Emerald Supply Chain Management: An International Journal

REVERSE LOGISTICS IN HOUSEHOLD RECYCLING AND WASTE SYSTEMS: A SYMBIOSIS PERSPECTIVE

Journal:	*Supply Chain Management: an International Journal*
Manuscript ID:	SCM-02-2015-0056.R1
Manuscript Type:	Original Manuscript
Keywords:	Reverse logistics, symbiosis, household waste recycling system, mixed methods, household recycling behaviour

REVERSE LOGISTICS IN HOUSEHOLD RECYCLING AND WASTE SYSTEMS: A SYMBIOSIS PERSPECTIVE

ABSTRACT

Purpose: The article investigates the proposition there is a symbiosis effect for exchanges between household waste recycling systems (HWRS) and household recycling behaviour (HRB) within the reverse logistics (RL) discourse.

Design/methodology/approach: The article contains empirical findings from a two phase, multi-method approach comprising consecutive inductive and deductive investigations. The qualitative and quantitative data underpin exploratory and explanatory findings which broaden and deepen understanding of this phenomenon.

Findings: Analysis identified significant interactions between situational and personal factors, specifically demographic factors, impacting on HRB with key factors identified as engagement, convenience, availability and accessibility.

Research limitations/implications: Findings confirm the existence of a symbiosis effect between situational and personal factors and inform current research threads in the environmental sciences, behavioural and logistics literature, particularly identifying consumers as being an important pivot point between forward and reverse logistics flows.

Practical implications: Findings should inform RL-HWRS design by municipalities looking to more effectively manage MSW and enhance recycling and sustainability. RL practitioners should introduce systems to support recovery of MSW in sympathy with communication and education initiatives to affect HRB and should also appreciate a symbiosis effect in the design of HWRS.

Social implications: The social implications of improved recycling performances in municipalities are profound. Even incremental improvements in the performance of HWRS can lead to enhanced sustainability through higher recycling rates, reduced diversion of MSW to landfill, decreases in pollution levels, reduced carbon footprints and reduction in depletion of scarce natural resources.

Originality/value: The paper marks an early contribution to the study of symbiosis in HWRS and HRB pertaining to RL. Findings are offered that identify the key situational and personal factors that interact to affect enhanced HWRS, and also offer insights above those available in current multi-disciplinary literature that has largely examined such factors in isolation. Conclusions offer the possibility of an epistemological bridge between the social and natural sciences.

Keywords: Reverse logistics, symbiosis, household waste recycling systems, mixed methods, household recycling behaviour

INTRODUCTION

Municipal solid waste (MSW) management services are reverse logistics (RL) operations of significant scale and importance throughout the developed world, and yet the topic has only received limited attention within the logistics and supply-chain management literature. The activities underlying MSW management services, when successful can have a significant impact on sustainable living by increasing levels of recycling and decreasing the amount of MSW being sent to landfill or to incineration (Beullens, 2004; Breen, 2006; McLeod et al., 2008). The under-emphasis on MSW management services in the RL literature seems at odds with an increasing policy focus on sustainability issues. All OECD municipal RL service providers have become dedicated to diverting MSW from landfills and improving their waste recovery planning (Dovidio, 2013).

Further, a household consumer's role as the turning or pivot point in a supply chain from a forward to a reverse flow is also not well-understood. Usual definitions of logistics discussing 'point-of-origin to point-of-consumption' (Grant, 2012) imply that the consumer is the end node in a supply chain. However, the nature of forward flow in supply chains to a retailer really means the supply chain considers 'point-of-origin to point-of-sale' (Teller et al., 2012). But in terms of being within a closed-loop supply chain and participating in the return, recycling or disposal of goods and waste, the consumer is actually a pivot point node between forward or inbound and reverse or outbound flows (Anderson and Huge Brodin, 2005), and hence consumers have a critical exchange role in working with a municipality as the first tier 'customer' in an RL context. Further, consumers have an important role as both a source and initial separator of MSW.

This paper reports a research study of what we term a symbiosis effect for exchange between consumers at the pivot point as first stage suppliers to a RL system and municipalities as first-tier 'customers' for MSW. The behaviour of individual consumers and their households as collective agents is significant in enhancing or constraining household waste recycling systems (HWRS) (Wright et al., 2011). Critically, the pivot point in a RL-HWRS system relies on sorting and separation of recyclables by a consumer for kerbside collection services by a municipality. Thus

the household recycling behaviour (HRB), and the attitudes and norms underpinning it, must increasingly be considered in conjunction with the provision and design of RL systems for MSW, e.g. sorting processes and guidelines, collection and transport. If the objective of municipal RL services in a HWRS is to increase the proportion of recyclables relative to the amount disposed of in landfill or by incineration, then it is essential to consider what the relationship is between municipally-controlled situational factors and household characteristics or personal factors in the first stage of RL system handling MSW. Thus, we examine the extent and manner in which the relationship, which we conceptualise as a symbiosis effect, is an element of successful RL operations in the context of HWRS.

We approach our central question through an interdisciplinary lens. A single discipline study has a limited ability to access the complex and multifaceted issues involved in managing household waste patterns and recycling behaviour (Choptiany et al., 2014). We use a pluralistic methodology and qualitative and quantitative approaches to develop both a rich and generalisable theoretical framework of the factors underpinning a successful first-stage RL system for MSW. Our empirical study was conducted with two English municipalities or local authorities (LAs) whose first stage of the RL system are households, and where the success of their HWRS is significantly reliant on HRB.

Our theoretical contribution addresses the under-researched interactions of behavioural and physical RL system design at the turning point where a consumer's role is akin to that of a supplier. Further, our findings should inform management of municipal RL channels, particularly where greater involvement of consumers in the sort and separation of recyclables is desired. Finally, the findings advance the credibility of RL as a means of enhancing sustainable living.

The remainder of the paper is structured as follows. First we outline the role of RL in an end-of-life context, explain the two bodies of separate precursors (situational and personal factors) that we suggest interact to create a symbiosis effect which affects the performance of HWRS, and present our conceptual framework. We then outline the principles of our mixed method approach and provide details of first the inductive/qualitative and deductive qualitative phases of

investigation and then present our findings. We conclude with the contribution of the study, implications for RL theory and practice, and limitations of the study.

THEORETICAL BACKGROUND

Reverse Logistics

Much work has been done on reverse logistics (RL) or product recovery management concepts since the late 1990s (Carter and Ellram, 1998). A useful definition of RL is *"the movement of product or materials in the opposite direction for the purpose of creating or recapturing value, or for proper disposal"* (Tibben-Lembke and Rogers, 2002:271). Reverse logistics is also considered a crucial element in green supply chain management (Hervani et al., 2005).

One under-investigated area in RL is how to deal with 'end-of-life' or 'end-of-use' goods (Xie and Breen, 2014), particulalry as regards the recycling or disposal of them (Mishra et al., 2012). Additionally, Wright et al. (2011:10) suggest that *"little attention has been given to the best methods to develop overall recycling channels."* However, the burgeoning attention to the recycling and management of waste has followed the increasing prevalence of end-of-life take-back laws (Toffel, 2003); for example the European Union's waste electrical and electronic equipment (WEEE) directive that stipulates all such goods must be recycled and not disposed (Grant et al., 2015).

There are two main streams for the handling of end-of-life products (or outbound flows), either commercial management or municipal management, particularly municipal solid waste (MSW) management (Zhang et al., 2011). These streams can also be sub-divided as having inbound flows from commercial and domestic origins (Belien et al., 2014). In all three classifications, there are situations where household consumers form a key stage in the RL system as both a recipient of inbound flows and initiator of outbound flows. However, there is little research to date regarding this phenomenon at the supply chain 'turning point' from forward to reverse logistics. This omission seems odd given the current prioritisation of resource recovery from MSW (Dovidio, 2013). This appears to be a problem for logistics research in general and RL service design and implementation in particular.

For the management of household waste recycling systems (HWRS), recycling can be defined as *"the process of systematically collecting, sorting, decontaminating and returning of waste materials to commerce as commodities for use or exchange"* (Wiard and Sopko, 1991:3). However we argue that it is useful to re-envisage the more commonly used term of 'customer' in RL discourse and instead consider the 'consumer' as a basis on which notions of forward and reverse logistics are converge at the pivot point (Xie and Breen, 2014). Anderson and Huge Brodin (2005:79) further note that after the pivot point:

> *"…the household is no longer the end-customer. … The households' role in recycling systems might very well be equalled with that of supplier, and …to an industrial process."*

The consideration of RL in HWRS is from the turning point at consumption and going back upstream in the supply chain through an RL channel for recycling or waste channel to a landfill, recycling or energy recovery base. The consumer's role here is akin to that of a first-stage supplier (Baeyens et al., 2010). In considering this role, it is also important to consider the design of logistics systems compatible with consumer behaviour as a supplier. Consumers have a critical role in determining whether end-of-life goods are captured by an RL system or are disposed of as waste. This is especially true for mundane household waste items such as food and beverage packaging, as opposed to the more durable electronic items covered by take-back regulations. Municipal waste systems are relatively neglected in the RL literature compared to commercial RL systems.

