Edith Cowan University

Research Online

1-1-2014

Australian SMEs: Waste sent to landfill

Janice Redmond
Edith Cowan University, j.redmond@ecu.edu.au

Elizabeth A. Walker
Edith Cowan University, elizabeth.walker@ecu.edu.au

Craig M. Parker

Mike Simpson

Australian SMEs: Waste Sent to Landfill

Janice Redmond and Elizabeth A. Walker

School of Management, Small and Medium Enterprise Research Centre, Edith Cowan University, Joondalup, Australia

Craig M. Parker

School of Information and Business Analytics, Deakin University, Burwood, Australia

Mike Simpson

Management School, University of Sheffield, Sheffield, UK

ABSTRACT

Landfill waste has a negative impact on the environment and Small and Medium Enterprises (SMEs) are believed to be significant contributors. There is little government or scholarly research, however, quantifying the collective volume of waste SMEs send to landfill. The limited studies instead measure total volumes (landfill and recycling combined) and/or do not distinguish between specific waste streams (e.g. wood) and subcategories (e.g. dust). This paper contributes to knowledge by reconceptualising SME waste into subcategories and by measuring landfill volumes. It presents findings from 404 Australian SMEs which found that, in descending order, cardboard, paper, plastic wrap, wood dust and particleboard were the subcategories these SMEs sent to landfill in the greatest volumes. It also argues that this reconceptualisation and associated data collection protocols have the potential to enable scholars and policymakers to determine the waste subcategories to which SMEs contribute most, formulate targeted interventions and research/evaluate environmental outcomes.

KEY WORDS

INTRODUCTION

Small and medium sized enterprises (SMEs) are a major part of all world economies (Mir, 2008). In countries such as Australia (EPHC, 2010) and the UK (DEFRA, 2010a) they are also believed to be major contributors to landfill (DEFRA, 2010b; Environment Agency Wales, 2009) which is of concern because many waste streams (e.g. metals, liquids, plastics) can cause environmental contamination (Messineo and Panno, 2008). Landfill should be the last choice but many SMEs use it as a first choice for waste (Radwan et al., 2010; Revell and Blackburn, 2007). This is emphasised by Environment Agency Wales (2009, p.22) which found 50% of waste produced by small firms (fewer than 50 staff) and 40% by medium firms (fewer than 250 staff) was sent to landfill in 2007. There are no government reports which provide data about the volumes of waste Australian SMEs send to landfill. However, one scholarly survey reporting on waste volumes produced by SMEs in Hobart suggests the Welsh findings may be indicative because the study noted that 48% of waste was not recycled and likely destined for landfill (Parsons and Kriwoken, 2010).

Addressing this environmental management problem requires data, as provided in our study, which quantifies the waste streams SMEs send to landfill in the largest volumes. While government studies in the UK (DEFRA, 2010a) and Australia (EPHC, 2010) report total waste produced by SMEs, they do not separate the volumes by disposal type (e.g. landfill, recycling, reuse) or waste stream. Further, these studies and the Welsh study do not divide waste streams into subcategories (e.g. types of plastic waste such as plastic wrap, plastic containers and polystyrene). This makes it difficult to identify the waste subcategories requiring the most attention and to tailor (possibly different) interventions accordingly. The collection of this data longitudinally would also facilitate evaluation of interventions and their environmental outcomes.

Existing scholarly research also offers limited quantification of waste streams/subcategories which SMEs contribute most to landfill. Prior research has focused on whether SMEs recycle (e.g. Corderio et al., 2012; Revell et al. 2010), barriers to and determinants of waste management behaviour (e.g. Radwan et al., 2010), and/or describing recycling practices (e.g. Bos-Brouwers, 2010; Evans and Sawyer, 2010). These works are important, but failure to distinguish between waste streams/subcategories and/or to quantify landfill volumes may disguise the fact that SMEs may recycle and yet still send large volumes of specific waste streams/subcategories to landfill (Parsons and Kriwoken, 2010).

Only three recent surveys, all Australian, quantify waste volumes produced by SMEs. Of these, Redmond et al. (2008) does not distinguish between recycling and landfill volumes and Walker et al. (2008) makes this distinction but only for a few waste streams. The findings of the third survey, Parsons and Kriwoken (2010), are discussed extensively in our paper for two reasons. First, it appears to be the only study in Australia which has attempted to quantify the waste streams SMEs recycle versus those sent to landfill. This complements the results we report in this paper. Our work differs from Parsons and Kriwoken, however, because we subdivided many waste streams into subcategories to determine what waste SMEs send to landfill. Further, we also identify options for reducing the landfill volumes for a range of selected subcategories. Second, a comparison of waste recovery rates across Australia in 2008-09 shows that Tasmania and Western Australia are two of the worst states for recovery and diversion from landfill at 16% and 32% of material recovered respectively and the remaining percentage sent to landfill compared to recovery rates of 75% (ACT) and 68% (SA) (Western Australian Waste Authority, 2012). In Australia SMEs, the context of this paper, are those with fewer than 200 staff and comprise 99.7% all businesses, equating to over two million enterprises as of June 2009 (ABS, 2010).

