Reducing building waste in Alice Springs

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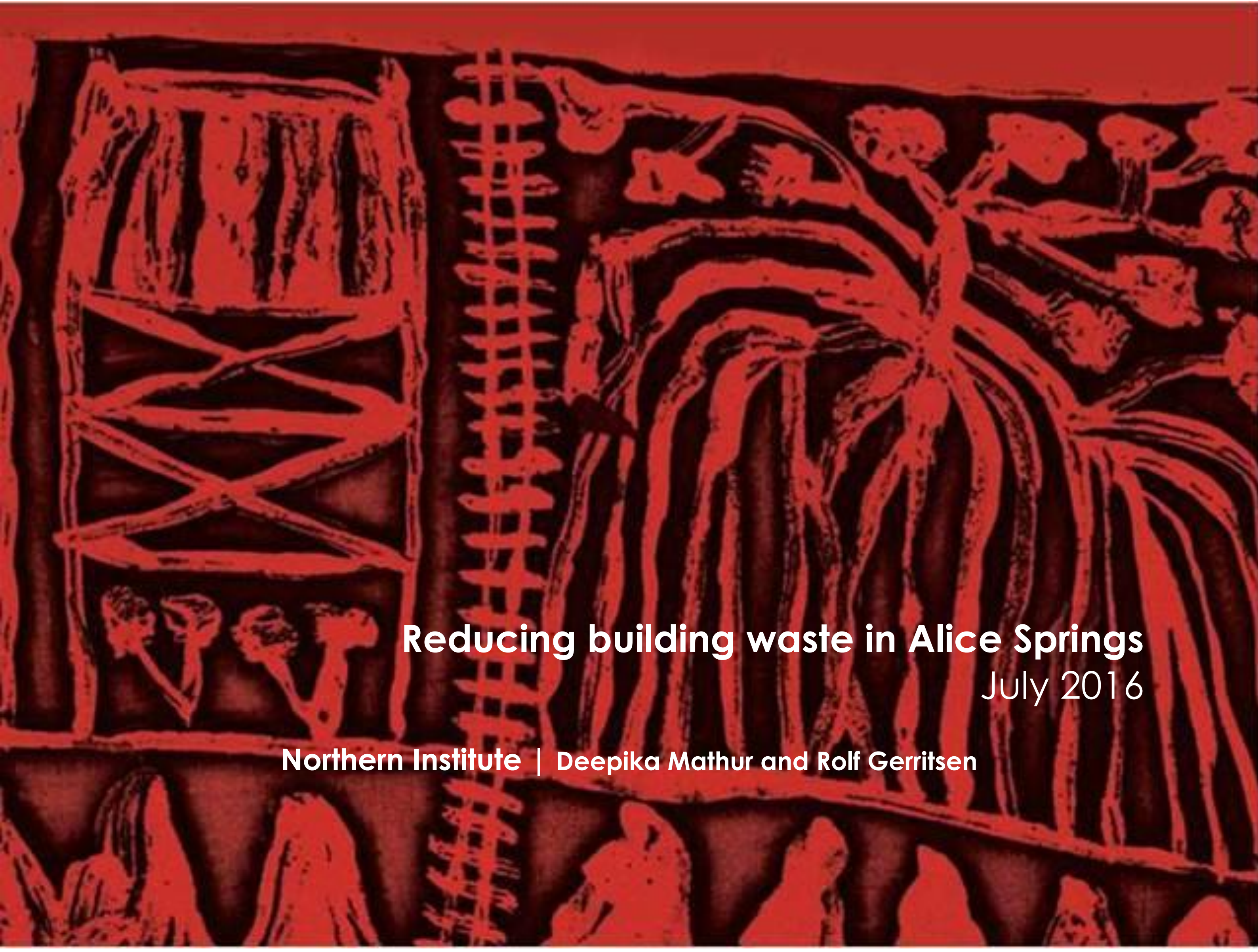

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Glossary and abbreviations used

ASTC	Alice Springs Town Council
C&D	Construction and Demolition
RWMF	Regional Waste Management Facility
Landfill	A site used for the controlled and legal deposit of solid waste onto or into land
Material recovery	Waste collected for recycling or reuse
Recycling	A set of processes (including biological) that converts solid waste into useful materials or products
Reuse	The use of a used product or material in its original state without reprocessing or remanufacture

Executive summary

Construction and demolition (C&D) waste is a critical issue in Australia, where it forms more than one third of the total waste generated. Several town councils and other regulatory authorities have developed policies towards construction and demolition material recovery and resource efficiency. However the situation with C&D waste is very different in the Northern Territory, especially in remote regional centres such as Alice Springs. Little information on construction waste management makes it difficult to form appropriate polices for waste reduction in this town. This project examines the composition of construction waste stream and identifies some of the challenges facing material recovery in Alice Springs.

The study used a qualitative methodology and data was collected through interviews of building contractors. The analysis of this data helped construct a list of construction and demolition waste materials generated on sites. The interviews also revealed the builders' approach to waste management and help identify some of the critical challenges to waste management in Alice Springs.

The findings reveal that some of the barriers facing the building industry recycling and reusing of construction waste are: limited options for recycling construction waste; lack of incentives and regulations for sorting waste; limited information on what C&D materials can be recycled and how; and a marked difference between the pro-environment attitude of construction professionals and their actions.