There is also a distinction between source-separation and post-separation activities for RL (Bing et al., 2014). Source-separation involves the 'supplier' (i.e. the consumer) presenting pre-sorted recyclables for collection, whereas post-separation occurs at a separation centre after collection. Thus the physical aspects of RL channel design for source-separation starts with the provision of waste containment for the supplier or consumer, e.g. wheelie bins, kitchen food waste baskets, and biodegradable recycling bags.

As with other suppliers, a municipality or LA must treat households as an external element in an exchange relationship. The question is how to motivate them to separate waste, which is cheaper LAs than post-source separation of co-mingled waste, but risks lower participation rates. Studies have shown that a range of logistics design factors influence recycling behaviour. We refer to these as situational factors, i.e., those factors that are controlled by the LA and which comprise the HWRS presented to households to and which influences the extent to which they comply. These can also be considered 'hard' factors that can be quantified and measured (Caplice and Sheffi, 1994). Strategically, the physical aspects affect the degree to which suppliers-consumers can be motivated to create multiple streams of separated recyclables, with the alternative being a single stream or a fully co-mingled supply of recyclables (Woodard et al., 2006; Abbott et al., 2011).

Prior studies have ascertained that what could be termed 'soft' RL factors (Caplice and Sheffi, 1994) such as convenience, perceived improvement in recycling facilities communication and financial incentives from LAs tend to lead to higher household recycling levels (Abbott et al., 2011; Wright et al., 2011; Keramitsoglou and Tsagarakis, 2013). However, 'hard' factors in RL design can also influence household behaviour (Woodard et al., 2004). Given the many and varied different RL schemes deployed by LAs in the UK and beyond, it is difficult to separate out the effects of the hard and soft factors, hence we combine these as situational factors. All are controlled by the LA or first-tier RL customer in their effort to engage with the household as supplier-consumer.

The behavior and attitudes of suppliers-consumers towards recycling are also important in the design of a succesful RL system in the context of MSW and it is the consumer's role as a first-stage supplier to a municipal RL system that is the focus of this study. A key question here is the degree of voluntary involvement that suppliers-consumers are willing to exhibit in delivering recyclable items to a point where the LA RL service provider accepts ownership of them. Processes to do so, as noted in our Introduction, need to be clear and easy to understand for supplier-consumer involvement. In sharp contrast to conventional supplier-customer

relationships, many households do not attach a value to their waste. Thus, HWRS need to consider the primary desire of households (i.e., 'suppliers-consumers') is to discard their tins, plastic, bottles, etc. within the bounds of culturally acceptable behaviour (Deutz and Frostick, 2009).

Indeed, household characteristics can also be precursors to effective recycling behaviour. Certain demographic personal factors such nationality. cultural background socio-economic contexts (e.g. property type, socio-economic level and residential type), age and income level were found to be significant in affecting recycling performance (Woodard et al., 2005; Bekin et al., 2007; Abbott et al., 2011, Saphores et al., 2012; Keramitsoglou and Tsagarakis, 2013).

Importantly though, the studies did not consider personal and situational factors in conjunction with one another. HWRS thus would seem to not only rely on situational factors but also on personal factors. To date, studies that integrate insights into sustainable RL in the context of HWRS are rare. Research exploring the first-stage of HWRS has focussed on the effective design and implementation of a recycling system i.e. situational factors regardless of the effects of personal factors in enhancing positive HRB (Dahlén & Lagerkvist, 2010;). Equally, other studies that have focused on personal factors in recycling performance contain limited discussion of situational factors (Keramitsoglou and Tsagarakis, 2013; Saphores et al., 2012). To date, the closest empirical study looking at these two sets of factors holistically was Bhate (2005), who examined pro-environmental attitudes in the consumption of consumer goods.

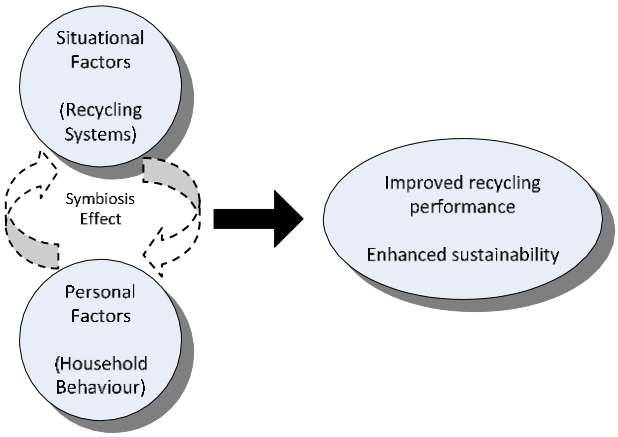
Symbiosis Effect and Conceptual Model

We argue that without exploring a symbiosis effect, i.e. the interactions between personal and situational factors that will have a positive effect on HRWS, studies that attempt to determine the effects of a recycling system cannot adequately explain why levels of collecting, sorting, decontaminating, of recycling of waste materials have worsened or improved (Dahlén and Lagerkvist, 2010; Keramitsoglou and Tsagarakis, 2013). Symbiosis is a term to be found primarily in the physical sciences but which has also been applied within the social sciences to denote a favourable association between separate but interrelated items of consideration

(Ehrenreich, 2002). We propose that the relationship between supplier (household) and customer (in this context the LA) can be understood as producing a symbiosis effect. Symbiosis has also been used in the context of industrial waste, or residues, to encapsulate a situation where the residue of one entity becomes the input or another, to the mutual benefit of both (Deutz, 2014). Extending the concept of industrial symbiosis to encompass post-consumer waste raises additional co-ordination challenges (Deutz, 2009). To date, however, the idea of a symbiotic relationship has not been employed in the analysis of an RL-HWRS for MSW.

We see waste collecting, sorting, reduction of contamination and recycling as the outcomes of an effective RL system, and we will refer to these factors collectively from here on as improved first stage RL efficiency is shown in Figure 1. As the tier 1 customer, a municipality must treat their tier 1 suppliers-consumers as external elements in an exchange relationship. Consideration of household motivation to sort and separate household waste is an element of a 'multi-agent architecture' for an entire reverse logistics system (Hervani et al. 2005) and we posit that the symbiosis effect occurs in the exchange between groups of agents or households and HWRS service providers or LAs, and that the householder's agency role as the first stage or tier 1 supplier affects the entire RL channel going upstream.

Figure 1: Proposed theoretical framework based on relevant theories and frameworks



When households respond positively to recycling systems, LAs can further refine their HWRS and gain step improvements in recycling rates. In contrast, one weak condition (either situational or personal) can undermine the other and the expected recycling performance may be

diminished. As such, we further posit that the symbiosis effect cannot be ignored in design of RL-HWRS if positive outcomes in respect of recycling levels are to be achieved.

The preliminary conceptual framework guiding this study in Figure 1 is derived from multiple disciplines. These include an RL framework (Carter and Ellram, 1998), consumer behavioural setting (Bhate, 2005), the norm activation model (Biel and Thøgersen, 2007) and environmental significant behaviour (Thøgersen, 2006) which is an extended version of the theory of planned behaviour (Ajzen, 1991).

To consider HRB as the first-stage of the RL system and to gain a better understanding of behaviour, we employ insights from the Theory of Planned Behaviour and Norm Theory. The most complex factors affecting HRB are the precursor personal factors which have two distinctive aspects: attitudinal and personal capabilities. Attitudinal factors are driven for instance by perceptions, predispositions, beliefs, norms, religion and culture (Ajzen, 1991;Stern et al., 1995). The Theory of Planned Behaviour suggest that people behave reasonably and that they are aware of the consequences of their actions.

In addition, studies conducted using Norm Theory also offer insight into matters of personal capabilities such as knowledge, social status and experiences that define individuals in a socio-economic and demographic contexts (ibid.). Under the umbrella of these theories, individuals, and in combination households, collectively contain the ability to perform tasks such as recycling, sorting and separating, providing that they at least understand the basic materials such as paper, glass, plastics or aluminium that can be recycled (Tonglet et al., 2004; Barr and Gilg, 2007). The degree to which they may be motivated to perform sort and separation activities is however a more complex matter (Barr et al., 2001).

Pro-environmental behaviour is a term found in marketing (Bhate, 2005; Kalamas et al., 2014) and applied social psychology literature (Stern et al., 1995) to denote a predisposition to certain outcomes such as purchasing and post-purchase behaviour. Stern (2000) presented a taxonomy

defining those aspects of pro-environmental behaviour most relevant to HWRS and which elements fall outside this consideration, and we incorporate these factors into our model.

