especially when asked in person can influence results, also self-reporting of behaviour may not always be strongly related to actual behaviour as people may answer in a socially desirable way. (Corral- Verdugo, 1997)

There are also potential issues with the randomness of questioned householders and missing hard to reach demographics which maybe could be overcome by using a larger scale survey of random addresses with a paid-for return but this would be cost prohibitive.

The assessment of the scheme is also being completed as a case-study, the ability to recommend elements of the scheme may be more reliable if several different schemes were compared from rural and urban councils.

I believe this research is timely and relevant, local authorities are cash-strapped and waste management is a significant proportion of council costs at a time when council budgets are being cut, whilst recycling and waste reduction targets are increasing.

I believe the research also begins to address one of the concerns with what has been a narrow focus on recycling rates as a marker of success which undermines the importance of waste prevention and re-use as shown in the waste hierarchy, by looking at the potential change in householder's approach to waste and purchasing habits and the much-needed reduction in overall volume recycling and residual waste.

The research is feasible within the timescale available and it can be carried out over a relatively short timetable. This research will evaluate a significant new waste and recycling scheme and that will add to the knowledge of the impacts of different waste management policy instruments which is relevant for other local authorities in Wales and beyond.

References

- Andersson, M., & von Borgstede, C. (2010). Differentiation of determinants of low-cost and high-cost recycling. *Journal of Environmental Psychology*, 30(4), 402–408.
<https://doi.org/10.1016/j.jenvp.2010.02.003>
- Ando, Amy W, & Gosselin, Anne Y. (2005). RECYCLING IN MULTIFAMILY DWELLINGS: DOES CONVENIENCE MATTER? *Economic Inquiry*, 43(2), 426–438. <https://doi.org/10.1093/ei/cbi029>
- BiPRO/CRI 2015, Assessment of separate collection schemes in the 28 capitals of the EU, Final report, November 2015. BiPRO and the Copenhagen Resource Institute (CRI) in cooperation with ENVIRON, ENVIROPLAN, Geotest and ACR+ report for European Commission.
https://ec.europa.eu/environment/waste/studies/pdf/Separate%20collection_Final%20Report.pdf
- Chen, S.J., Ru-Chun, L.I., Yong-Bin, M.A., 2015. Paradox between Willingness and Behavior: Classification Mechanism of Urban Residents on Household Waste. *China Population Resources & Environment*.
- Cimpan, C., Maul, A., Jansen, M., Pretz, T., & Wenzel, H. (2015). Central sorting and recovery of MSW recyclable materials: A review of technological state-of-the-art, cases, practice and implications for materials recycling. *Journal of Environmental Management*, 156, 181–199.
<https://doi.org/10.1016/j.jenvman.2015.03.025>
- Cimpan, C., Rothmann, M., Hamelin, L., & Wenzel, H. (2015). Towards increased recycling of household waste: Documenting cascading effects and material efficiency of commingled recyclables and biowaste collection. *Journal of Environmental Management*, 157, 69–83.
<https://doi.org/10.1016/j.jenvman.2015.04.008>
- Corral-Verdugo, V. (1997). DUAL 'REALITIES' OF CONSERVATION BEHAVIOR: SELF-REPORTS VS OBSERVATIONS OF RE-USE AND RECYCLING BEHAVIOR. *Journal of Environmental Psychology*, 17(2), 135–145. <https://doi.org/10.1006/jevp.1997.0048>
- Dai, Y. C., Gordon, M. P. R., Ye, J. Y., Xu, D. Y., Lin, Z. Y., Robinson, N. K. L., Woodard, R., & Harder, M. K. (2015). Why doorstepping can increase household waste recycling. *Resources, Conservation and Recycling*, 102, 9–19. <https://doi.org/10.1016/j.resconrec.2015.06.004>
- DEFRA. (2018a). Our waste, our resources: a strategy for England. *HM Government*, 1–146.
www.nationalarchives.gov.uk/doc/open-government-licence/version/3/oremailPSI@nationalarchives.gsi.gov.uk
- Defra (2018b), UK Statistics on Waste
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/683051/UK_Statisticson_Waste_statistical_notice_Feb_2018_FINAL.pdf
- Environment Agency 2016. Waste collection authority separate collection arrangements: survey results, Version 1, January 2016
- Eunomia and European Environmental Bureau (2017), Recycling – who really leads the world?
<https://www.eunomia.co.uk/reports-tools/recycling-who-really-leads-the-world-issue-2/>