It is recommended that the Alice Springs Regional Waste Management authority has different disposal fee structure for sorted and unsorted waste and uses flyers to inform the builders about the recycling options. Additionally there is need for more research on quantity of C&D waste generated, identifying ways of reducing waste in design and planning stages as well as identifying new markets for recycling C&D waste materials.

1.0 Introduction

1.1 Background

Reliable information on the expected waste streams of C&D waste is important in order to establish reasonable policies as well as to propose alternative solutions for disposal of individual materials (Ding and Xiao, 2014). What needs stressing is that the data generated on waste recycling and reuse is mostly from large Australian cities and inner regional areas and might not incorporate the challenges of material recovery in remote regions. The discussion in this report centers on the need for understanding C&D waste composition as well as disposal practices in Alice Springs in order to form appropriate polices on C&D waste management in remote regional areas. Highlighting areas where intervention can lead to greater levels of material recovery is even more critical since it is anticipated that the local landfill will reach its capacity by 2010 at the current waste residual rates (Tonkin Consulting, 2010).

Alice Springs is a remote central Australian town with a population of 28,720(ABS, 2015). Construction is the second largest industry ($313 million) in this region after mining ($552 million) (NTG 2013). Data extrapolated form Alice Springs Town Council waste records suggest that 40% of the total waste is construction and demolition (C&D waste)(O'Leary, 2016). In Alice Springs the overall cost of construction is higher due to the additional freight cost of transporting virgin materials by road or railway. Additionally, higher fuel prices in Central Australia add to the cost of the building materials as well as to the cost of running construction machinery (Szava et al., 2007). Recycling of materials is very different in Alice Springs because of its remoteness and lack of access to reprocessing centres and subsequent transport costs.

1.2 Aim, scope and methodology

This report arises out of a research project "Reducing waste in Alice Springs", funded by the Northern Territory Environmental Protection Authority (NTEPA). The aim of this study was to gain an understanding of the current waste flow streams from building construction and to identify challenges in recycling and reusing waste in this sector. The study focuses on Alice Springs, although the results will be relevant for other remote towns as well.

This report will make recommendations, specifically for Alice Springs, for increasing level of recycling and reducing waste arising from construction and demolition activities. It is hoped that higher levels of recycling and reusing C&D waste will lead to reduced waste to landfill.

The project followed the following stages:

Literature review

A comprehensive survey of literature on C&D waste was done prior to starting the analysis. National and international publications were studied to identify best practices in recycling/reusing C&D materials, methodologies used and the barriers identified. Literature review also reflected the lack of literature on C&D waste management in regional centers.

Qualitative analysis

C&D waste stream analysis forms the core of the project. The data for this analysis was obtained through interviews of building contractors in Alice Springs, since they are responsible for disposing waste from construction sites.

Potential for increasing waste recycling and reusing

The analysis of qualitative data gave insights into current waste management practices and identified opportunities for increasing the waste reuse and recycling.

1.3 Acknowledgements

This study would not have been possible without the support and assistance of a number of building contractors, recyclers and other individuals who freely gave their time and information. The authors would particular wish to thank Joel Olzomer from MPH Carpentry and Construction who supported this project throughout with suggestions and sound advice.

2.0 Construction and demolition waste

2.1 Need for reducing construction and demolition waste

Construction and demolition (C&D) waste is generated throughout the life cycle of the building, during new construction, renovations and finally demolition. It is a mix of inert and non-inert materials which are either the by-product of the construction process or damaged or excess materials that cannot be used on site (Ekanayake and Ofori, 2004, Yuan et al., 2013, Fishbein, 1998, Kofoworola and Gheewala, 2009). Managing construction and demotion (C&D) waste is an important issue worldwide since the building industry utilizes 40% of material resources (Mercader-Moyano and Ramírez-de-Arellano-Agudo, 2013) and generates 35% of the total solid waste produced (Hendriks and Pietersen, 2000). Internationally the huge volumes of waste generated in various economies have been a problem. In 1996, the US generated 136 million tons of building-related C&D debris (Franklin Associates, 1998), the UK 70 million tons (McGrath et al., 2000) and Europe generated approximately 890 million tonnes of C&D waste (Villoria-Sáez et al., 2011, Brodersen et al., 2002). These large volumes pose a major challenge for regions with limited landfill capacity. Added to this is the difficulty and expense of developing new landfill sites, especially with increasing environmental concerns and public opposition(Wang, 2004) leading to calls to reduce C&D waste going to landfill. In Australia 18.2 million tonnes of C&D waste was produced nationally in 2010-11, of which 34 % was disposed to landfill, 65% was recycled and 0.3 % was used in energy recovery (DoE, 2013). Nationally the C&D waste stream constituted the greatest amount of waste generated as well as the waste stream with the highest recovery rate. However there is a large variation in resource recovery rates as well as target recovery rates between states and territories. The Australian states and local councils are responsible for regulation of waste and they have different recovery rates as well as targets (Brewer and Mooney, 2008). For example, in 2010-2011 South Australia and New South Wales recovered 75% of their C&D waste, Victoria 69%, Queensland 59 %, Western Australia 40%, Tasmania 2% and the Northern Territory 1% (DoE, 2013). Similarly other states (except Tasmania) have set targets for material recovery which are over 75% but Northern Territory's target are far lower, to divert 50% of the overall waste by 2020 but with no specific target for C&D waste (Hyder Consulting Pty Ltd, 2011).