METHODOLODY

One of the problems with gaining insights into the postulated symbiosis effect is that of complexity. Consequently, our approach is pluralistic in a number of ways, supported by our multi-disciplinary backgrounds. We pursue a mixed methodology approach applying both quantitative and qualitative approaches to the same research problem (e.g., Midgley 1989). Our findings are therefore grounded in Yolles's (1996) term, in a 'virtual' or emergent paradigm with different underlying assumptions to those of functionalist and interpretative paradigms. This approach is arguably closer to how practitioners approach problem solving in practical contexts (Skyrme, 1997). In our two-phase approach we seek to combine the inductive exploratory value of qualitative approaches with the deductive, generalisability and robustness advantages of a quantitative approach. Our samples were drawn from within the remits of two English municipalities or LAs and the two geographic areas were evenly represented. We provide further details on methods pertaining to the two phases of fieldwork in the following section in juxtaposition to the findings from each phase.

FINDINGS AND DISCUSSION

The first inductive (qualitative) phase of fieldwork and analysis involved cross-case and within case analyses and identification of themes using thematic analysis (Braun and Clarke, 2006). This approach to thematic analysis is consistent with the principles of phenomenological interviewing (Roulston, 2010) where the themes derived from a priori literature are highlighted during the interviews but which also allows for new themes to emerge. The semi-structured interviews were between 90 and 120 minutes long. A total of fourteen respondents participated in this phase: two of which were local authority officers – one each from the East Riding of Yorkshire and the City of Hull.

The demographic profile of the remaining twelve respondents was diverse; they lived or used to live in the East Riding of Yorkshire (five respondents) or the City of Hull (seven respondents).

The sample included nine female and five males aged between (24 – 52) years (mean age = 29). More females (67%) than males (33%) participated in the interviews, which is consistent with past research in recycling (Smith, 2008) which noted women were more likely to participate in research where environmental issues were the major concern. The recycling experience of respondents ranged from two to twenty years, with three of the respondents reporting that they had been recycling before LA recycling initiatives started.

Conversations were digitally recorded, transcribed and subsequently coded using NVIVO software. The overall aim of this phase of the study was to explore the notion of a 'symbiosis effect' and was intended to be both confirmatory and revelatory. Interviewing concluded in line with the principles of theoretical saturation (Lincoln and Guba, 2013). Themes identified in phase one substantively corresponded to the conceptualisation of the HWRS problem outlined in Figure 1 and we summarise in Table 1 the questions asked and themes identified from analysis of the transcripts.

Table 1: Research questions with key themes derived from a priori literature and those which emerged in phase one

1. What are the different factors associated with HRWS that may affect HRB, (Targeted at Local Authority staff).

- Why were changes made to HRWS?
- Who were the most significant contributors to ensure these changes to HRWS led to successful outcomes?
- Why were these changes to HRWS seen as significant?

apriori themes supported: sustainability (diversion from landfills, reduction of CO2 emissions were imposed on the operators and incineration has been chosen as the best recovery option for City of Hull residents). Situational factors (new improved schemes scheduling for blue and black bins for Hull residents and East Riding (County of) had opted for co-mingled strategy a bit later than Hull however the East Riding had introduced brown bins (similar to Hull) which had increased their composting performance which as a whole increased their recycling performance in comparison to Hull. Accessibility (closer distances for drop-in) and availability (public amenities) in the recycling systems were probed and responses were that financial constraints were a major barrier to providing such services to households. Marketing initiatives were an important factor in promoting HRB; however limited financial resources deterred local authorities from engagement with households.

Emergent themes: integration between institutions (university, retailers, schools etc.), the importance of roles played by the central government through relevant agencies (DEFRA, WRAP, Environment Agency etc) and their development of effective policies in tackling environmental issues.

2. How is HRB manifest in different Local Authorities (Targeted at households)

- When I say "recycling" what is the first thing comes to mind?
- How do you feel when you are sorting and separating your rubbish for recycling?
- Is it convenient for you to do this on a daily basis?
- What would make it easier?

a priori themes supported: situational factors (collection schedules, distances, bins, sorting, information, engagement, education, rewards, distance, convenience, availability, accessibility and fees), personal factors (knowledge, awareness, recycling attitudes, neighbourhood norms, local authority engagement, education, easy to understand pamphlets, family norms, brands/ retailers that promote recycling) and situational factors.

3. What are the interaction and symbiosis effects and what are the conditions that support the symbiosis between HRWS and HRB? (Targeted at households and LA staff).

- I'd like to ask you... before the three wheelie bins were introduced in 2009 and looking at your current address, can you recall a time when you felt the need for changes in how the LA managed your waste.
- Do you feel current practices amount to a convenient way of recycling?
- Do you find it important for you to be able to recycle?
- When I say "sustainability" what does this term mean to you, your neighbourhood and environment?
- What is it about the environment that you value?
- Do you think that you are recycling enough?
- Are communications from your LA clear and easy to understand?

a priori themes supported: personal factors (self-awareness, responsible attitude, social and family norms, doing good to society) and situational factors (advertising, information, education, public engagement)

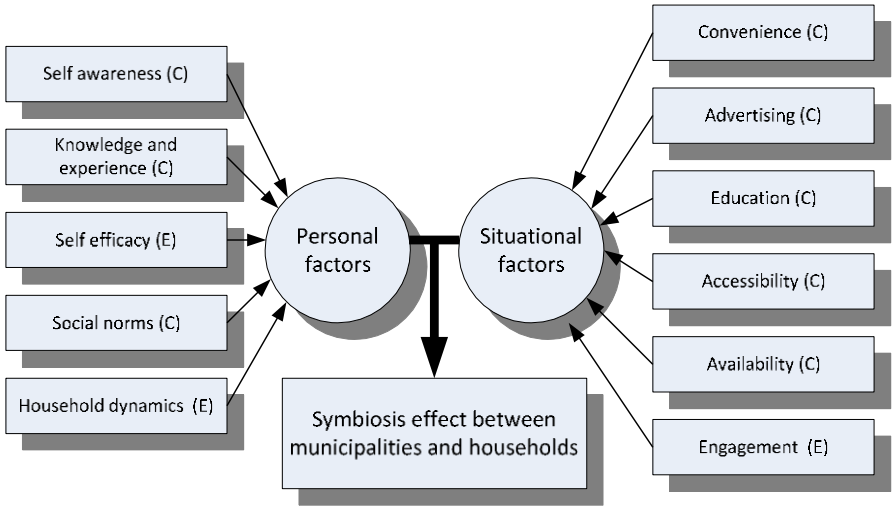
Emergent themes: personal factors (self-efficacy and creativity) and situational factors (retailers' engagement and institutional engagement)

Analysis of the transcripts revealed a number of codes, some which were combined as similar themes. The most commonly occurring themes (both those *a priori* and emergent) were taken forward into the phase two quantitative study as shown in Figure 2. The themes of 'self-awareness', 'knowledge' and experience', 'self-efficacy', 'social norms' and what we will here call 'household dynamics' (number of persons per household and type of dwelling. i.e. marital status, family, cohabitants), are considered as personal factors. Most of these can be found in the behavioural literature (Park & Ha, 2014). In addition, situational factors were based on themes identifiable in logistics and supply chain discourse; particularly backwards movement (product, services or waste) and flows (Grant et al., 2015).

Other aspects such as the provision of services and facilities from LAs (wheelie bins, liners, schedule times, drop-in centres, customer services, etc.) are further considered here as 'availability' and 'accessibility' and the process of sorting with given instructions (i.e. an LA's recycling manual) is considered here as 'convenience' (the ease of doing) and 'education' (LA involvement in inducing a recycling culture (Young et al., 2013; Wagner, 2013), 'advertising' (getting awareness messages across to households, after) and 'engagement' (direct communication on recycling i.e. door-to-door consultation), and a road awareness program (Fischer et al., 2012; Wong et al., 2013).

A symbiosis effect was apparent in phase one, in that it seemed that HRB will alter in sympathy with changes made by recycling schemes introduced by municipalities. Previous studies have pointed to cause and effect relations between improved recycling schemes and improved recycling rates (Woodard et al. 2005; Williams and Cole, 2013). In addition, the present study also found that interaction and engagement from the municipality was of significant importance. The results of phase one broadly provided support for our conceptual model in Figure 1 as a viable basis for further theoretical development. Using a 'thematic analysis network' in Figure 2 we illustrate the confirmed (C) and emergent (E) themes from phase one. Figure 2 is therefore the development of our original conceptual framework based on the findings from phase one and was taken forward for quantitative investigation in phase 2.

Figure 2: Thematic analysis network of Conceptualization on *symbiosis effect* between Municipalities and Households (*n=14*) contributed as a theoretical framework.