This paper makes two important contributions to knowledge. First, it argues that SME waste should be reconceptualised as waste subcategories, not just waste streams. Second, it is one of few studies quantifying the subcategories SMEs send to landfill in the greatest volumes. The research approach has the potential to enable policymakers to formulate targeted interventions and to evaluate the environmental outcomes of these interventions over time. This approach can provide the basis for future scholarly and policymaker research.

LITERATURE REVIEW

The existing SME literature related to environmental issues provides limited insights into how to reduce the volumes of waste SMEs send to landfill because waste is often subsumed into general SME environmental management issues, which also includes carbon emissions and water conservation. In addition several studies have found that many SMEs are not fully engaged in environmental management *per se* (e.g. Bos-Brouwers, 2010; Evans and Sawyer, 2010). However, they often do engage in waste management (Cassells and Lewis, 2011; Redmond et al. 2008) even if owner-managers do not see appropriate waste disposal as part of an environmental management strategy (Evans and Sawyer, 2010). So there is an obvious need to educate and motivate SMEs to become interested and more actively involved.

In regard to general waste management behaviours some studies state whether SMEs recycle or not (e.g. Corderio et al., 2012; Revell et al. 2010) or provide responses about the specific waste streams SMEs produce using a single measure of recycling (e.g. Cordano et al., 2010; Marshall et al., 2010). Similarly, other studies focus on generic waste reduction or recycling practices irrespective of the waste stream (e.g. Cassells and Lewis, 2011; Bos-Brouwers, 2010) or just list waste streams which one or more SMEs recycle (Evans and Sawyer, 2010). These approaches, while clearly appropriate to the individual studies' objectives, do not give a holistic picture of the issue of differing waste streams.

A holistic picture begins to emerge in the few studies discriminating between waste streams (e.g. DEFRA, 2010b; Granek and Hassanali, 2006; Radwan et al., 2010) which have found that SMEs produce multiple waste streams and the potential for recycling and cost savings differ for each (see Walker et al., 2008). In addition, some waste streams/subcategories are a cost regardless of whether they are recycled or sent to landfill (e.g. paper and cardboard) and/or for some there is a lack of recycling services (e.g. wood pallets) (DEFRA, 2010b; Walker et al., 2008). Similarly, other studies have found that some SMEs struggle to handle multiple waste streams due to lack of time to separate them, no space to store multiple bins, and/or the need to treat some waste streams/subcategories prior to recycler collection (Radwan et al., 2010; Parsons and Kriwoken, 2010).

Some studies do provide insights into a single waste stream (e.g. Alcalde et al., 2005) or into a few waste streams/subcategories (e.g. Radwan et al., 2010) but do not report on the volumes produced. One study reports on the total volumes of various waste streams produced by SMEs, but did not separate recycling from landfill volumes (Redmond et al., 2008). Studies which do calculate landfill waste volumes or reductions are at the organisational level (Cote et al., 2008; Friedman and Miles, 2001; Gombault and Versteege, 1999; Zackrisson et al., 2008) or across entire waste reduction programmes (Granek and Hassanali, 2006; Heras and Arana, 2010; Huppe et al., 2006) and tend to focus on a few waste streams but do not distinguish between streams/subcategories. Some studies identify multiple waste streams but do not examine the volumes SMEs produce of each (e.g. Laner and Rechberger, 2009; Seiffert, 2008) or which they send to landfill (e.g. DEFRA, 2010b; Environment Agency Wales, 2009); and these studies tend not to divide waste streams into more granular subcategories.

Additional challenges with collecting waste volume data from this sector include SMEs not recording waste volumes (DEFRA, 2010b), and SMEs operating in shared or rented premises so that individual business volumes cannot be determined (DEFRA, 2010a). When data has been collected it has been via face-to-face surveys on a large scale (DEFRA, 2010a; Environment Agency Wales, 2009) or smaller scale (Parsons and Kriwoken, 2010; Redmond et al., 2008; Walker et al., 2008). While these face-to-face surveys are resource intensive, this approach can produce insights into the waste streams/subcategories SMEs send to landfill so that future research and interventions can be targeted more effectively. Our analysis of the literature therefore suggests the need to answer the following research question:

> *Which waste streams/subcategories do SMEs produce which are destined for landfill in the largest volumes?*

DATA COLLECTION METHOD

A quantitative face-to-face survey was deemed to be the most effective way to collect data on waste stream/subcategory volumes which SMEs sent to landfill (see Parsons and Kriwoken, 2010; Redmond et al., 2008; Walker et al., 2008). Therefore the survey was administered on-site to 466 SMEs in two light industrial areas in metropolitan Perth, Western Australia. Results presented here are a subset of a larger study which explored the engagement of SMEs in environmental management, including their energy and water conservation practices. The overarching focus of the survey, however, was on waste management.