2.2 Waste management strategies

Research on waste management strategies has had a significant impact on waste management practices in several countries. Different approaches have been instituted to reduce C&D waste. Extensive research has been conducted around the well-established hierarchy of the four strategies, namely waste reduction, reuse, recycling and disposal (Peng et al., 1997). Waste reduction strategies are considered the most effective and efficient method for minimizing waste generation thus reducing environmental problems and problems of disposal. These are adopted at the reducing waste generation in the design, planning and construction phases of a project (Poon et al., 2003, Gangolells et al., 2014, Ekanayake and Ofori, 2004, Osmani et al., 2006, Wang et al., 2014).

Since some C&D waste is inevitable, the other options for reducing materials to landfill are reusing and recycling the C&D waste materials. Reusing implies using the same material again, either for the same purpose, such as for timber formwork, or for a different purpose, such as crushing concrete to use as sub base (Wang et al., 2010, Ling and Leo, 2000, Duran et al., 2006, Peng et al., 1997, Issam Srour, 2012).If a material cannot be reused then often it can be reprocessed into a new material. For instance recovered plasterboard is ground and used in the manufacture of new plasterboard (Kartam et al., 2004, Tam, 2008). Proper disposal at the landfill site is considered the last option for materials that cannot be reused or recycled.

2.3 Policies and their impact

Initiatives through the regulatory framework, the economic pull of the market and incorporating waste management in the education of architects and engineers has helped in abating waste in several countries (Weisleder and Nasseri, 2006). The options of reducing, reusing and recycling are driven by legislation of waste management, mandatory requirements for different materials as well as the economic viability of recovery (Brewer and Mooney, 2008, Teo and Loosemore, 2001). Several European countries demonstrate examples of best practice by achieving very high rates of C&D waste recycling through these tools. Denmark is cited as the success story for achieving a 92% recycling rate for construction and demolition waste (Danish Environmental Protection Agency, 1999). They achieved this by higher taxes on the non-recycled waste and by making pre-separation of waste compulsory. To aid pre-separation the Danish Government has an agreement with the demolition contractors ensuring environmentally correct demolition of buildings leads to more recycling and less waste (Montecinos and Holda, 2006). Similarly, the Netherlands achieved its goal of recycling 90% of its C&D waste in 1999 and since then has aimed to achieve 95% recycling of waste produced (European Topic Center on Sustainable Cosumption and Production, 2008). The Dutch Building Material Decree(BMD) played a very important role in this by laying down rules for use and reuse of building materials (Eikelboom et al., 2001). Germany produces the most C&D waste in Europe but also recycles or reuses 85% of this waste (Mália et al., 2013). This was realized by focusing on the complete material life cycle, from production, removal, recycling and reuse. Therefore some of the successful instruments used to reduce waste going to landfill are regulatory frameworks forcing source separation, landfill tax, understanding life cycle of materials and setting mandatory targets.

The above mentioned approaches to reduce C&D waste in landfill are underpinned by analysis of waste data (London et al., 2013, Spivey, 1974, Dahlbo et al., 2015). This data can provide baseline information for forming policies and action plans. Cochran and Townsend (2010) emphasize the importance of understanding the material composition of the waste streams before suggesting solutions to manage these. They discuss the varying service life of different materials and hence the need to recycle or reuse them. Therefore, identifying categories for the waste generated is the first step towards managing waste. This allows the adoption of specific techniques in dealing effectively with each type of material waste.

3. Methodology

The aim of this project_was to identify C&D waste streams and approaches towards recycling and reducing waste in Alice Springs. A qualitative research approach was adopted for this study and data was collected through semi-structured interviews. Semi-structured interviews were conducted with builders, recyclers and the local town council staff. The objective was mapping the waste streams generated and obtaining insights into waste management strategies. Selected builders were from large, medium and small size construction businesses. Builders were selected as the primary source of information on C&D waste since they are responsible for disposing the waste generated on construction sites. The informants were broadly representative of builders working in a remote regional town.

Of the thirty nine builders listed in the Yellow Pages under Building Contractors, three worked only in remote areas outside of Alice Springs, one was an interior designer and five conducted only one trade, such as domestic and industrial fencing. The remaining thirty one builders were contacted. Of these ten builders agreed to be interviewed. Semi-structured interviews were chosen as the preferred method of data collection over a postal survey, since the participants were more likely to spend 20 minutes answering questions than filling in a survey and posting it back. The interviews were carried out between October, 2015 and February 2016. The study protocol was approved by the Charles Darwin University's ethic committee and written consent was obtained from the interviewees.

The interview questions were designed around C&D waste generated and how this waste was dealt with by the local builders. The common streams of materials identified in literature on C&D waste are concrete and bricks, asphalt, metals, timber, plastics, plasterboard, rock and excavation stone, soil/sand, roof tiles, asbestos, insulation and cardboard (Hyder Consulting Pty Ltd, 2011, Shen et al., 2004, National Key Centre for Design, 1997). These categories are the most likely elements of the waste generated and recovered in Alice Springs. Understanding that each material needs to be recovered differently is important when examining waste management approaches in Alice Springs. Data thus gathered would help understand current practices and the logistics surrounding disposal of C&D waste.

The interview questions were tested in a pilot study to ensure ease of understanding and clarity. The analysis consisted of pulling themes from the interview questions. This helped to group and unpack the ideas emerging from the interviews (Glaser, 1998).

This study is based on limited interviews and is exploratory in nature. It does not aim to make generalizations. It aims to raise issues that can be studied in-depth in subsequent research.