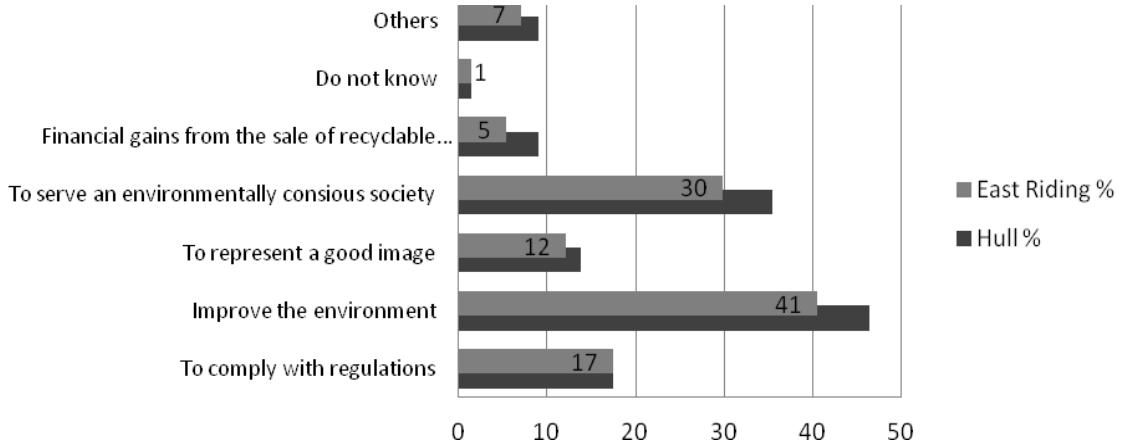
For the second deductive phase of research, the target population consisted of residents from the two LA areas investigated in the first phase, the East Riding of Yorkshire and the City of Hull, and the unit of analysis was the household. A postal-survey questionnaire was sent to 500 households from each area (1000 in total). In addition, to allow for the impact of the low response rate normally associated with postal surveys, an online survey was also published via a social media platform, the affiliated community networks of the local municipality's, a public community online news network with selected companies within the population parameters. Table 2 shows the theoretical sources behind the 55 items used in the survey.

Table 2: Demographic background (*n*=412)

Item	**N**	***%***
Age		
20 or under	21	5.1
21-30	85	20.6
31-40	96	23.3
41-50	59	14.3
51 or older	151	36.7
Gender		
Male	157	38.1
Female	255	61.9
Recycling Experience (years)		
More than 4	307	74.5
Less than 4	105	25.5
Living in current property (years)		
More than 4	286	69.4
Less than 4	126	30.6

The final realized sample amounted to a total of 212 usable questionnaires derived from postal surveys and an additional total of 200 usable online questionnaires (412 in total). Table 3 provides a summary of the socio-demographic profiles of the respondents. The sample was slightly dominated by female respondents (62%) and the majority of respondents fell within the 51 or older age group. Most respondents have more than four years of recycling experience (75%), and had been living in the same property for more than four years (69%). The frequency analyses in Figure 3 that more than 90% of households were clearly aware of why they recycled. Many considered their motives for recycling as being grounded in a belief that recycling improved their environment and that they wanted to live in an environmentally conscious society.

Figure 3: Summary of responses to question "I recycle because_____" based on local authority (n=412)



Power analysis was deployed to the data to ensure sample adequacy and to avoid Type I and II errors and overall statistical robustness. We considered four situational factors of convenience, engagement, accessibility, and availability alongside personal factors for correlation and predictive values. Pearson correlation was used to analyse the relationship between situational and personal factors and draw conclusions as to a symbiosis effect between HWRS and HRB. Then, multiple regression analysis was used to analyse the direction and strength of the relationship between the two sets of variables, as well to indicate whether these variables were covaried (Cohen et al., 1983).

We further tested the relationship between the aforementioned four situational factors with five demographic factors (age, employment, knowledge, experience and household dynamics) and a combination of three personal factors (self-awareness, self-efficacy and social norms). Items underlying the personal and situational factors were formed into relevant composite factors and then a statistical correlation was tested between these composite factors including all demographic items. Those representing a more than a 0.05 significance level were omitted from further analysis. The correlation between these two composite factors is illustrated in Table 4.

Table 4: Correlation table

	PEARSON CORRELATION					*Sig. (2-tailed)*
Factors	Situational	Age	Household Dynamic	Employment	Knowledge and Experience	
Personal	0.41	0.24	0.20	0.23	0.15	0.00
Situational	1	0.10	0.12	0.17	n.s	0.01

Results detailed in the table reveal that personal factors have a significant relationship to situational factors ($p < 0.01$) and vice versa; with a positive correlation ($r\ (412) = +0.41$). Four demographic items were also found to have positive relation with both factors ($r\ (412) > +0.07$) and a correlation between composite personal factors with those four demographic items had a significant relationship ($p < 0.01$). However, household employment has a significant influence at ($p < 0.01$) on composite situational factors, thus the age of a household and household dynamics such as marital status were at a ($p < 0.05$) significant level. 'Recycling experiences' had no significant correlation with composite situational factors. The analyses indicated that a socio-demographic profile of a local constituent has a positive correlation with factors contributing to HRB. A correlation was also performed with composite personal factors and individual situational factors as shown in Table 4. The results showed that the personal factors had a significant relationship with engagement ($p < 0.01$) with positive correlation ($r\ (412) = +0.71$); as well as convenience ($p < 0.01$) with positive correlation ($r\ (412) = +0.44$) and accessibility and availability ($p < 0.01$) with positive correlation ($r\ (412) = +0.27$).

In order to examine whether personal factors interacted with the four situational factors, a multiple regression analysis was performed and the results are shown in Table 5. This analysis was relevant as it addressed the assessment of various relationships, using the information from independent variables to improve the accuracy in predicting values for the dependent variable (Green, 1991). We found that engagement ($\beta=+0.32$, $p < 0.01$), convenience ($\beta=+0.16$, $p < 0.001$), and accessibility and availability ($\beta=-0.13$, $p < 0.01$) were significant predictors of recycling behaviour. The overall model fit was R^2= 0.838. The main effect of all situational factors was significant, $F\ (5, 406) = 191.61$ $MSE = 12.06$, $p< 0.01$.

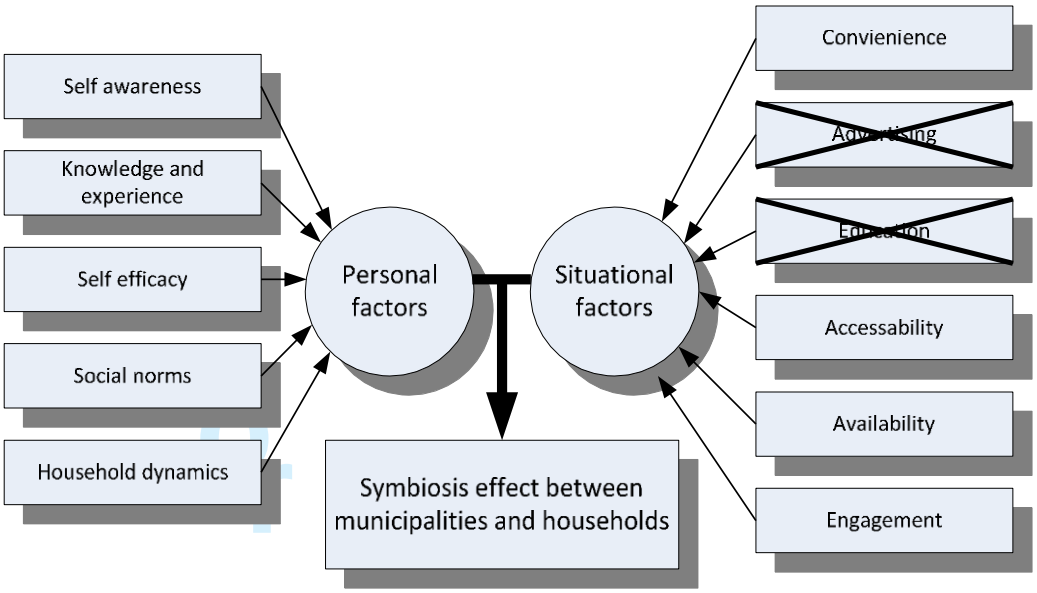
Table 5: Coefficients table

Model 1	***Unstandardize***		***Standardized Coefficients***	***T***	***Sig.***
d	***Coefficients***				
	B	Std. Error	Beta		
(Constant)	15.093	1.851		8.154	0.000
Engagement	0.316	0.032	0.359	9.890	0.000
Convenience	0.156	0.048	0.106	3.225	0.001
Accessibility and Availability	-0.125	0.031	-0.126	-3.994	0.000

This analysis showed that both situational and composite personal factors interact to manifest HRB. An initial inference statistical analysis was applied to investigate initial relationships between situational and personal factors and explore their interplay with confounding variables (demographic factors). The analysis demonstrated that composite personal and situational factors interact when affecting HRB. Findings suggest that different demographic profiles have an effect on the recycling intention of householders. This finding is consistent with much previous research into HRB. Additionally, previous literature has contained suggestions that different localities based on geographical setting such deprived versus affluent areas strongly impact recycling performance (Abbott et al., 2011). However, we reject here a naïve association between deprivation and affluence and positive HWRS performance in favour of suggesting that these factors are part of a more complex symbiotic relationship supporting Akil and Ho (2014).

