Waste minimisation in office refurbishment projects: an Australian perspective

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Abstract

The refurbishment of commercial buildings is growing as a percentage of overall construction activity in Australia and this trend is likely to continue. Refurbishment generates a significant waste stream much of which is potentially reusable or recyclable. Despite this potential, several factors are known to unnecessarily inhibit the amount of recycling that actually occurs on renovation projects. In order to identify the reasons causing this reluctance, a process of project monitoring and expert consultation was carried out. Twenty three experts experienced in commercial refurbishment projects and three waste contractors with specific knowledge of construction waste were interviewed. Records of receipts for waste from a case study project reveal three principal factors inhibiting recycling rates: the presence of asbestos in the building; the continued occupation of the building during construction; and the breaking up of a large project into small separate contracts thereby reducing economies of scale. To ascertain the potential for improvement, current rates for reuse and recycling of materials were collected from the experts. The results revealed a considerable variation in practice between companies and indicated key areas which should be targeted to improve performance.

Keywords

Waste minimisation, recycling, reuse, refurbishment projects, asbestos, potential improvement, Australia

Introduction

Recent studies in the UK have demonstrated the sustainability benefits of office refurbishment when compared to demolish and rebuild (Anderson and Mills, 2002). In many areas of the world the desire for more sustainable building practice is one of the factors driving the trend towards renovation and refitting of existing building premises rather than new construction (Balaras 2002). In addition to the environmental imperative, property values and planning restrictions are combining to make renovation an economically attractive alternative to demolition and rebuild, especially on Central Business District (CBD) sites. All refurbishment, however, generates some amount of solid waste and generally this is at a higher rate than new construction for a given floor area.

According to a major commercial property analysis group's newsletter, the office building stock in the major Australian cities can be described as 'mature', that is, either refurbished some time ago or reaching a stage where major refurbishment is necessary. In Sydney the average age of office buildings is 28 years and the average time since initial construction or the most recent refurbishment is 19 years (Jones Lang LaSalle, 2005). On the assumption that office buildings usually require a major refurbishment every 20 to 25 years, it can be expected that commercial refurbishment activity is likely to be a significant and increasing portion of overall construction activity for the foreseeable future. Consequently if the refurbishment sector is to be environmentally responsible there is a need to find suitable recycling and waste management techniques in order to avoid overburdening the already heavily utilised landfill system.

Impediments to Reuse and Recycling

There are several commonly cited impediments to waste minimisation in general construction projects and several authors have looked at the process. Factors identified include - available space and time restrictions that have been shown to limit on site sorting of the waste stream (Poon *et al.* 2004; Shen *et al.* 2004; Kartam *et al.* 2004; Formoso *et al.* 2002; Touart 1998; Gavilan and Bernold 1994); work practices and attitudes that may mitigate against reuse and recycling (Teo and Loosemore 2001); small quantities of a recyclable material that may be uneconomic to sort and transport to a recycling facility (Seydel *et al.* 2002). It is likely that several of these problems may be heightened in the more restricted area of refurbishment projects where specific management skills are needed (Egbu 1997).

Recycling practice in Australian construction

Raising the level of reuse and recycling on construction projects has been a stated aim of Australian regulatory authorities for some time. The construction of facilities for the Olympic Games in Sydney in 2000 gave impetus to this policy and several initiatives were set in place to ensure the environmental impact of the Olympic venues was minimised. Among these initiatives was the WasteWise Construction program which was established in 1995 as a partnership between the Australian government, major construction companies and industry organisations (Andrews 1998). The program represented a major step forward in on site sorting and separation of construction waste. Targets were set and achieved for up to 50% diversion of material from landfill by 2000. Unfortunately, when the program finished in 2001 considerable impetus was lost and there is evidence of some return to former wasteful practices.

Incentives for waste minimisation

The principal incentive for waste minimisation on construction sites remains an economic one. However studies have shown that there other drivers of waste minimisation initiatives and that the workforce can take ownership of these issues and actively participate in waste management (Lingard *et al*. 2001; Lingard *et al*. 2000). One of these is site safety. A well organised, controlled and monitored construction site where materials inflows and outflows are carefully tracked is likely to have fewer problems with accident and injury due to trips and falls. Also a frugal attitude towards materials can encourage the whole workforce on site to look for efficiencies and savings and to consequently avoid waste. The desire to minimise the environmental damage done by construction waste has led to the development of systems for assessing, tracking and managing such waste (Cheung *et al.* 2004). This trend has been observed in several countries and appears likely to continue (Lockwood 2006).

Effect of 'Green Ratings'

Increasingly the commercial office building market in Australia is being influenced by a customer desire to score well on the various forms of green rating schemes which are now available. There are several schemes for environmental rating of buildings currently in use in Australia including:

NABERS (National Australian Built Environment Rating System) is a voluntary performance based rating system that can be used for the existing building stock. NABERS rates a building on the basis of its measured operational impacts which include energy, refrigerants (greenhouse and ozone depletion potential), water, stormwater runoff and pollution, sewage, landscape diversity, transport, indoor air quality, occupant satisfaction, waste and toxic materials. As it does not look at the building or renovation process, it does not specifically assess recycled content or construction waste minimisation.