4. Results & Discussion

The following are the results from the interviews conducted in Alice Springs. The business size of the builders ranged from a one man business (sole trader) to a medium sized (3 to 8 employees) to a large construction business (more than 8 employees). These categories are not national but are appropriate for this based in a regional town.

4.1 C&D Waste composition and disposal

Builders were asked to comment on how they would dispose the listed C&D waste materials generated on a residential site. Table 1 shows how the builders currently dispose of their C&D waste.

Table 1: Disposal of C&D waste

Waste Material	Disposal method	
	Number of builders sending the C&D waste material to the tip	**Number of builders sending the C&D waste material elsewhere**
Sand	0	10- Reused on site
Clean fill	0	10- Reused on site
Metal	0	10- recycler
Concrete	7	3- subcontractor or reuse
Bricks	7	3- subcontractor or reuse
Timber	7	3- save for other projects/firewood
Cardboard boxes (packaging)	9	1
Indoor tiles	9	1-reuse
Glass	10	0
Plastic	10	0
Plasterboard	10	0
Any other:		
Insulation	10	0
Bad rubble	10	0
Paint residue	10	0

Clean Fill

From Table 1 it is evident that clean fill and sand were not considered waste and were reused on site. Clean fill has always been classified differently by various town councils and is not considered a waste in certain studies. Clean fill drop-off is deposited free of charge at the Alice Springs landfill.

Metal

Previously metal was always separated by the builders. It was then sent to the local metal recycler. Since that business closed down early 2015, some of the builders now send metal to the landfill. There are other metal recyclers in town but most of the builders were unsure whether they recycle ferrous or non-ferrous metals. Metal is mostly sorted on-site since it was the one material for which the builders are paid when they take it to the recyclers. When builders send the metal to the tip they have to pay for it, even if it is sorted. Ferrous (mild steel) and non-ferrous metals (Aluminium, Brass, Copper, Nickel, Tin, lead and Zinc) are usually recovered because of the price obtained for scrap metal through metal recyclers. This aligns with the conclusions of Hyder Consultants (2011), who found that very little metal ends up in landfill since it is constantly removed from the waste streams in both the metropolitan as well as the regional markets because it garners high returns.

Bricks and concrete

Bricks and concrete were the two biggest waste products on demolition sites. This was of concern to all the builders since they are heavy materials and therefore cost far more to dispose of at the landfill. The builders who did not send their bricks and concrete to the tip had an informal arrangement with contractors who crushed it at a smaller cost; but this was done thorough informal channels. A builder explained the re-processing when there was an established business in Alice Springs crushing concrete and bricks.

"There was an individual contractor but he had to close down due to environmental issues. We would take concrete to them and they would grind it and sell it back to us for a small fee. They were charging us $25 a tonne and we could buy back crushed concrete for $20 a tonne and use it for backfill. The tip charges us $ 110 to dump!"(Builder with 20 years' experience of working in Alice Springs, owner of a medium sized business)

Most builders would like to dispose of concrete and bricks in a cheaper way and buy back the crushed product. Although there is no study estimating the percentage of concrete and bricks in demolition projects in the Norther Territory, a study by Malia et al (2013) for the European Union found waste bricks from a residential refurbishment project could be up to 80% of the overall waste. This is supported by the study done by Osmani et al (2006) who found that brick masonry and concrete have by far the largest potential for recycling across the USA, UK, China, Brazil, Korea and Hong Kong. In metropolitan towns in Australia, the presence of large quantities of waste brick and concrete results in more attempts at recovery of these materials and more market development for reuse of these materials. Hyder Consultants (2011) claimed that in Sydney the high landfill costs and longer distances to access quarry products mean that reprocessed material has a higher demand. Similarly in Melbourne the higher landfill levy has led to developing the market for recycled concrete. In South Australia the prohibition on accepting goods that have not been pre-sorted increased the recovery of concrete and bricks. Additionally South Australia and Victoria have specifications that support the use of recycled masonry, which helps improve the recycling market. On the other hand, in Alice Springs there is a strong market for recycled product but no identified re-processors who would sell the reprocessed concrete and bricks back to the builders.

Timber

Timber was recycled by three respondents. They saved the doors, window frames and other materials that could be used in future projects or used as firewood. Two of these builders had off-site sheds for storing salvaged materials and the third builder got rid of the salvaged timber by giving it to people who would reuse it. Nationally there is a mixed market with a high value market for the reuse of good quality hardwood timber and a low value market for contaminated timber. As pointed out in a report by Edge Consultants (2012) wood from demolition waste was far harder to recover and recycle than wood from construction waste. Where there is mixed timber in demolition works, much of it is shredded and used as mulch in landscaping. However, contamination with even small amounts of treated material presents a barrier, since these materials cannot be used as mulch. The recycled wood needs to be clean of paints, stain and weather proofing and entire loads tend to be rejected for recycling at the tip because of contamination (Falk and McKeever, 2004). Therefore for timber to be reusable, it will need to be sorted at site into stockpiles of timber frames, structural members that can be reused and timber that is good for mulching, as well as timber that is only good as firewood.

Glass

All builders stated that there was negligible wastage of glass in new construction and glass from a demolition project was sent to the tip.