A 47 item survey was developed consisting of quantitative questions related to the SMEs' characteristics (e.g. What is your business? Are the premises owned or leased?) and waste practices (e.g. what waste streams/subcategories are produced and, for each, whether it was recycled or sent to landfill). Prior to conducting the survey, checks were made for both face validity and content validity (Cavana et al., 2001). Staff that administered the survey were trained to ensure consistency and reliability of data collection. A total of 404 SMEs took part in the study resulting in a response rate of 87%. We strongly believe that the face-to-face protocol contributed to the high response rate.

The research noted earlier (Parsons and Kriwoken, 2010; Radwan et al., 2010) which found that waste storage is a challenge for some, especially smaller SMEs, suggests that volume was a better measure than weight for most waste streams/subcategories in an SME context. Using this method also enabled us to compare our findings with Parsons and Kriwoken (2010) who reported the waste stream volumes in litres. Respondents were asked to estimate the total volume of each waste stream/subcategory produced each week in cubic metres. Our protocol

used more waste subcategories than prior research (e.g. Environment Agency Wales, 2009; Parsons and Kriwoken, 2010), so in a few cases we reverted to measures respondents found easier: liquids in litres; metals in kilograms; and items such as batteries and tyres in units. This meant we had to convert these measures to cubic metres (as outlined later) to enable comparisons between waste streams/subcategories and the findings of Parsons and Kriwoken (2010). One limitation of our study compared to Parsons and Kriwoken (2010) was that staff did not measure the waste storage containers, but consistent with these other authors the face-to-face protocol meant staff could verify respondents' estimates.

Respondents were asked for each waste stream/subcategory, whether it was recycled or sent to landfill. Consistent with Parsons and Kriwoken (2010), recycling included disposal using recycling contractors, municipal kerbside recycling or reuse within the business. The face-to-face protocol meant staff could also verify or sight proof of respondents' claims about the disposal method. Unlike Parsons and Kriwoken we examined non-recycling disposal types in more detail for liquids (the sewer system and stormwater drains). Respondents were assured of anonymity as some of these disposal methods are illegal and, while we were certainly not condoning these actions, we believed that it was critically important to collect the real data so it was important that businesses did not see us as regulators. It should also be noted that local regulators were well aware of inappropriate disposal from anecdotal sources, but had no quantitative data. We considered all non-recycling forms of disposal (i.e. council collections) to be destined for landfill (see Parsons and Kriwoken, 2010). Whilst acknowledging that some waste transfer stations and landfill sites may recover some waste streams (e.g. metal) and by-products (e.g. methane converted to energy) this is not guaranteed and so we considered waste which was not reused or handled by recycling services to be destined for landfill from an SME perspective and as having potential negative environmental impact.

RESULTS

Sample

The profile of the SME respondents is consistent with light manufacturing and service businesses in Australia and elsewhere in that the majority were independently owned (92%), operated by males (84%) aged 50 and under (75%), with high school or trade related backgrounds (63%) at the micro or small businesses level (88%) with few employing 20 or more staff (12%). The sample is also biased toward manufacturers, but this reflects our focus on light industrial areas. For this reason, the findings are likely to be indicative only of SMEs in light industrial areas. We have addressed this limitation to some extent by comparing the waste volumes from this study with Parsons and Kriwoken (2010) who surveyed SMEs in Hobart, Australia, as those SMEs were not necessarily in light industrial areas. Parsons and Kriwoken did not provide a respondent profile to enable us to compare our studies' demographic breakdown by industry or business size.

Waste streams/subcategories from SMEs destined for landfill

Table 1 summarises, for each waste stream/subcategory, the total mass/volume produced each week in total, the percentage and volume which was destined for landfill each week, and the total mass/volume destined for landfill each year (based on 52 weeks each year). It also summarises Parsons and Kriwoken's (2010) findings to enable comparison. Comparing the two Australian studies, while not always enabling full explanation of the differences found between locations, does provide some valuable insights to SME waste streams sent to landfill in Australia and also highlights some of the issues with data collection and reporting methods.

Insert Table 1 about here

Our study and that of Parsons and Kriwoken (2010) (referred to as Study A and B respectively for brevity from here) did not use stratified samples so we cannot extrapolate to the population of Australian SMEs like government studies (e.g. Environment Agency Wales, 2009) which do use such samples. Unlike these government studies, however, these studies focus on landfill volumes (not total waste including recycling) and suggest that SMEs, collectively, may contribute significant volumes of many waste streams to landfill. The total volumes for each stream differ between Studies A and B but those destined for landfill in the greatest volumes (in approximate descending order) are plastic and paper/cardboard, wood, metal, glass, liquids and rubber.

Our findings emphasise the need to analyse waste *subcategories* to gain a better picture. For instance, Environment Agency Wales (2009), due to the wide scale nature of their research, mostly use waste streams rather than subcategories. Table 1 provides more detailed insights than these large scale studies because, for instance, it shows that the SMEs contribute large quantities of plastic wrap to landfill. It is possible that different interventions may be effective at reducing the volumes of each subcategory.