We also performed an inferential statistical analysis, a summary of which is presented in Figure 4. First, the interaction between accessibility and availability, as well that between convenience and engagement (situational factors) with personal factors, were found to be the main predictors of positive HRB. Second, the interaction these situational factors with composite personal factors pointed to HRB enhancement. Third, to project or manifest HRB in a way that increases recycling performance, households must be motivated by the right stimuli such as the such as these four situational factors in HWRS (Keramitsoglou and Tsagarakis, 2013). Figure 4 is a visual representation of the conclusions from the second phase when compared to the phase one framework in Figure 2.

Figure 3: Model with supported and unsupported elements.



This quantitative phase confirmed the proposition of symbiosis effect from the first phase. The quantitative analysis demonstrates and validates the first stage findings, that higher interactions and engagement influences sustainable HRB and a higher spatial coverage of service provision and availability of recycling facilities the performance of recycling initiatives by municipalities.

CONCLUSIONS

This article has investigated the proposition there is a symbiosis effect for exchanges between HWRS and HRB within the RL discourse, and identified such an effect between households and LAs which influences the effectiveness of recycling schemes. We envisioned households, or suppliers-consumers in the main, as a pivot point between forward and reverse logistics flows, and thus a first-stage or tier 1 supplier to a RL system, as devised by the LA who is the tier 1customer for the recycled material.

The resultant empirical study had two phases of investigation and analysis. The first phase was inductive and sought to both confirm constructs and ideas drawn from different disciplinary bodies of work and identify emergent themes that have not received significant discussion. Exploratory findings suggested a symbiosis effect between personal factors and situational factors similar to that described in the norm activation model and five personal factors and six

situational factors were identified. The second phase was deductive and sought to extend generalizability by performing several statistical tests on two samples drawn from two geographically contiguous municipal areas.

The second phase descriptive analyses showed no differences among aspects of self-awareness, self-efficacy, social norms, knowledge, experience and dynamic household or personal factors between householders from the East Riding of Yorkshire and the City of Hull. Correlation analysis revealed a positive relationship between situational and personal factors that included four dominant demographic or personal factors: age, household dynamic, employment and knowledge and experience; impacting on HRB with key factors identified as engagement, convenience, availability and accessibility and supporting the existence of a symbiosis effect.

Findings highlight management issues in relation to the environmental impact of consumer society, sustainable living, the green economy and municipal solid waste management. The terrain of many findings in exiting literature have considered personal factors in the context of HRB and situational factors in the context of RL in isolation from each other. This study has found support for the importance of considering interaction between situational factors and personal factors when examining the effectiveness of an entire HWRS.

The behavioural theories such as norm activation, theory of planned behaviour, a model of recycling behaviour, and a consumer behaviour setting were found to be important in encapsulating and explaining symbiosis. Overall findings indicate that personal factors interact with situational factors and that HRB will transform in accordance with how effective the design and implementation of what we have called situational factors of accessibility, availability, convenience and engagement by municipalities or LAs.

The findings also point to significant efficacy in the deployment of a mixed-methodology approach in examining complex multi-dimensional and interdisciplinary problems. Further, the inductive-deductive phasing incorporates different ontological assumptions and the approach is therefore essentially both mixed-method and multi-paradigmatical.

This article contributes in several ways towards this special issue on managing reverse exchanges service supply chains. Firstly, we confirmed the existence of a symbiosis effect between situational and personal factors and inform current research threads in the environmental sciences, behavioural and logistics literature, particularly identifying consumers as being an important pivot point between forward and reverse logistics flows.

This article also marks an early contribution to the study of symbiosis in HWRS and HRB pertaining to RL and identified the key situational and personal factors that interact to affect enhanced HWRS, and also offer insights above those available in current multi-disciplinary literature that has largely examined such factors in isolation. Finally, the outcomes from this study offer the possibility of an epistemological bridge between the social and natural sciences.

From a practical perspective the findings should inform RL-HWRS design by municipalities looking to more effectively manage MSW and enhance recycling and sustainability. RL practitioners should introduce systems to support recovery of MSW in sympathy with communication and education initiatives to affect HRB and should also appreciate a symbiosis effect in the design of HWRS.

This article and its topic have profound social implications for improved recycling performances in municipalities or LAs. Even incremental improvements in the performance of HWRS can lead to enhanced sustainability through higher recycling rates, reduced diversion of MSW to landfill, decreases in pollution levels, reduced carbon footprints and reduction in depletion of scarce natural resources.

Further research would be useful to examine the symbiosis effect over an extended time period. How does the relationship between households and LA evolve? How do incoming residents adapt to the practices of their new LA? How do LAs cope with a transient population? How do the suppliers-consumers in this scenario influence each other? A larger scale, randomised,

sampling approach would further investigate the robustness, which would also be enhanced by replication in other municipalities in the UK and the OECD.

REFERENCES

Abbott, A., Nandeibam, S. and O'Shea, L. (2011), "Explaining the variation in household recycling rates across the UK." *Ecological Economics*, Vol. 70, No. 11, pp. 2214-2223.

Ajzen, I. (1991), "The theory of planned behavior." *Organizational behavior and human decision processes*, Vol. 50, No. 2, pp. 179-211.

Akil, A.M. and Ho, C.S. (2014), "Towards sustainable solid waste management: Investigating household participation in solid waste management." *IOP Conference Series: Earth and Environmental Science*, Vol. 18, No. 1, pp. 012163.

Anderson, H. and Huge Brodin, M. (2005), "The consumer's changing role: the case of recycling." *Management of Environmental Quality*, Vol. 16, No. 1, pp. 77-86.

Baeyens, J., Brems, A. and Dewil, R. (2010), "Recovery and recycling of post-consumer waste materials. Part 2.." *International Journal of Sustainable Engineering*, Vol. 3, No. 4, pp. 232-245.

Barr, S., Gilg, A.W. and Ford, N.J. (2001), "A conceptual framework for understanding and analysing attitudes towards household-waste management." *Environment and Planning A*, Vol. 33, No. 11, pp. 2025-2048.

Barr, S., Ford, N.J. and Gilg, A.W. (2003), "Attitudes towards recycling household waste in Exeter, Devon: quantitative and qualitative approaches." *Local Environment*, Vol. 8, No. 4, pp. 407-421.

Barr, S., Gilg, A.W. and Ford, N.J. (2005), "Defining the multi-dimensional aspects of household waste management: a study of reported behavior in Devon." *Resources Conservation and Recycling*, Vol. 45, No. 2, pp. 172-192.

Barr, S. and Gilg, A.W. (2007), "A conceptual framework for understanding and analyzing attitudes towards environmental behaviour." *Geografiska Annaler Series B-Human Geography*, Vol. 89B, No. 4, pp. 361-379.

Bekin, C., Carrigan, M. and Szmigin, I. (2007), "Caring for the community: An exploratory comparison of waste reduction behaviour by British and Brazilian consumers." *International Journal of Sociology and Social Policy*, Vol. 27, No. 5/6, pp. 221-233.

Belien, J., De Boeck, L. and Van Ackere, J. (2014), "Municipal solid waste collection and management problems: a literature review." *Transportation Science*, Vol. 48, No. 1, pp. 78-102.

Beullens, P. (2004), "Reverse logistics in effective recovery of products from waste materials." *Reviews in Environmental Science and Biotechnology*, Vol. 3, No. 4, pp. 283-306.

Bhate, S. (2005), "An examination of the relative roles played by consumer behaviour settings and levels of involvement in determining environmental behaviour." *Journal of Retailing and Consumer Services*, Vol. 12, No. 6, pp. 419-429.

Biel, A. and Thøgersen, J. (2007), "Activation of social norms in social dilemmas: A review of the evidence and reflections on the implications for environmental behaviour." *Journal of Economic Psychology*, Vol. 28, No. 1, pp. 93-112.

Bing, X., Bloemhof-Ruwaard, J.M. and van der Vorst, J.G.A.J. (2014), "Sustainable reverse logistics network design for household plastic waste." *Flexible Services and Manufacturing Journal*, Vol. 26, No. 1-2, pp. 119-142.

Braun, V. and Clarke, V. (2006), "Using thematic analysis in psychology." *Qualitative research in psychology*, Vol. 3, No. 2, pp. 77-101.

Breen, L. (2006), "Give me back my empties or else! A preliminary analysis of customer compliance in reverse logistics practices (UK)." *Management Research News*, Vol. 29, No. 9, pp. 532-551.

Caplice, C. and Sheffi, Y. (1994), "A Review and Evaluation of Logistics Metrics." *The International Journal of Logistics Management*, Vol. 5, No. 2, pp 11-28.

Carter, C.R. and Ellram, L.M. (1998), "Reverse logistics - a review of the litertaure and framework for future investigation." *Journal of Business Logistics*, Vol. 19, No. 1, pp. 85-102.

Choptiany, J.M.H., Pelot, R. and Sherren, K. (2014), "An interdisciplinary perspective on carbon capture and storage assessment methods." *Journal of Industrial Ecology*, Vol. 18, No. 3, pp. 445-458.

Cohen, J., Cohen, P., West, S. and Aiken, L. (1983), "Bivariate correlation and regression." *Applied multiple regression/correlation analysis for the behavioral sciences*, No. 25-78.