Plastic and Plasterboard

Plastic and Plasterboard were proportionately the next largest waste products but they were not of great concern because they are light materials. All the plastic and plasterboard was sent to the tip by builders. Although plasterboard is highly recyclable its friable nature makes it difficult to separate from mixed loads. It is considered a contaminant when mixed with other recovered C&D materials.(Edge Environment Pty Ltd, 2012, 2004, Hyder Consulting Pty Ltd, 2011). Some of the manufacturers in New South Wales, Victoria, Perth, the Gold coast and the ACT have schemes for collecting offcuts from construction sites (REGYP, 2012). Where the material is recovered it is ground down and reused as a substitute for virgin gypsum. However such schemes are limited to the metropolitan cities and most regional cities do not offer this facility. It would be useful to have a cost benefit study on collection and transporting offcuts of plasterboard board to a reprocessing centre in Adelaide. On construction sites plastic falls into packaging and non-packaging categories. The challenge is to separate recovery processes for single use plastic products, such as film, through to long term plastic products such as PVC pipes. There have been attempts in cities to recover long term durable products such as PVC piping form construction waste. The PVC recycling scheme has recovered 300-400 tonnes of demolition pipes and offcut PVC pipe in Sydney, Brisbane and Melbourne (Edge Environment Pty Ltd, 2012) but this recovery is very localised (PIPA, 2014).Although reprocessing of this material has established processes (Prestes et al., 2016) and has led to high rates of recycling in Denmark (Montecinos and Holda, 2006), it is the collection and transport to reprocessing centres that can be challenging in remote towns.

Cardboard

Although large quantities of cardboard are generated at the fit-out stage of a project, it is also sent to the landfill. Only one builder mentioned saving cardboard boxes, to use for transporting materials to remote areas. A considerable quantity of cardboard is generated during the fit-out stage of construction but is often put in landfill with other contaminants reducing its potential for being recycled. This view is supported by Hyder Consultants (2011), who point out that there are options for clean cardboard recovery but storage and consolidation are deterrents. If there was an incentive for at-source separation of cardboard, as well as separate bins on site for onsite storage, uncontaminated cardboard could be collected separately. Domestic cardboard is free to be dropped off at the local recycling centre (Cleanaway) but the commercial organizations, such as building contractors, have to pay a high price ($200 for a three week hire of a skip for cardboard and paper) for a skip bin to be delivered to site and then emptied at the tip. As a result it is more economical for the builders to dispose of it at the tip as mixed waste.

The results show that there is a high demand for using crushed concrete and bricks in Alice Springs but that builders have limited options. They have to send the bricks and concrete waste to the tip landfill and do not get the opportunity to buy it back. In remote towns, where the costs of virgin construction materials are higher due to distance from suppliers, it would beneficial for them to have the choice of subcontractors crushing these heavy and bulky products and reselling it to them. It is critical to let the users, in this case the builders, know the options regarding recycling. Additionally more information on metal recyclers accepting scrap metal is required so that they source separate the metal and get returns on it. Again since timber is already being recycled by a few contractors, the options of recycling need to be made available for the other builders. A cost benefit analysis needs to be carried out to compare the advantages of separating cardboard, plasterboard, and plastics from the waste stream and taken for reprocessing. Since plasterboard contaminates other waste, its separation would lessen the contamination of other materials. However, with a lack of data on what the current generation rate is in the construction industry, it is difficult to recommend the best options for these materials. It is critical to establish whether it is economically viable for any of the materials to be recycled locally.

4.2 On site -sorting of C&D waste

Builders were asked a) the level of sorting they undertook before disposing waste in the landfill and b) what were the difficulties and advantages of on-site sorting. The respondents had a range of sorting approaches, as shown in Table 2. All ten builders separated the metal out of the C&D debris on site and then dealt with the remaining waste as per Table 2:

Table 2: Onsite sorting approaches

Level of sorting	Separating only metal from waste		Separating metal as well as bricks and concrete		Separating metal, bricks and concrete and timber/cardboard	
Type of transport /container for taking to landfill	skip	Ute	skip	Tipper trucks	Utes/tipper trucks to shed and landfill	Ute/Tipper truck to landfill
Number of builders adopting this practice	1	2	2	2	2	1

The results show three levels of sorting- firstly, where only the metal is separated; secondly where the heavy construction waste materials such as brick and concrete were removed from the waste stream and the third level, where the timber, cardboard and other reusable materials were recovered.

The levels of on-site sorting of waste was dependent on

- The cost of sorting (including labour cost, cost of educating the subcontractors and the size of the builders business)
- Transport costs
- Availability of an offsite shed or land for storing recovered materials

4.2.1 Cost of sorting

Sorting waste on site was more dependent on costs incurred rather than on availability of space on site for sorting. Sorting waste on-site involved several costs, such as for labour, the cost of several bins containing sorted waste as well as the cost of educating the sub-contractors. Using a skip was an easier option in several cases, where all unsorted waste could be dumped. Nine out of 10 respondents mentioned time and labour costs related to sorting waste as the main deterrents for on-site sorting. These costs were first incurred at the site in sorting, then by double handling of the waste while loading it in a tipper truck and then at the tip where the waste has to be sorted into specific bays.

The builders were very critical of the manual sorting required at the tip. The tip design did not allow the tipper trucks to tip in waste. As a result the builders sorted the waste on site and put it in layers the tipper trucks for easy manual unloading at the tip. Another builder with several sites in town did a specific material run every week, picking up one kind of a waste from different sites and taking it to the tip to save time at the tip. However big trucks and skip bins are allowed to bypass the separating bays and go directly to the landfill site and tip the mixed C&D waste. Eight builders also mentioned that there would be more source separation if there was a financial incentive for the builders, such as lower fees for sorted waste. This would make on-site sorting cost neutral.