The Australian Building Greenhouse Rating Scheme (ABGR) provides market recognition and a competitive advantage for low greenhouse emitting and energy efficient buildings. The scheme encourages best practice in the design, operation and maintenance of commercial buildings to minimise greenhouse emissions. Administered nationally by the NSW Department of Energy, Utilities and Sustainability (DEUS) and locally by leading state greenhouse agencies, the ABGR scheme rates buildings from one to five stars with five stars representing exceptional greenhouse performance. Current market best practice in Australia is three stars. As ABGR applies to both existing and new buildings it is particularly useful for modelling the effect of a refurbishment project. The use of recycled materials and waste minimisation practices are not, however, specifically addressed.

The Green Building Council of Australia's 'Green Star' rating has eight environmental impact categories: management; indoor environment quality; energy; water; materials; land use and ecology; transport; and emissions. There is some allowance for the inclusion of recycled and recyclable materials.

The LCADesign (Life Cycle Assessment) tool is currently being upgraded by researchers at the Australian Cooperative Research Centre for Construction Innovation to include recycled content as a component layer in its decision making tool for designers. It is likely that this element of recycled and recyclable content in buildings will increasingly be included in green rating tools as more data becomes available about the potential energy and emission savings for building material recycling.

For the moment, however, such ratings are unlikely to have a significant effect in lifting recycling performance in office building refurbishments.

THE STUDY

Expert consultation methodology

A structured interview process with industry practitioners and consultants was undertaken in order to determine the current state of reuse and recycling practice in Australian commercial refurbishment projects.

As data on reuse and recycling rates in commercial refurbishment projects is likely to be held in different formats by different project participants, there is a comparability problem when collecting data across projects and companies (Khan *et al.* 2006). As a result it was decided to seek expert opinion from individuals involved at varying stages and in varying capacities in refurbishment projects and to ask for the reuse and recycling rates that were currently being achieved in such projects. The experts approached included environmental consultants specialising in waste management as well as other consultants such as architects and quantity surveyors who were known to have been involved in successful and award-winning office refurbishment projects. In the case of contractors involved in refurbishment work, the person responsible for waste management within the organisation was identified. These ranged from construction managers to engineers, OH&S/environment managers or demolition/strip-out specialists. Contractors specialising in handling and removing waste were also consulted and in each case the person responsible for construction and demolition waste was interviewed / surveyed. The majority of the respondents are from companies specialising in general commercial construction.

Respondents ranged from some of Australia's largest construction companies to small specialist contractors in commercial strip-outs. A total of twenty six experts were interviewed or surveyed. Some were only able to provide a limited response. For example contractors specialising in waste could tell us little about Waste Management Plans which occur at the approval stage of a project, but they were able to provide specific information about quantities and recycling potential of different materials.

Of the twenty six experts interviewed/surveyed, ten involved face-to-face meetings, twelve were conducted by telephone and four were conducted through email. Face-to-face interviews/surveys were recorded and transcripts prepared as well as notes taken by the interviewer. Data was collected from respondents in New South Wales, Victoria, Queensland and the Australian Capital Territory. Most respondents had interstate experience and one had national responsibility for waste management issues in a large construction/property corporation. Most of the experts had more than ten years experience in the construction industry with fifty percent having more than twenty years experience. Those with fewer than ten years experience were generally site managers who had day to day contact with waste minimisation issues.

The experts were asked 25 questions on waste minimisation practices, attitudes, drivers and inhibitors. Then in order to overcome an initial reluctance by many of the experts to provide data which they considered 'commercially in confidence', rates of recycling of building materials were collected in two ways. Initially an estimate of the percentage of recycling for five common building materials was asked for. Later a more complex break down of building elements was requested. The information received from the experts in the initial interviews was used to inform the format of a spreadsheet of building components classified into more detailed categories for the second round of data collection. Confidentiality of the information provided by those interviewed / surveyed was requested and assured. The researchers retain the names and positions of the individual respondents as well as the companies they are associated with for verification purposes but this information will not be linked to any of the published data.

RESEARCH FINDINGS

Current rates

Fifteen of the twenty six participants in the expert consultation process provided their best estimates of reuse and recycling rates that are currently being achieved in office refurbishment projects. The breakdown of the respondents providing rates was 9 practitioners, 5 consultants and 1 waste contractor. For the purposes of this study 'Reuse' refers to a second life for a building material or component without significant alteration or transformation. 'Recycling' refers to the use of salvaged material as feedstock for new material. Significant transformation and reprocessing is involved in the case of recycling. In addition, the expert respondents were asked to distinguish between reuse on site, reuse off site, recycling on site and recycling off site. The amount of data collected was significant and the correlations between sections and respondents are complex. The average of the responses for components in the four categories of building fabric, fittings, finishes and service components is presented in Figs. 1 to 4 below. Some general results can be gleaned from the figures for the four component categories and some trends are emerging.