Another reason for differentiating between subcategories is that each may have different environmental impacts as shown in the Study A results in particular. For example, degreasers are destined for landfill in smaller

volumes relative to many other streams/subcategories, but 4% was disposed into stormwater drains, which is highly likely to have a negative impact on the waterways to which the drains connect. With cardboard, the volume sent to landfill may be the major environmental concern because it is an expensive waste of a useable resource in terms of transport, space and cost to industry in raw material.

Table 1 also highlights the need for consistent waste streams/subcategories to enable comparison of future studies. The subcategories we use are tailored for an SME context and we believe they are useful because they offer different insights than prior work (e.g. DEFRA, 2010b; Environmental Agency Wales, 2009; Parsons and Kriwoken, 2010). For instance, Study A shows that pallets, dust and particleboard are the main wood-based subcategories which are destined for landfill.

DISCUSSION

Our findings reveal that overall there is a significant amount of business waste from various streams and subcategories being disposed of via landfill or other methods. This is not a surprising result, given the nature of business processes, so the issue that really needs to be considered is how can the volume be reduced? Interventions for engaging SMEs in greater recycling or waste/environmental management are well known and include: regulations; voluntary schemes; financial penalties and incentives; education and awareness campaigns; waste audits; business advice services; SME networking; and market-based mechanisms (see Parker et al. 2009). There is debate, however, about their effectiveness with SMEs. For example, owner-managers often state that regulations drive their behaviour (e.g. Revell et al., 2010) but regulations are ineffective if authorities do not conduct compliance visits (e.g. Wilson et al., 2010). Therefore even if there are regulations that stipulate specific actions in regard to waste disposal for SMEs, some may weigh up the cost of compliance versus the chance of being 'caught' not complying. In reality many SMEs take that risk and fly under the radar when it comes to environmental compliance (Redmond and Walker, 2009). Policymakers typically favour voluntary schemes where SMEs pursue cost savings or competitive advantage (Revell and Blackburn, 2007) but whether such benefits are achievable depends on the waste stream/subcategory (DEFRA, 2010b; Radwan et al., 2010) and SME characteristics such as lack of planning and poor or reactive management style (Revell et al., 2010; Simpson et al., 2004). Reducing landfill volumes produced by SMEs therefore necessitates a mix of interventions which takes into account the heterogeneity of SMEs (Parker et al., 2009) and the waste streams/subcategories.

In the next sections we discuss the findings and relevant literature regarding selected waste subcategories which SMEs sent to landfill in the largest volumes. More importantly, we show the value of reconceptualising waste into subcategories by exploring interventions which could be considered for reducing the volumes and/or arising future research opportunities.

Steel

The volume of steel destined for landfill varied between Studies A and B. Most Study A SMEs (90%) recycled steel and as a consequence the mass being sent to landfill was lower compared to many other waste streams/subcategories. Our findings are consistent with the few prior studies which mention steel recycling by SMEs (Redmond et al., 2008; Walker et al., 2008). Study B SMEs, by contrast, only recycled 7% of steel and the amount destined for landfill was higher than many other streams/subcategories in Study B.

The reason for this disparity is not clear. One explanation could be that prior research found that some Perth SMEs derived income from recycling steel or were not charged for collection (Walker et al., 2008) and it may be that the quantities from Study B SMEs were too low to receive income or get it collected. Further, Study A SMEs were located in light industrial areas and this may have facilitated collection/income due to conglomeration, while Study B SMEs (not necessarily in industrial areas) had to deliver to the few/inconvenient recycling locations and/or faced challenges such as separating steel from other waste and having insufficient space to store it.

Future research into these issues could determine if a possible intervention is introducing convenient drop-off locations to accept small volumes for collection by recycling contractors. For instance, fuel stations may be an option because there are many of them, they are convenient and may have room for storage and collection. Our findings also suggest that future data collection protocols may need to breakdown steel into types (perhaps tailored to SMEs' industries) to identify the steel waste types causing the problems.

Dust, particleboard and MDF

The findings in Table 1 show that wood was a waste stream both Study A and Study B SMEs were sending to landfill in higher quantities than other streams such as metals and liquids, with 43% of Study A and 100% of Study B volumes not being recycling. Our results show that (for Study A SMEs) dust, particleboard and, to a

lesser extent, MDF were the subcategories comprising most of this waste. For example, Table 1 suggests that Study A SMEs do not recycle particleboard (80%) and MDF (93%), perhaps because it takes up more storage space compared to wood dust.

The few studies with wood recycling findings looked at waste reductions by SMEs in an environmental sustainability club (Huppe et al., 2006). The only interventions studied related to SMEs working together in supply chains (Cote et al., 2008) or business networks (Peters and Turner, 2004) to reduce wood waste. It should be noted that both of these interventions rely on SMEs being proactive. Future research is needed to identify interventions for targeting more reactive SMEs so desired volume reductions can be achieved.