Dahlén, L. and Lagerkvist, A. (2010), "Evaluation of recycling programmes in household waste collection systems." *Waste Management & Research*, Vol. 28, No. 7, pp. 577.

DeCoster, J. (2004), *Data Analysis in SPSS*, Available at: <http://www.stat-help.com/spss.pdf>.

Deutz, P. (2009), "Producer responsibility in a sustainable development context: Ecological modernisation or industrial ecology? " *The Geographical Journal*, Vol. 175, No. 4, 274-285.

Deutz, P. (2014), "Food for thought: Seeking the essence of industrial symbiosis. " in R. Salomone and G. Saija (Eds) *Pathways for Environmental Sustainability: Methodologies and Experiences*, Springer.

Deutz, P. and Frostick, L.E. (2009), "Reconciling policy, practice, and theorisations of waste management." *The Geographical Journal*, Vol. 175, No. 4, pp. 247-250.

Dovidio, J.F. (2013), "Bridging intragroup processes and intergroup relations: Needing the twain to meet." *British Journal of Social Psychology*, Vol. 52, No. 1, pp. 1-24.

Ehrenreich, N. (2002), "Subordination and symbiosis: Mechanisms of mutual support between subordinating systems." *UMKC L. Rev.*, Vol. 71, No. 251.

Fischer, J., Dyball, R., Fazey, I., Gross, C., Dovers, S., Ehrlich, P.R., Brulle, R.J., Carleton, C. and Borden, R.J. (2012), "Human behavior and sustainability." *Frontiers in Ecology and the Environment*, Vol. 10, No. 3, pp. 153-160.

Grant, D.B. (2012), *Logistics Management*, Pearson Education.

Grant, D.B., Trautrims, A. and Wong, C.Y. (2015), *Sustainable logistics and supply chain management: principles and practices for sustainable operations and management (revised edition)*, Kogan Page.

Green, S.B. (1991), "How many subjects does it take to do a regression analysis?" *Multivariate Behavioral Research*, Vol. 26, No. 3, pp. 499-510.

Hervani, A.A., Helms, M.M. and Sarkis, J. (2005), "Performance measurement for green supply chain management." *Benchmarking: An International Journal*, Vol. 12, No. 4, pp. 330-353.

Kalamas, M., Cleveland, M. and Laroche, M. (2014), "Pro-environmental behaviors for thee but not for me: Green giants, green Gods, and external environmental locus of control." *Journal of Business Research*, Vol. 67, No. 2, pp. 12-22.

Keramitsoglou, K.M. and Tsagarakis, K.P. (2013), "Public participation in designing a recycling scheme towards maximum public acceptance." *Resources Conservation and Recycling*, Vol. 70, pp. 55-67.

Lincoln, Y.S. and Guba, E.G. (2013), *The constructivist credo*, Left Coast Press.

McLeod, F., Hickford, A., Maynard, S., Cherrett, T. and Allen, J. (2008), "Developing innovative and more sustainable approaches to reverse logistics for the collection, recycling and disposal of waste products from urban centres." *Green Logistics report, University of Southampton (www. greenlogistics. org)*.

Midgley, G. (1989), "Critical systems and the problem of pluralism." *Cybernetics and Systems*, Vol. 20, No. 3, pp. 219-231.

Mishra, N., Kumar, V. and Chan, F.T.S. (2012), "A multi-agent architecture for reverse logistics in a green supply chain." *International Journal of Production Research*, Vol. 50, No. 9, pp. 2396-2406.

Murphy, P.R. and Poist, R.F. (2003), "Green perspectives and practices: a "comparative logistics" study. *Supply Chain Management: An International Journal*, Vol. 8, No. 2, pp. 122-131.

Park, J. and Ha, S. (2014), "Understanding consumer recycling behavior: combining the theory of planned behavior and the norm activation model." *Family and Consumer Sciences Research Journal*, Vol. 42, No. 3, pp. 278-291.

Roulston, K. (2010), *Reflective interviewing: A guide to theory and practice*, SAGE Publications Limited.

Saphores, J.-D.M., Ogunseitan, O.A. and Shapiro, A.A. (2012), "Willingness to engage in a pro-environmental behavior: An analysis of e-waste recycling based on a national survey of U.S. households." *Resources, Conservation and Recycling*, Vol. 60, No. March, pp. 49-63.

Skyrme, D. (1997), "Multimethodologies, the knowledge perspective." in J. Mingers and A. Gill, (Eds.) *Multi methodology*, John Wiley & Sons, pp. 217-239.

Smith, W.G. (2008), "Does gender influence online survey participation? A record-linkage analysis of university faculty online survey response behavior." *Eric Document ED501717. Retrieved December*, Vol. 31, No. 2009.

Stern, P.C., Kalof, L., Dietz, T. and Guagnano, G A. (1995), "Values, beliefs, and proenvironmental action: attitude formation toward emergent attitude objects." *Journal of Applied Social Psychology*, Vol. 25, No. 18, pp. 1611-1636.

Stern, P.C. (2000), "New environmental theories: Toward a coherent theory of environmentally significant behavior." *Journal of social issues*, Vol. 56, No. 3, pp. 407-424.

Teller, C., Kotzab, H. and Grant, D.B. (2012), "The relevance of shopper logistics for consumers of store-based retail formats." *Journal of Retailing and Consumer Services*, 19 (1), 59-66.

Thøgersen, J. (2006), "Norms for environmentally responsible behaviour: An extended taxonomy." *Journal of Environmental Psychology*, Vol. 26, No. 4, pp. 247-261.

Tibben-Lembke, R.D. and Rogers, D.S. (2002), "Differences between forward and reverse logistics in a retail environment." *Supply Chain Management; An International Journal*, Vol. 7, No. 5, pp. 271-282.

Timlett, R.E. and Williams, I.D. (2008), "Public participation and recycling performance in England: a comparison of tools for behaviour change." *Resources, Conservation and Recycling*, Vol. 52, No. 4, pp. 622-634.

Toffel, M.W. (2003), "The growing strategic importance of end-of-life product management." *California Management Review*, Vol. 45, No. 3, pp. 102.

Tonglet, M., Phillips, P.S. and Bates, M.P. (2004), "Determining the drivers for householder pro-environmental behaviour: waste minimisation compared to recycling." *Resources Conservation and Recycling*, Vol. 42, No. 1, pp. 27-48.

Wagner, T.P. (2013), "Examining the concept of convenient collection: An application to extended producer responsibility and product stewardship frameworks." *Waste Management*, Vol. 33, No. 3, pp. 499-507.

Wiard, M.L. and Sopko, B.G. (1991), *Recycling basics: a positive waste management alternative for Ohio*, Ohio Department of Natural Resources, Division of Litter Prevention and Recycling.

Williams, I.D. and Cole, C. (2013), "The impact of alternate weekly collections on waste arisings." *Science of The Total Environment*, Vol. 445, No. 29-40.

Wong, C., Lai, K.-H., Shang, K.-C. and Lu, C.-S. (2013), "Uncovering the value of green advertising for environmental management practices." *Business Strategy and the Environment*, Vol. 23, No. 2, pp. 117-130.

Woodard, R., Bench, M., Harder, M.K. and Stantzos, N. (2004), "The optimisation of household waste recycling centres for increased recycling—a case study in Sussex, UK." *Resources, Conservation and Recycling*, Vol. 43, No. 1, pp. 75-93.

Woodard, R., Bench, M. and Harder, M.K. (2005), "The development of a UK kerbside scheme using known practice." *Journal of Environmental Management*, Vol. 75, No. 2, pp. 115-127.

Woodard, R., Harder, M.K., and Bench, M. (2006), "Participation in curbside recycling schemes and its variation with material types." *Waste Management*, Vol. 26, No. 8, pp. 914-919.

Wright, R.E., Richey, R.G., Tokman, M. and Palmer, J.C. (2011), "Recycling and reverse logistics." *Journal of Applied Business and Economics*, Vol. 12, No. 5, pp. 9-20.

Xie, Y. and Breen, L. (2014), "Who cares wins? A comparative analysis of household waste medicines and batteries reverse logistics systems." *Supply Chain Management; An International Journal*, Vol. 19, No. 4, pp. 455-474.

Yolles, M.I. (1996), "Critical systems thinking, paradigms, and the modelling space." *Systems Practice*, Vol. 9, No. 6, pp. 549-570.

Young, W., Davis, M., McNeill, I. M., Malhotra, B., Russell, S., Unsworth, K. and Clegg, C. W. (2013), "Changing Behaviour: Successful Environmental Programmes in the Workplace." *Business Strategy and the Environment*, IN PRESS

Zhang, Y. M., Huang, G. H. and He, L. (2011), "An inexact reverse logistics model for municipal solid waste management systems." *Journal of Environmental Management*, Vol. 92, No. 3, pp. 522-530.