The cost of unsorted waste disposal was easily absorbed by the larger business because they built it into the contract and did not want to incur extra costs by sorting waste on site. For them the priority was finishing on time as delays and time overruns would cost them far more. Further they used large trucks or tips that could go directly the landfill to dump the unsorted waste, avoiding separating bays, and saving on labour cost. One of the builders explained why he did not use the separating bays:

"We stay clear of the bins because time is money and we have truck full loads and we don't want to hand unload it."(Manager of a large construction firm, Alice Springs)

Builders with a medium sized business were most proactive in sorting waste. They ran on small profit margins and would try and recycle as much as possible to save tip fees. Waste was sorted periodically at site clean-up stages and loaded in layers in small trucks, ready for a tip run. Periodic sorting was also necessary since some sites do not have enough space available for keeping the sorted materials for the whole duration of the project. This group of builders was also inventive with ways of disposing the sorted waste. One builder gave an example:

"I removed a fence once and got about 6000 bricks. I removed them on pallets and advertised on social media that they could be picked up for free. They got rescued for residential paving and I saved the tip fees."(builder/owner of a medium size business, Alice Springs)

The sole traders had dissimilar views. Most of their work was smaller renovation projects rather than the construction of a whole houses. Two of them mentioned not having the time or capacity to sort and recycle. Often it was easiest to use a skip. One builder explained:

"It is more an issue of time. It is easier to put the stuff in a skip than spend hours separating it. If the tip fees were lower for separated waste, I would separate it." (builder/owner of a small business, Alice Springs)

There was also no time to self-educate about the recycling options for this group. As a result all waste would go in the skip and at the end to the project the skip would be taken to the tip. However the third sole trader ensured he reused the materials and sent minimal material to the landfill, citing high landfill fees as the primary reason for this. Every time he had roof sheets or carpets in a renovation projects he asked around town if anyone wanted to reuse them and would give them away rather than taking the materials to the tip.

4.2.2 Transport costs

One of the factors that impacted the sorting of waste was whether the builders were using a skip to store and transport waste or using small trucks to carry that waste to the tip. Since a skip allows a larger amount of unsorted waste to be disposed, it is used by the larger businesses but has the disadvantage of not facilitating sorting waste. The builders using a skip dumped all the waste in the skip until it was full and emptied it at the tip. One builder, who was against using a skip, said:

" Once something goes into a skip or big tipper then you can say goodbye to the materials." (Builder/owner of a medium size business, Alice Springs)

At the tip small trucks have to manually unload in the marked bays. The building sites don't have sufficient space to store the separated waste, so builders using small tip trucks conduct periodic cleaning with a quick run to the tip. This also allows for a higher degree of waste sorting and recovery. This is supported by a five year study done on the composition of C&D waste disposed to landfill in the Sydney Metropolitan area (DECC, 2007). The study discusses in detail the recoverable composition of waste that is brought in through a small vehicle as opposed to the waste composition in large vehicles.

Several trips in a small truck to the landfill are an easier option in a small town where the distances are short. Unfortunately since all the waste is put unsorted in a skip, it leads to less material recovery at site and more contaminated waste materials at the tip. Additionally, with no material recovery of the waste on site, a UK study highlights that the builder pays for the skip, labour costs to fill it as well as the cost of the cost materials that go in it (BRE and AEAT, 2006), which is what the large businesses in Alice Springs currently do.

4.2.3 Off-site storage

An off-site storing space, such as a shed or an empty piece of land, was useful when certain construction materials were recovered and stored for future use. Two of the builders mentioned separating door and window frames, bricks, steel and corrugated iron for future use in other projects. Timber was saved for firewood and large cardboard boxes were saved in the shed to pack construction materials for 'out bush' (remote communities). This also implies that if they have storage space, then the builders are more likely to sort and reuse. When saving concrete and bricks from a demolition project, three builders mentioned having an empty site for stockpiling this. When they had a big enough load they would then take this to a known sub-contractor who would crush it for them. However, the cost of land for stockpiling was an additional expense and because of this one of the builders stopped doing this and started putting the waste concrete and bricks in the skip for landfill.

It is evident that on-site sorting leads to more efficient waste disposal, with the recoverable materials out of removed from the waste streams. Poon et al (2001) found that on-site sorting increased the rates of reusing and recycling and thus reduced the transport and the disposal costs. This was supported by the Hao et al (2008) study, which showed how the sorted reduced waste would eventually prolong the lifespan of landfills. In Alice Springs it was evident that the builders would prefer the C&D waste sorting to be cost neutral. Metal was removed from the waste streams because of the returns on it covered any labour cost involved in separating it. Wang et al (2010) discuss manpower as one of the factors that plays a critical role in this. Poon et al (2001) also identified the reluctance of builders to do onsite sorting. Builders find it difficult to allocate labour to waste sorting, which is a lower priority as compared to other objectives of saving costs and time. Gangolells et al (2014) discuss how the size of the business is an important to the waste disposal practices. They use the example of tip fees, which might be too high for the small and medium sized businesses but easily manageable for the large companies. Lower rates for sorted waste could be an incentive for small and medium sized businesses to conduct on-site sorting. Currently the only deterrents for using skips seem to be the skip hire charges. It is also evident that builders with off-site storage space were the ones engaging in sorting since they could stockpile the recovered material until it could be reused or reprocessed. The different sizes of businesses responded differently to on-site sorting because of their ability or inability to absorb the cost of landfill fees. Lower tip fees for separated waste would be one incentive for onsite sorting. Several councils in South Australia will not accept unsorted waste, which forces the builders to sort at source (SA, 2013). Therefore a combination of regulation and incentives would be required for onsite sorting to be successful.