Plastic wrap

Plastic wrap is a film typically used to package products and secure pallet loads received by SMEs (Cote et al., 2008) and ends up as waste. Table 1 shows that SMEs from Studies A and B typically did not recycle plastic wrap (75% and 69% respectively) and instead sent it to landfill in large volumes compared to most other waste streams/subcategories. The studies on SMEs and plastic wrap found that only a few reuse (Evans and Sawyer, 2010) or recycle it (Peters and Turner, 2004).

The research by Peters and Turner (2004) looked at some of the interventions which helped SMEs to reduce the volume of this waste. Peters and Turner (2004) found some SMEs in business networks reduced plastic wrap by compacting it on-site (in a box with a small hole) and then taking it to another company on the same industrial site which bailed and recycled for other SMEs. This is an excellent example of business-to-business support for recycling, however, such networks are difficult to establish (Peters and Turner, 2004) and attract only those who are or wish to be proactive (Collins et al., 2007).

An alternative is for SMEs to require suppliers to take-back plastic wrap and other packaging waste (Cote et al., 2008) but SMEs have little power unless voluntary industry principles or regulations require this of suppliers. The limited research on SMEs and packaging suggests existing Extended Producer Responsibility (EPR) schemes in some countries (e.g. Spain) place the onus on SMEs to recycle (Alcalde et al., 2005). The Australian Packaging Covenant (2010), which is the packaging industry's voluntary EPR initiative, appears to have a similar principle (along with packaging reduction by manufacturers) which focuses on small business recycling rather than suppliers taking responsibility by retrieving packaging from SMEs.

Cardboard and paper

Similar interventions with suppliers as those outlined above for plastic wrap are likely to be needed to address the issue that paper/cardboard was the largest waste stream which Study A and Study B SMEs sent to landfill despite 59% and 58% (respectively) recycling this waste (see Table 1). Most of the research on SME recycling of paper/cardboard found that many SMEs state they do recycle this waste stream (Cote et al., 2008; Dewhurst and Thomas, 2003; Evans and Sawyer, 2010; Tzchentke et al., 2008) and yet our findings suggest that, collectively, SMEs may still send this stream to landfill in volumes larger than other streams. Future research can investigate why. For instance, SMEs may reuse what they can but the total volume they produce outweighs their reuse needs and/or they may find that recycling options for (the remainder of) this stream are unavailable or too costly.

Study B found that cardboard was destined for landfill in greater volumes than paper, despite more SMEs sending paper (82%) to landfill relative to cardboard (34%), which suggests that future data collection protocols should differentiate between these subcategories. Possible reasons why cardboard is recycled less than paper, and requiring further research, might be cardboard taking up more space on-site and being more difficult to compact. The finding that paper and cardboard are being sent in the greatest volume to landfill compared to most other waste streams needs investigation and may reflect a lack of (or high cost) collection services.

Our findings overall suggest packaging and recycling industries could help provide co-mingled recycling services for SMEs including plastic wrap and paper/cardboard due to the SME waste separation barriers noted earlier. This would go some way to facilitating recycling of mixed waste commonly produced by SMEs (see Environment Agency Wales, 2009) which may otherwise be destined for landfill. SMEs with on-site space limitations would require frequent collection and/or communal bins for groups of SMEs which can be secured against contamination by third parties if the bins are in open space.

CONCLUSION

We argued in this paper that there has been limited research (or government data accessible to researchers) which has quantified the waste streams/subcategories which SMEs send to landfill. Our study makes a contribution by providing this information and the findings suggest that the waste streams requiring the highest priority research and intervention (in terms of volume) are paper/cardboard, plastics, wood and metal.

Our research also suggests future data collection protocols should include detailed waste subcategories, as this could complement other studies by identifying specific subcategories destined for landfill in greater volumes, developing targeted research or industry/government led interventions, evaluating the environmental outcomes of interventions, and facilitating comparative studies. Refinements to our protocol (such as splitting the paper/cardboard stream into subcategories) and future research opportunities arose from our research. We acknowledge that any data collection protocol that includes the recommended changes, including face-to-face collection, is resource intensive, but we suggest that it is needed to more effectively measure and evaluate progress towards zero waste policies in countries such as Australia, and ensuring that recycling funding achieves optimal outcomes. Further, such a protocol can be tailored for particular industries or localities such as industrial areas and retail strips to enable researchers, industry and policymakers to identify appropriate interventions such as stimulating innovation into affordable and convenient waste separation technology.

This paper makes a contribution to knowledge by presenting empirical evidence that future environmental management research should reconceptualise SME waste as separate streams and subcategories to develop a more accurate understanding of collective SME waste disposal behaviours. Our findings suggest that collective contributions by SMEs to landfill volumes may be significant even if many are recycling because practices vary widely depending on waste subcategories. It is also possible that some government and/or industry interventions may differ depending on waste subcategories, in addition to the characteristics of SMEs and their locality. Without more local, standardised measurement of SME waste subcategories, important information that can point us toward effective intervention or innovation investment will be missed and waste reduction targets will not be achieved.