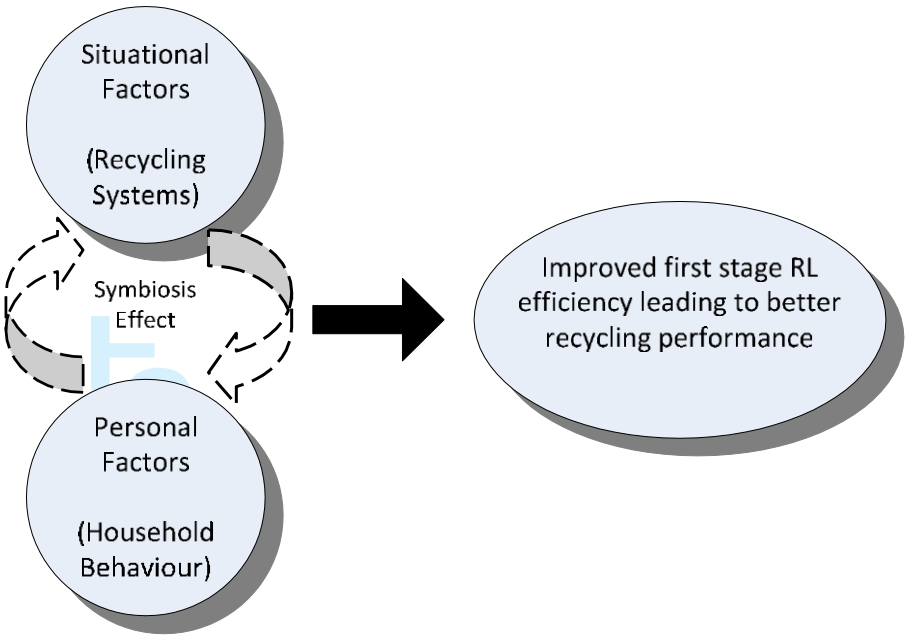


Figure 1: Proposed theoretical framework

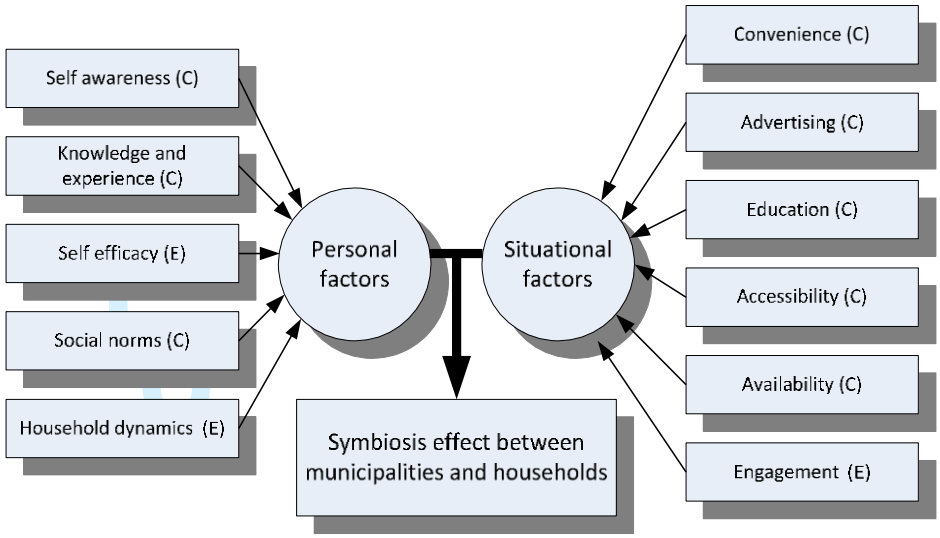


Figure 2: Thematic analysis network of symbiosis effect between personal and situational factors

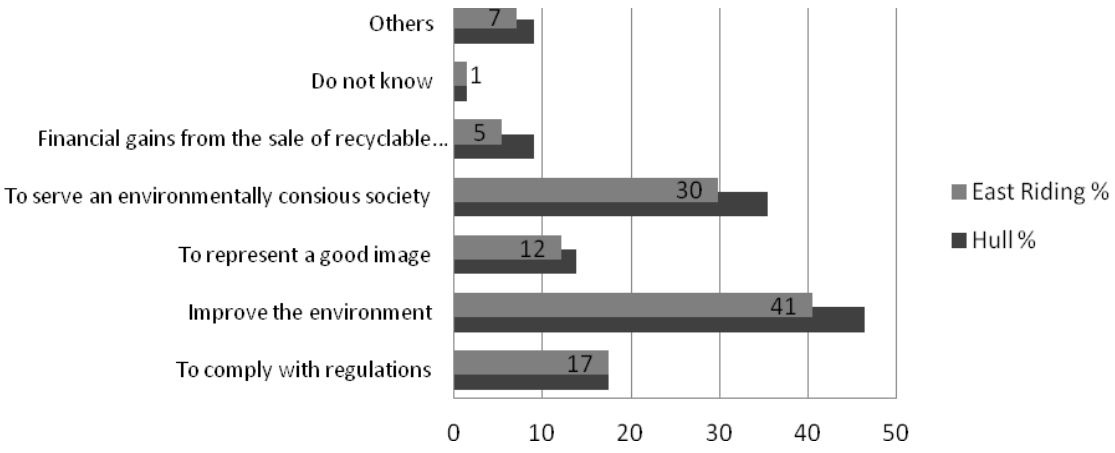


Figure 3: Summary of responses to question "I recycle because_____" (n=412)

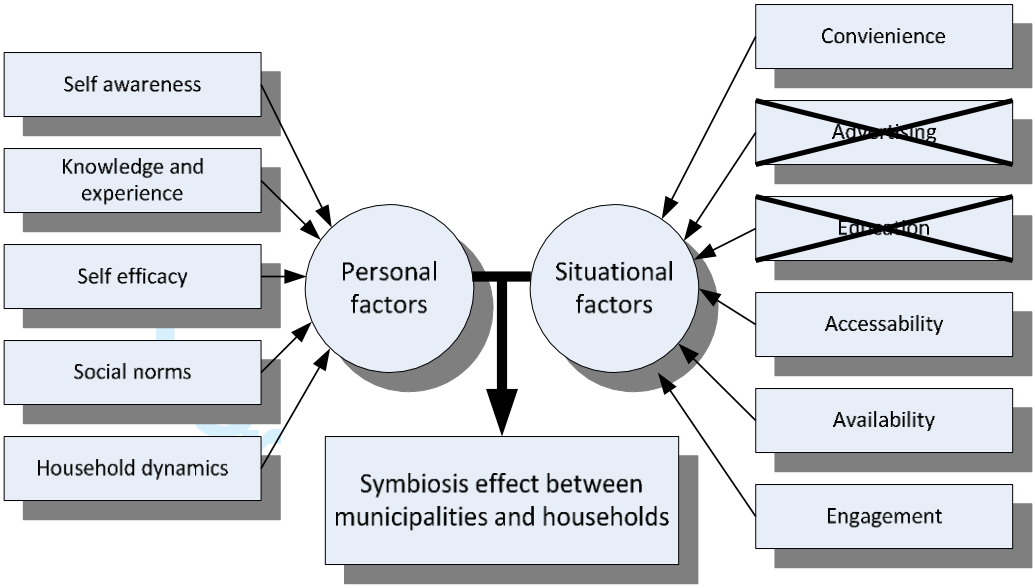


Figure 4: Model with supported and unsupported elements

Table 1: Research questions with key themes derived from literature and phase one study

1. What are the different factors associated with HWRS that may affect HRB, (Targeted at local authority (LA) staff).

- Why were changes made to HWRS?
- Who were the most significant contributors to ensure these changes to HWRS led to successful outcomes?
- Why were these changes to HWRS seen as significant?

A priori themes supported: sustainability (diversion from landfills, reduction of CO2 emissions were imposed on the operators and incineration has been chosen as the best recovery option for City of Hull residents). Situational factors (new improved schemes scheduling for blue and black bins for Hull residents and East Riding (County of) had opted for co-mingled strategy a bit later than Hull however the East Riding had introduced brown bins (similar to Hull) which had increased their composting performance which as a whole increased their recycling performance in comparison to Hull. Accessibility (closer distances for drop-in) and availability (public amenities) in the recycling systems were probed and responses were that financial constraints were a major barrier to providing such services to households. Marketing initiatives were an important factor in promoting HRB; however limited financial resources deterred local authorities from engagement with households.

Emergentthemes: integration between institutions (university, retailers, schools etc.), the importance of roles played by the central government through relevant agencies (DEFRA, WRAP, Environment Agency etc) and their development of effective policies in tackling environmental issues.

2. How is HRB manifest in different Local Authorities (Targeted at households)

- When I say "recycling" what is the first thing comes to mind?
- How do you feel when you are sorting and separating your rubbish for recycling?
- Is it convenient for you to do this on a daily basis?
- What would make it easier?

*Apriori*themessupported: situational factors (collection schedules, distances, bins, sorting, information, engagement, education, rewards, distance, convenience, availability, accessibility and fees), personal factors (knowledge, awareness, recycling attitudes, neighbourhood norms, local authority engagement, education, easy to understand pamphlets, family norms, brands/ retailers that promote recycling) and situational factors.