- Garcés, C., Lafuente, A., Pedraja, M., & Rivera, P. (2002). Urban waste recycling behavior: Antecedents of participation in a selective collection program. *Environmental Management*, 30(3), 378–390. <https://doi.org/10.1007/s00267-002-2601-2>
- Gellynck, X., Jacobsen, R., & Verhelst, P. (2011). Identifying the key factors in increasing recycling and reducing residual household waste: A case study of the Flemish region of Belgium. *Journal of Environmental Management*, 92(10), 2683–2690. <https://doi.org/10.1016/j.jenvman.2011.06.006>
- Hotta, Y., & Aoki-Suzuki, C. (2014). Waste reduction and recycling initiatives in Japanese cities: Lessons from Yokohama and Kamakura. *Waste Management and Research*, 32(9), 857–866. <https://doi.org/10.1177/0734242X14539721>
- Husaini, I. G., Garg, A., Kim, K. H., Marchant, J., Pollard, S. J. T., & Smith, R. (2007). European household waste management schemes: Their effectiveness and applicability in England. *Resources, Conservation and Recycling*, 51(1), 248–263. <https://doi.org/10.1016/j.resconrec.2006.09.009>
- Kaplan Mintz, K., Henn, L., Park, J., & Kurman, J. (2019). What predicts household waste management behaviors? Culture and type of behavior as moderators. *Resources, Conservation and Recycling*, 145(September 2018), 11–18. <https://doi.org/10.1016/j.resconrec.2019.01.045>
- Lane, G. W. S., & Wagner, T. P. (2013). Resources, Conservation and Recycling Examining recycling container attributes and household recycling practices. *Resources, Conservation & Recycling*, 75, 32–40. <https://doi.org/10.1016/j.resconrec.2013.03.005>
- Meng, X., Tan, X., Wang, Y., Wen, Z., Tao, Y., & Qian, Y. (2019). Investigation on decision-making mechanism of residents' household solid waste classification and recycling behaviors. *Resources, Conservation and Recycling*, 140(June 2018), 224–234. <https://doi.org/10.1016/j.resconrec.2018.09.021>
- Miranda, R., & Blanco, A. (2010). Environmental awareness and paper recycling. *Cellulose Chemistry and Technology*, 44(10), 431–449.
- Parliament, 2014b. Waste Management in England, Available from: <http://www.publications.parliament.uk/pa/cm201415/cmselect/cmenvfru/241/24102.htm>
- Pembrokeshire County Council (2017) Waste Working Group *Review of Waste Services*
- Pembrokeshire County Council (2018) Waste Working Group *Review of Waste Services*
- Pretz, T., 2000. Processing of municipal household waste material. In: Ozbayoglu, G., Hosten, C., Atalay, M.U., Hicyilmaz, C., Arol, A.I. (Eds.), *Mineral Processing on the Verge of the 21st Century*
- Ricardo Energy & Environment (2015). Which local authorities would be the winners and losers if we moved to a carbon league table rather than the traditional recycling % table? Article in *Recycling and Waste World*, June 2015.
- Silpa Kaza, Lisa Yao, Perinaz Bhada-Tata, A., & Woerden, F. Van. (2018). *What A Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. Urban Development. World Bank.

- Thomas, G. O., Poortinga, W., & Sautkina, E. (2016). The Welsh Single-Use Carrier Bag Charge and behavioural spillover. *Journal of Environmental Psychology*, 47, 126–135.
<https://doi.org/10.1016/j.jenvp.2016.05.008>
- Traven, L., Kegalj, I., & Šebelja, I. (2018). Management of municipal solid waste in Croatia: Analysis of current practices with performance benchmarking against other European Union member states. *Waste Management and Research*, 36(8), 663–669. <https://doi.org/10.1177/0734242X18789058>
- UK Resource Association 2015. Putting quality recycling at the heart of a circular economy.
<https://www.circularonline.co.uk/wp-content/uploads/2015/08/RA-Position-CEP-Position-Aug-2015.pdf>
- UNEP, 2015. United Nations Environmental Programme, Global Waste Management Outlook. Accessed January 17, 2019
- Van der Werff, E., Vrieling, L., Van Zuijlen, B., & Worrell, E. (2019). Waste minimization by households – A unique informational strategy in the Netherlands. *Resources, Conservation and Recycling*, 144(November 2018), 256–266. <https://doi.org/10.1016/j.resconrec.2019.01.032>
- Wales Audit Office. (2018). *Waste Management in Wales: Municipal Recycling*.
<http://www.cynulliad.cymru/Research Documents/Waste Management in Wales - Research paper-31032007-49198/07-052-Cymraeg.pdf>
- Wales Audit Office. (2019). *Waste Management in Wales: Preventing Waste*.
<http://www.cynulliad.cymru/Research Documents/Waste Management in Wales - Research paper-31032007-49198/07-052-Cymraeg.pdf>
- Welsh Assembly Government (2009). *Towards zero waste: one Wales: one planet: the overarching waste strategy document for Wales*.
- Welsh Assembly Government (2011). *Municipal sector plan part 1: Collections Blueprint*. March 1–148.
[http://www.wrapcymru.org.uk/sites/files/wrap/Municipal Sector Plan Wales - Collections Buleprint.pdf](http://www.wrapcymru.org.uk/sites/files/wrap/Municipal Sector Plan Wales - Collections Blueprint.pdf)
- Welsh Assembly Government (2017). Taking Forward Wales’ Sustainable Management of Natural Resources, June 2017.
- Welsh Government Consultation. (2019). *Beyond recycling: A Strategy to make the circular economy in Wales a reality* (No. WG39588).
- Welsh Government (2020) Waste Data Flow. Accessed November 2020
<https://statswales.gov.wales/Catalogue/Environment-and-Countryside/Waste-Management/Local-Authority-Municipal-waste/annualreusererecyclingcompostingrates-by-localauthority-year>
- Williams, I.D., Kelly, J., 2003. Greenwaste collections and public recycling behaviour in the Borough of Wyre, England. *Resources Conservation and Recycling* 38, 139-159.
- WRAP (2015) Household Food Waste in the UK
- Zhang, B., Lai, K. hung, Wang, B., & Wang, Z. (2019). From intention to action: How do personal attitudes, facilities accessibility, and government stimulus matter for household waste sorting? *Journal of*

Environmental Management, 233(November 2018), 447–458.
<https://doi.org/10.1016/j.jenvman.2018.12.059>