REFERENCES

ABS (2010) Counts of Australian Businesses, including Entries and Exits, Jun 2007 to Jun 2009, Australian Bureau of Statistics, Available from www.abs.gov.au/ausstats/abs@.nsf/mf/8165.0.

Alcalde, N., Garces, C., Pedraja, M., and Rivera, P. (2005) The Recycling of Container and Packaging Waste in the Spanish Retail Distribution Sector, *Environment and Planning A*, 37(8), pp. 1461-1477.

Australian Packaging Covenant (2010) The National Packaging Covenant 2010 Annual Report, Available www.packagingcovenant.org.au/page.php?name=apcannualreports

Bos-Brouwers, H. (2010) Corporate Sustainability and Innovation in SMEs: Evidence of Themes and Activities in Practice, *Business Strategy and the Environment*, 19, pp. 417–435.

Carrigan, M., Moraes, C., and Leek, S. (2011) Fostering Responsible Communities: A Community Social Marketing Approach to Sustainable Living, *Journal of Business Ethics*, 100(3), pp. 515-534.

Cassells, S., and Lewis, K. (2011) SMEs and Environmental Responsibility: Do Actions Reflect Attitudes?, *Corporate Social Responsibility and Environment Management*, 18(3), pp. 186-199.

Cavana, R.Y., Delahaye, B.L. and Sekaran, U. (2001) *Applied Business Research: Qualitative and Quantitative Methods*. Brisbane, Australia: Wiley.

Collins, E., Lawrence, S., Pavlovich, K. and Ryan, C. (2007) Business Networks and the Uptake of Sustainability Practices: The Case of New Zealand, *Journal of Cleaner Production*, 15(8-9), pp.729-740.

Cordano, M., Marshall, R.S., and Silverman, M. (2010) How do Small and Medium Enterprises go "Green"? A Study of Environmental Management Programs in the U.S. Wine Industry, *Journal of Business Ethics*, 92(3), pp. 463-478.

Cordeiro, J. J., Sarkis, J., Vazquez-Brust, D., Frater, L., and Dijkshoorn, J. (2012) An Evaluation of Technical Efficiency and Managerial Correlates of Solid Waste Management by Welsh SMEs using Parametric and Non-parametric Techniques, *Journal of the Operational Research Society*, 63(5), pp. 653-664.

Cote, R. P. Lopez, J. Marche, S. Perron, G. M. and Wright, R. (2008) Influences, Practices and Opportunities for Environmental Supply Chain Management in Nova Scotia SMEs, *Journal of Cleaner Production*, 16, pp. 1561-1570.

Darnall, N. Henriques, I. and Sadorsky, P. (2010) Adopting Proactive Environmental Strategy: The Influence of Stakeholders and Firm Size, *Journal of Management Studies*, 47(6), pp. 1072-1094.

DEFRA (2010a) Commercial and Industrial Waste Survey 2009: Final Report. Available www.defra.gov.uk/statistics/environment/waste/wrfg03-indcom/

DEFRA (2010b) Recycling Activities in SMEs: Final Report. Available randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16965

Dewhurst, H., and Thomas, R. (2003) Encouraging Sustainable Business Practices in a Non-regulatory Environment: A Case Study of Small Tourism Firms in a UK National Park, *Journal of Sustainable Tourism*, 11(5), pp. 383-403.

Redmond, J., Walker, E.A., Parker, C.M. and Simpson, M. (2012) Australian SMEs waste to landfill. This is the Authors' Original Manuscript of an article published by Taylor & Francis in the Australasian Journal of Environmental Management on 14 April 2014, available online: http://www.tandfonline.com/doi/abs/10.1080/14486563.2014.903210

Environment Agency Wales. (2009) Survey of Industrial and Commercial Waste Arisings in Wales. Produced by Urban Mines Ltd, The Cobbett centre for environmental Enterprise, Village Street, Norwood Green, Halifax, HX3 8QG for the Environment Agency Wales. Available from www.urbanmines.org.uk.

Evans, N. and Sawyer, J. (2010) CSR and Stakeholders of Small Businesses in Regional South Australia, *Social Responsibility Journal*, 6(3), pp. 433-451.

EPA (2011) Scrap Tires: Handbook on Recycling Applications and Management for the US and Mexico, Environmental Protection Agency, USA, Available www.epa.gov

EPHC (2010) National Waste Report 2010. Environment Protection and Heritage Council, Department of the Environment, Water, Heritage and Arts, Australian Commonwealth Government. Available www.ephc.gov.au/taxonomy/term/89/

Friedman, A.L., and Miles, S. (2001) SMEs and the Environment: Two Case Studies, *Eco-Management and Auditing*, 8(4), pp. 200-209.

Friedman, A.L., and Miles, S. (2002) SMEs and the Environment: Evaluating Dissemination Routes and Handholding Levels, *Business Strategy and the Environment*, 11(5), pp. 324-341.