3. What are the interaction and symbiosis effects and what are the conditions that support the symbiosis between HWRS and HRB? (Targeted at households and LA staff).

- I'd like to ask you... before the three wheelie bins were introduced in 2009 and looking at your current address, can you recall a time when you felt the need for changes in how the LA managed your waste.
- Do you feel current practices amount to a convenient way of recycling?
- Do you find it important for you to be able to recycle?
- When I say "sustainability" what does this term mean to you, your neighbourhood and environment?
- What is it about the environment that you value?
- Do you think that you are recycling enough?
- Are communications from your LA clear and easy to understand?

Apriori themes supported: personal factors (self-awareness, responsible attitude, social and family norms, doing good to society) and situational factors (advertising, information, education, public engagement)

Emergent themes: personal factors (self-efficacy and creativity) and situational factors (retailers' engagement and institutional engagement)

Table 2: Sources of items for quantitative instrument

Research Question s	Section	Sources for survey questions	Items
RQ1: What is the reasoning behind of HRB in different municipalities?	Personal	Barr et al. (2005); Timlett and Williams (2008)	11
RQ2: What are the different factors associated with household recycling systems that may affect HRB?	Situational	Tibben-Lembke and Rogers (2002); Woodard et al. (2005)	16
RQ4: What are the interaction and symbiosis effects and the conditions that support the symbiosis between household recycling system and household recycling behaviour?	Interaction	Barr et al. (2003); Woodard et al. (2006)	28
RQ2: What are the different factors associated with household recycling systems that may affect HRB?	Population Profile(s)	Developed from Office of National Statistics (ONS) (2013)	10

Table 3: Demographic background (*n*=412)

	N	%
Age		
20 or under	21	5.1
21-30	85	20.6
31-40	96	23.3
41-50	59	14.3
51 or older	151	36.7
Gender		
Male	157	38.1
Female	255	61.9
Recycling Experience (years)		
More than 4	307	74.5
Less than 4	105	25.5
Living in current property (years)		
More than 4	286	69.4
Less than 4	126	30.6

Table 4: Correlation table

	PEARSON CORRELATION					***Sig. (2-tailed)***
Factors	Situational	Age	Household Dynamic	Employment	Knowledge and Experience	
Personal	0.41	0.24	0.20	0.23	0.15	0.00
Situational	1	0.10	0.12	0.17	n.s	0.01

Table 5: Model coefficients

Model 1	*Unstandardized Coefficients*		*Standardized Coefficients*	*T*	*Sig.*
	B	Std. Error	Beta		
(Constant)	15.093	1.851		8.154	0.000
Engagement	0.316	0.032	0.359	9.890	0.000
Convenience	0.156	0.048	0.106	3.225	0.001
Accessibility and Availability	-0.125	0.031	-0.126	-3.994	0.000

Table 6: Model fit and univariate ANOVA Table

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.838	0.702	0.699	3.473

ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	11555.827	5	2311.165	191.607	0.000
	Residual	4897.171	406	12.062		
	Total	16452.998	411			

Table 7: Multiple regression univariate ANOVA

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	960.799	1	960.799	25.427	0.00
	Residual (age)	15492.199	410	37.786		
	Total	16452.998	411			
	Regression	639.494	1	639.494	16.580	0.00
	Residual (marital status)	15813.503	410	38.570		
	Total	16452.998	411			
	Regression	868.746	1	868.746	22.855	0.00
	Residual (employment)	15584.252	410	38.010		
	Total	16452.998	411			
	Regression	391.910	1	391.910	10.005	0.002
	Residual (num. year recycling)	16061.087	410	39.173		
	Total	16452.998	411			

Appendix: Survey Questionnaire

Situational factors (RQ1)

	Strongly Agree				**Strongly Disagree**
I am aware that environmental issues are becoming more urgent than before.	5	4	3	2	1
I know recycling is helping the environment.	5	4	3	2	1
I check product labels for disposal information when I go shopping.	5	4	3	2	1
Given a choice, I would definitely purchase a product that is easier to dispose of than similar alternatives.	1	2	3	4	5
Given a choice, I select products with the recycling symbol.	5	4	3	2	1
I recycle most of my recyclable items.	5	4	3	2	1
I would definitely recycle If I received information that recycling has become more important to the environment than previously believed.	5	4	3	2	1
I would still recycle if I received information that recycling is less important to the environment than previously believed.	5	4	3	2	1

Knowledge of householders about recyclates (RQ1).

Which goods/materials are you currently recycling…? Please tick O all that apply.	
Aluminium (packaging materials)	
Glass (bottles, jars and containers)	
Newspaper/Magazines/Pamphlets	
White A4 Paper	
Cardboard boxes (packaging materials)	
Plastic (bottles, tubs and containers)	
Plastic Bags	
Tin Cans	
Clothing and textiles	
Others (Please state the items)_____	
I recycle…: Please tick O all that apply.	
To comply with regulations	
Improve the environment	
To represent a good image	
To serve an environmentally conscious society	
Financial gains from the sale of recyclable products	
Do not know	
Other:_____	
Separation and Sorting the wastes are usually done by:	a. Myself b. Other member of the household _____ c. The whole household

Activities and stimulants derived from situational factors (RQ2).

	Always				**Never**
Most of the recyclables are being disposed by					
Putting them in with the rest of my rubbish (i.e. they are not separated).	5	4	3	2	1
Putting them separately from the rest of my rubbish.	5	4	3	2	1
Informing the right operator for collection (especially for larger items - furniture, electrical appliances or garden wastes).	5	4	3	2	1
Dropping them off to recycling centres (e.g. at a supermarket or household waste and recycling centre.	5	4	3	2	1
Would you be willing to drop off recycling items if given convenience (closer to residential and accessible) location?	5	4	3	2	1
It is good that the environment is taken more into account, and for me personally it is a disadvantage that more effort is expected to protect the environment.	1	2	3	4	5
It is good that the environment is taken more into account, but for me personally it is an advantage that I can now increase my effort to protect the environment.	5	4	3	2	1
If necessary, I would be willing to pay extra for recycling services to be provided.	5	4	3	2	1
My recycling bins are usually fuller than my general bins.	5	4	3	2	1
The bins' collection times really affect my recycling routines	5	4	3	2	1
The size and ease of use of the wheeled bins affect how I manage my waste and recycling routines	5	4	3	2	1
The liners or bags provided affect how I manage my waste and recycling routines	5	4	3	2	1
I have my own separation system in my house to make me and other occupants participate more in recycling at home.	5	4	3	2	1
I often find it difficult to dispose of larger items (mattresses, old furniture, electrical appliances)	5	4	3	2	1
I would definitely dispose of my larger items properly if there a collection services periodically in my residential area.	5	4	3	2	1
I would definitely improve my recycling routines if there were more recycling bins in public areas (shopping complexes, leisure centres, recreational centres, main streets)	5	4	3	2	1

Attributes and elements derived from the interaction between situational personal factors (RQ3).

	Strongly Agree				Strongly Disagree
The reasons people are not recycling are:					
They do not use goods/materials that can be recycled	5	4	3	2	1
They are not aware which goods and materials could be recycled	5	4	3	2	1
The cost associated with recycling	5	4	3	2	1
The accessibility to recycling facilities	5	4	3	2	1
The time required to prepare goods for recycling	5	4	3	2	1
Their lack of knowledge about recycling programmes	5	4	3	2	1
My major sources of information about recycling include:					
Magazines and newspaper	5	4	3	2	1
The Internet	5	4	3	2	1
Television	5	4	3	2	1
Local Councils	5	4	3	2	1
Environmental Community Group (of Non-Governmental Organizations)	5	4	3	2	1
I would like a pick up facility for my larger recyclable items.	5	4	3	2	1
What services would you expect from local council disposal facilities?					
Dependable scheduled pick-ups	5	4	3	2	1
Councils employees separate goods/materials (i.e., glass, aluminium, etc.)	5	4	3	2	1
Provision of storage unit recyclables (i.e., trash cans, bins, etc.)	5	4	3	2	1
I am aware of a facility where I can take recyclable items that I may wish to dispose of.	5	4	3	2	1
I find out about recycling centres from:					
Council's webpage	5	4	3	2	1
Friends / family tell me	5	4	3	2	1
I read about it in the local paper	5	4	3	2	1
Information mailed to me by my local council	5	4	3	2	1
I enquired at my local council	5	4	3	2	1
I use the bulk rubbish collection service provided by my local council.	5	4	3	2	1
If the council provides all the necessary facilities (in public areas and near the residential areas) for recycling, I would definitely use it.	5	4	3	2	1
The distances from my residence to the recycling centres have a major impact on my recycling habits.	5	4	3	2	1
What would be the best way to communicate information regarding recycling facilities and services to you and your residence?					
Television advertising / promotion	5	4	3	2	1
Information in the local community paper	5	4	3	2	1
A letter from the council providing details of the facility	5	4	3	2	1
Awareness programmes held by government agencies or Non-Governmental Organisations	5	4	3	2	1