4.3 Approach towards waste

The builders were asked whether they thought recycling and reusing C&D waste was a good idea and if was convenient or not?

All the builders thought it was a good idea to recycle building waste. Some of the reasons why it was a good idea were:

"Yes. Because there is so much of it. If you can use it. Why not?"

"Yes. Salvage what we can"

"Great idea! Not filling up a huge space with rubbish."

"Yes. Our current economic growth system is undeniably unsustainable. Perpetual growth is leading to perpetual waste."

"Absolutely! The world is changing"

"The tip is acting as a recycling centre, what do what they can do with Alice Springs. Transporting it to Adelaide creates too much greenhouse gases. Better to bury it. It doesn't make a lot of sense in Alice Springs. There is not a critical mass for a recycling yard here and people have tried and gone out of business"

These above responses ranged from the pragmatic material recovery attitude to idealism relating to unsustainable growth. When asked whether they though recycling and reusing C&D waste materials was inconvenient or not, seven of the 10 builders thought it was a difficult to recycle C&D waste and three of them thought it was not. Their reasons for that attitude towards waste recycling are listed in Table 3:

Table 3: Recycling-convenient or not

Why recycling is not convenient	Why recycling is convenient
Not enough volume	Metal recycling is easy- know who to go to and would get money in return. But no processes in place for the rest of the material
Not enough information on what can be done to the C&D waste	Not difficult to separate window/ door frames, roof frames and sheets from the other demolition debris. This can be saved in the offsite shed for future use
Labour intensive with the additional costs of educating subcontractors and double handling of waste	Paying labour costs for stripping copper from wires is cost neutral
Sorting implies space for several bins and monitoring removal of those bins	
Concrete from demolitions can't be crushed on site even with subcontractors due to noise and dust issues.	
Sorting waste for recycling and then manually unloading at the tip in sorting bins means more labour and time and time is money	

Even with their pro-environmental attitudes, the builders did not turn this into action. The cost of sorting waste and decision-making regarding disposal was not seen as worth the time. This view is supported by Lingard et al's study (2000) discussing the perception held by the construction management and on site workers that material recovery is not cost effective. This perception conflicts with the main objective of companies, whose primary aim is to make a financial profit. They argue that even though research evidence suggests cost savings can be achieved through improved waste management only when the site management is convinced of cost saving benefits, would it bring about a change in their practices (Bossink and Brouwers, 1996, Graham and Smithers, 1996) . Poon et al (2002) also confirms that even if the tip fees are high ,the builders are reluctant to sort waste. They perceive it to be high in labour and time costs since there is no incentive. This aligns with the results from the current study which also shows a gap between beliefs and action.

The approach to waste management also differed with the size of the business as shown in Table 4.

Table 4: Size of business and waste disposal approach

Size of Business	Approximate number of employees	Waste disposal approach
Large	15-30(project managers, builders, plumbers, electricians, administration staff)	Meeting contract deadlines a priority Waste disposal cost already in the contract-client pays for it so less inclined to spend time in separating waste Use skips on site
Medium	5-10 (builder, carpenter, labourers, administration staff)	More motivated to reduce waste going to the tip to cut costs Work on smaller profit margins Use Utes or trucks rather than a skip Will sort building waste in categories if it reduces the tip cost More likely to reuse building materials such as bricks, window frames
Small	2-3 (builder, labourer)	Do not have the time or capacity to sort Unsorted waste dumped at landfill

The large businesses operated according to the attitude of the decision makers in the firm. If the decision maker had a pro-recycling attitude then there were initiatives such as stockpiling waste on site, saving recyclable products for future use and using smaller trucks for transporting separated waste to the tip. On the other hand, if cost and time were the decision makers' main drivers, then the employees were less driven to separating and attempting recycling of waste products.

It was also found that the builders need to know the explicit ways that cost saving can be done for each material. For materials such as metals, where the recycling options were clear and the incentive was evident, the builders willingly separated the material for recovery. For the other materials the processes or options of reuse or recycling were not clear and this information was not easily accessible to the builders. This was a significant factor in the reluctance towards recycling.

There is information on the Town Council' website on some of the materials that can be recycled in town but none of the builders interviewed had accessed it. This shows that new ways of getting information across to the builders have to be explored for recycling programs to be successful.

4.4 C& D Material Recovery at the tip

Not all the C&D waste going to the tip goes into landfill. Table 4 shows how the tip management salvages and sorts C& D materials that are brought there.

At the tip the smaller trucks unload in the marked bays for demolition waste, cardboard, glass, plastic, metal, mix waste, green waste and aluminium containers, and the large trucks or the skips go directly to the landfill site and unload. Both get charged by the weight of waste they are carrying. The materials that are dropped off at the tip are sorted and either put in the tip shop for reusing, collected for sending to Adelaide for recycling or put in landfill.