Gombault, M., and Versteege, S. (1999) Cleaner Production in SMEs through a Partnership with (local) Authorities: Successes from the Netherlands, *Journal of Cleaner Production*, 7(4), pp. 249-261.

Granek, F. and Hassanali, M. (2006) The Toronto Region Sustainability Program: insights on the Adoption of Pollution Prevention Practices by Small to Medium-sized Manufacturers in the Greater Toronto Area (GTA), *Journal of Cleaner Production*, 14, pp. 572-579.

Gunningham, N. and Sinclair, D. (2002) Partnerships, Management Systems and the Search for Innovative Regulation in the Vehicle Body Shop Industry, *Business Strategy and the Environment*, 11, pp. 236–253.

Heras, I., and Arana, G. (2010) Alternative Models for Environmental Management in SMEs: the Case of Ekoscan vs. ISO 14001, *Journal of Cleaner Production*, 18(8), pp. 726-735.

Huppe, F. Turgeon, R. Ryan, T. and Vanasse, C. (2006) Fostering Pollution Prevention in Small Businesses: The Enviroclub Initiative, *Journal of Cleaner Production*, 14, pp. 563-571.

Laner, D. and Rechberger, H. (2009) Quantitative Evaluation of Waste Prevention on the Level of Small and Medium Sized Enterprises (SMEs), *Waste Management*, 29, pp. 606–613.

Marshall, R.S., Akoorie, M.E.M., Hamann, R., and Sinha, P. (2010) Environmental Practices in the Wine Industry: an Empirical Application of the Theory of Reasoned Action and Stakeholder Theory in the United States and New Zealand, *Journal of World Business*, 45(4), pp. 405-414.

Messineo, A. and Panno, D. (2008). Municipal Waste Management in Sicily: Practices and Challenges, *Waste Management*, 28, pp.1201-1208.

Mir, D.F. (2008) Environmental Behaviour in Chicago Automotive Repair Micro-enterprises (MEPs), *Business Strategy and the Environment*, 17(3), pp. 194-207.

National Timber Product Stewardship Group (2007) Development of an Extended Producer Responsibility Strategy for Waste Timber, Available www.timberstewardship.org.au/resources

Parker, C. Redmond, J. and Simpson, M. (2009) A Review of Interventions to Encourage SMEs to make Environmental Improvements, *Environment and Planning C: Government and Policy*, 26(2), pp. 279-301.

Parsons, S. and Kriwoken, L.K. (2010) Report: Maximizing Recycling Participation to Reduce Waste to Landfill: A Study of Small to Medium-sized Enterprises in Hobart, Tasmania, *Waste Management & Research*, 28, pp. 472–477.

Peters, M., and Turner, K.R. (2004) SME Environmental Attitudes and Participation in Local-scale Voluntary Initiatives: some Practical Applications, *Journal of Environmental Planning and Management*, 47(3), pp. 449-473.

Radwan, H.R.I., Jones, E., and Minoli, D. (2010) Managing Solid Waste in Small Hotels, *Journal of Sustainable Tourism*, 18(2), pp. 175-190.

Redmond, J. & Walker, B. (2009). Environmental Education in Small Business: The Owner-Manager's Perspective. *Australian Journal of Environmental Education, 25*, 117-128.

Redmond, J. Walker, B. and Wang, C. (2008) Issues for Small Business with Waste Management, *Journal of Environmental Management*, 88, pp. 275–285.

Revell, A. and Blackburn, R. A. (2007) The Business Case for Sustainability? An Examination of Small Firms in the UK's Construction and Restaurant Sectors, *Business Strategy and the Environment*, 16(6), pp. 404-420.

Revell, A., Stokes, D., and Chen, H. (2010) Small Businesses and the Environment: Turning Over a New Leaf?, *Business Strategy and the Environment*, 19(5), pp. 273-288.

Seiffert, M.E.B. (2008) Environmental Impact Evaluation Using a Cooperative Model for Implementing EMS (ISO 14001) in Small and Medium-sized Enterprises, *Journal of Cleaner Production*, 16, pp. 1447-1461.

Redmond, J., Walker, E.A., Parker, C.M. and Simpson, M. (2012) Australian SMEs waste to landfill. This is the Authors' Original Manuscript of an article published by Taylor & Francis in the Australasian Journal of Environmental Management on 14 April 2014, available online: http://www.tandfonline.com/doi/abs/10.1080/14486563.2014.903210

Simpson, M, Taylor, N. and Barker, K. (2004) Environmental Responsibility in SMEs: Does it Deliver Competitive Advantage?, *Business Strategy and the Environment*, 13(3), pp. 156-171.

Vale of Glamorgan Council (2012) Recycling Performance since Introduction of the Co-mingled Recycling Kerbside Collection Service in September 2011, Available www.valeofglamorgan.gov.uk/our_council/council/minutes,_agendas_and_reports/reports/cabinet/2012/12-03-14/recycling_performance.aspx

Tzschentke, N.A., Kirk, D., and Lynch, P.A. (2008) Going Green: Decisional Factors in Small Hospitality Operations, *International Journal of Hospitality Management*, 27(1), pp. 126-133.

Walker, B, Redmond, J, and Wang, C. (2008) Waste Recycling: Local Methods for Successful Interaction with Small Business, *International Journal of Environment and Sustainable Development*, 7(4), pp. 363-382.

Western Australian Waste Authority. (2012). Western Australian Waste Strategy: "Creating the Right Environment". Available at www.zerowaste.wa.gov.au

Wilson, C., Williams, I.D., and Kemp, S. (2011) Compliance with Producer Responsibility Legislation: Experiences from UK Small and Medium-sized Enterprises, *Business Strategy and the Environment*, 20(5), pp. 310-330.

Zackrisson, M., Rocha, C., Christiansen, K., and Jarnehammar, A. (2008) Stepwise Environmental Product Declarations: Ten SME Case Studies, *Journal of Cleaner Production*, 16(17), pp. 1872-1886.

Table 1. Waste produced and sent to landfill by Australian SMEs in one week.

Waste streams / subcategories	Perth SMEs (n=404) Study A				Hobart SMEs (n=436) (Parsons & Kriwoken) Study B			
	Total	Destined for landfill			Total	Destined for landfill		
	/ week	%	/ week	/ year	/ week	%	/ week	/ year
Metals (kg)	**157,050**	**10%**	**15,404.13**	**801,015**	**39 m³**	**90%**	**35 m³**	**1,820 m³**
Steel / ferrous metals (kg) [d]	153,916 (19 m³)	10%	15,391.60 (1.95 m³)	800,363 (101 m³)	30 m³	93%	28 m³	1,456 m³
Other metals / non-ferrous metals (kg)	3,134	0.4%	12.53	652	9 m³	78%	7 m³	364 m³
Plastics (m³)	**457**	**35%**	**158.22**	**8,227**	**119**	**76%**	**90**	**4,680**
Polystyrene (m³)	16	100%	16	832				
Plastic drums (m³)	67	23%	15.41	801				
Plastic wrap (m³)	88	75%	66	3,432	59	69%	41	2,132
Car bumpers (units)	25	24%	6	312				
Rigid plastic (m³)					21	90%	19	988
Container plastic (m³)					39	77%	30	1,560
Other plastic (m³)	261	21%	54.81	2,850				
Cardboard & paper (m³)	**235**	**41%**	**96.35**	**5,010**	**766**	**42%**	**319**	**16,588**
Paper (m³)					124	82%	102	5,304
Cardboard (m³)					642	34%	217	11,284
Wood (m³)	**168.49**	**43%**	**72.94**	**3,793**	**21.5**	**100%**	**21.5**	**1,118**
Solid timber (m³)	54	24%	12.96	674				
Pallets (units) Pallets (m³) [e]	62 (2.49 m³)	71%	44 (1.77 m³)	2,288 (92 m³)				
Dust (m³)	70	32%	22.4	1,165				
Particleboard (m³)	25	80%	20	1,040				
Medium Density Fibreboard (m³)	17	93%	15.81	822				
Liquids (litres)	**7,704 (7.7 m³)**	**5%**	**369.82 (.37 m³)**	**19,230 (19.2 m³)**	**51,305 (51.3 m³)**	**17%**	**8,570 (8.6 m³)**	**445,640 (447 m³)**
Oil (litres)	6,224	0.0025%	0.16	8	51,305	17%	8,570	445,640
Radiator coolant (litres)	1,032	31% [c] 0.5% [b]	319.92 [c] 5.16 [b]	16,636 [c] 268 [b]				
Paint (litres)	4	21%	0.84	44				
Thinners (litres)	211	13%	27.43	1,426				
Degreasers (litres)	233	4% [a] 3% [b]	9.32 [a] 6.99 [b]	485 [a] 363 [b]				
Rubber (m³)	**48**	**11%**	**5.31**	**276**				
Tyres (units) Tyres (m³) [f]	630 (48 m³)	11%	69 (5.31 m³)	3,588 (276 m³)				
Rubber buffed (m³)	1,200	0%	0	0				
Glass (m³)	**18**	**94%**	**16.92**	**880**	**42.5**	**16%**	**7**	**364**
Electronic (m3)	**3**	**39%**	**1.17**	**61**				
Other waste								
Vehicle batteries (units)	147	2% [b]	3 [b]	153 [b]				

Note: Figures are rounded to the nearest sensible value and some rounding errors may be present. The figures exclude cases where no response was given. [a] Disposed of in on-site storm water wells. [b] Type of disposal not specified. [c] Disposed of in sewer. [d] Converted using: www.aqua-calc.com/calculate/volume-to-weight
[e] Converted using www.translatorscafe.com/cafe/units-converter/volume-lumber/calculator/
[f] Estimated based on 13 passenger tyres per cubic metre (10 per cubic yard) (EPA, 2011, p.10)