Table 5: C&D waste streams at the tip

Waste Material	Disposal method at the tip	Disposal charges
Timber	All timber goes to landfill	Contaminated timber is charged as demolition waste
Glass	landfill	Charged as demolition waste
Concrete	Crushed and reused in council projects	Charged as glass waste
Electrical fittings/wiring	Not much in quantity. The copper is separated and sent to the metal recyclers	Charged as mix or demolition waste
Cardboard boxes (packaging)	Will be compacted and sent to Adelaide for recycling	Charged as cardboard waste
Clean fill	If in good condition sold at the shop and used as cover at the landfill	Free to be dropped off
Bricks	Pallets of bricks can be dropped off at the tip shop.	Contaminated bricks charged as demolition waste
Metal	Sent to metal recyclers	Charged as metal waste
Sand	Used as cover at the landfill	Free

Plastic	Usually contaminated. Salvaged plastic is compressed and sent off for recycling to Adelaide	Charged as demolition waste
Plasterboard	Landfill	Charged as demolition waste
Indoor tiles	If in good condition then sold at the tip shop, otherwise landfill	Charged as demolition waste
Any other: **Insulation** **Paint residue**	 Landfill Hazardous wastes section	 Charged as demolition waste Charged as hazardous waste, higher charge

As mentioned in the table, the materials that are recovered and reused locally are concrete and bricks, timber, glass, sand and clean fill. Concrete and bricks are crushed on site by subcontractors hired by the Town Council and then used as sub base for roads by the council in their projects. It is not sold back to the builders. Similarly, uncontaminated timber is converted to mulch, which is sold to local residents. Glass is also crushed and reused in the construction in Council projects. However this glass constitutes glass from bottles rather than C&D waste. Sand and clean fill are routinely used for covering sections of landfill and the excess is sold at the tip shop.

From the remaining C&D waste, cardboard and plastics are recovered and sent for reprocessing to Adelaide. Metal is sold to the local metal recyclers who send it to Adelaide for further processing. After this waste sorting, the C&D materials left are plasterboard offcuts, broken glass and tiles, insulation, bad rubble, contaminated plastic and timber. These are sent to landfill.

The landfill fee structures in other towns and cities vary enormously. Some remote towns councils such as Broken Hill charge fees under the categories of sorted and unsorted waste and for example, Mt. Isa have different rates for different total weight of waste. The landfill in cities, for example Kimbriki in Sydney achieve higher rates of sorting because they have different fees for different waste such as Asphalt, roof tiles, metal, cardboard and clean fill. This layered fee structure provides enormous incentive to the builders for source separation.

5.0 Conclusions

This project examined the C&D waste streams generated and disposal patterns in a remote regional town in Central Australia. It identified some of the challenges facing material recovery in Alice Springs. The findings show that bricks and concrete are the largest C&D waste products from demolition sites. The builders showed a preference for a cheaper option of disposing this waste and were in favour of buying back the recycled product for use in future projects. Currently the only option of disposing these materials is at the landfill and the builders found this option too expensive.

Sorting building waste and then recovering them is the ideal way for reducing waste to landfill. However the on-site sorting by builders was negligible due to high labour costs involved in sorting. Further there was little incentive to sort C&D waste since there are limited options to recycle or reuse materials other than metals. It was also difficult to store the sorted waste unless the builders had access to a shed or empty land, both options again involving additional cost.

All builders had a pro-environmental attitude and suggested that they would like to reduce waste to landfill but since they ran a business, the process should be cost neutral. With limited information on recycling options, onsite sorting and recycling were not worth their time.

There is limited data on quantities of different waste streams generated. This information is important for establishing reasonable polices for recycling waste as well as for proposing alternative reusing solutions.

This study was limited to analysis of 10 interviews. It provides insights into the C&D waste streams and their disposal but cannot be generalized. It only indicates some of the barriers to recycling and reusing C&D waste which need further study.

6.0 Recommendations

The following recommendations are suggested for increasing levels of recycling and reusing C&D waste in Alice Springs

- Currently the Regional Waste Management Facility charges the same fees for sorted and unsorted waste. It is very important to have a different fee structure for sorted and unsorted C&D waste. Additionally a substantial difference in disposal fees for sorted and unsorted waste would make the sorting cost neutral to the builders as well as provide an incentive for on-site sorting. It would also save the ACTC tip operators labour charges of sorting mixed waste
- Fees for disposing uncontaminated concrete and brick waste should be lower or it should be free since this is crushed and used in Town Council's projects.
- Currently information on rates and options of waste disposal at ASTC Waste Management Facility are on the Town council website. Other ways apart from the ASTC website of getting information on site sorting of waste and recycling of waste to the builders ned to be investigated. Building contractors are time poor and some are not very proficient with the internet. Relying only on the ASTC website for dissemination of information is likely to limit the spread of information. It might be worthwhile investing in finding a way of getting this information across to the various businesses, perhaps via leaflets issued with builders' registration renewals or available at the landfill.
- There is a need for a detailed study that estimates the amounts of different waste streams generated. This would help estimate the quantities of individual materials and whether there is a critical mass for either processing them in Alice Springs or for sending them interstate for reprocessing. The town Council data does not currently provide separate data on waste arising from C&D projects
- It is critical to identify major sources of construction waste, and focus on to how to minimize generation of waste rather than only focusing on handling the generated waste. Greater effort needs to be made to reduce waste generation at different stages of the building as, for instance, during design, planning, procurement and construction.
- It is also important to identify more options for recycling and reusing C&D waste. Currently metal and concrete are the only two materials that are being actively

recycled. Local markets need to be tapped into for finding alternative use of other products locally.

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