The building fabric removed in a commercial refurbishment project is likely to receive a significant level of recycling at present. Almost all of this recycling happens off site. Aluminium, structural steel and steel reinforcing are reportedly recycled at the rate of 86%, 79% and 84% respectively. Heavy masonry materials like bricks, blocks and concrete are also commonly recycled (rates of over 70% for each element). Stairs were the only element whose prime destination was landfill and this is probably due to their highly customised nature.

Landfill was the principle destination reported for most fittings removed from refurbishments except for suspended ceilings, partition walls, workstations and glazed partitions.

Workstations were commonly reused both on and off site (35% each category). Very little recycling was reported for fittings.

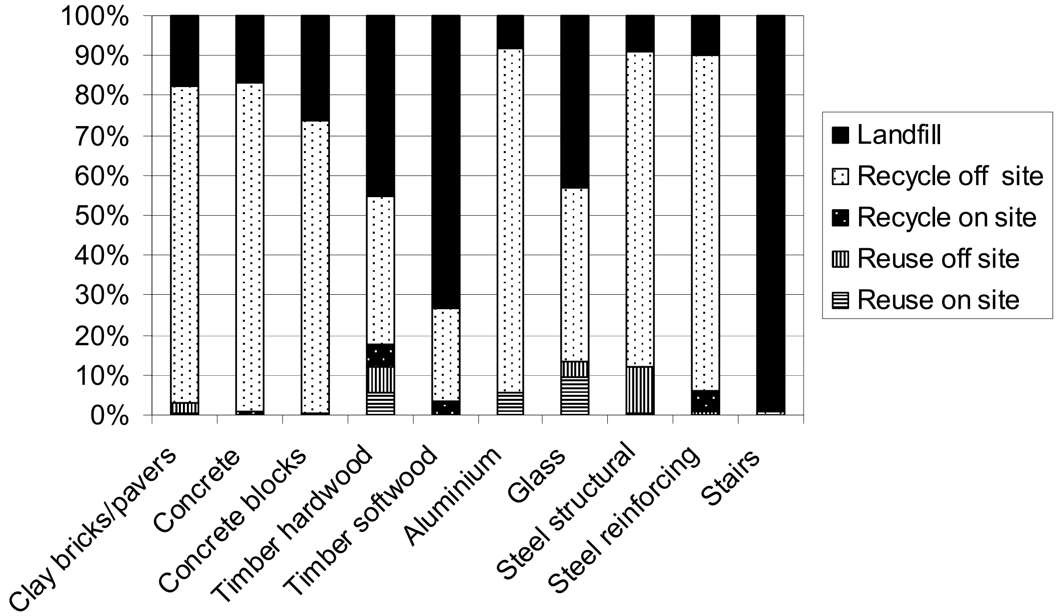

Figure 1 - Current rates for Building Fabric

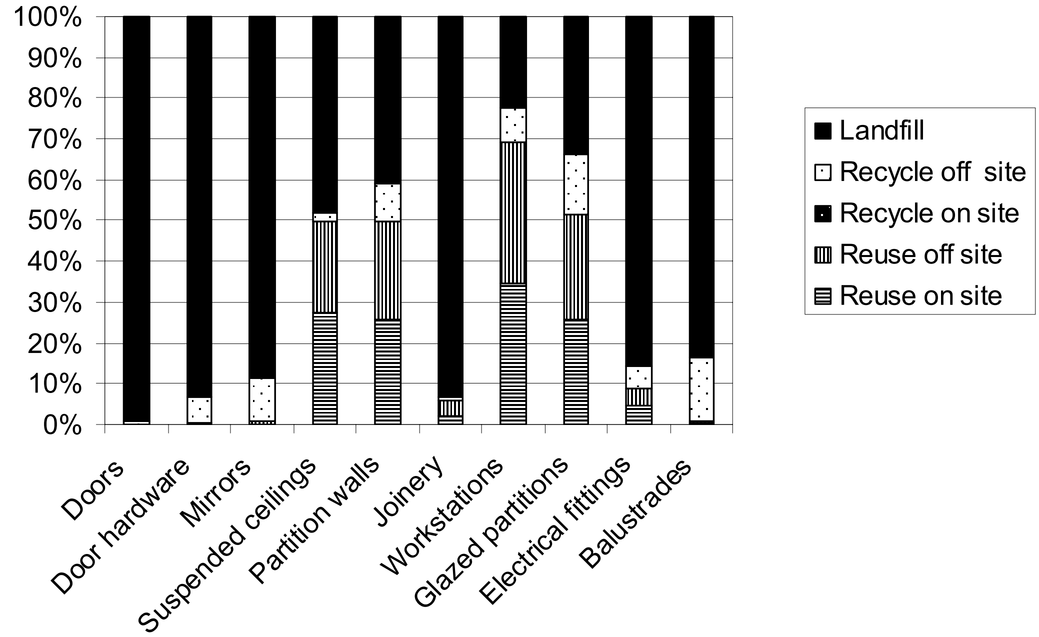

Figure 2 - Current rates for Fittings

The majority of all finishes removed during refurbishments end up in landfill and no recycling on site was reported. Reuse for carpet is reportedly a growing area. Plasterboard recycling was an area of considerable disagreement among the experts. While several reported that no recycling occurred, a few were able to report high levels of recycling. The differences appear to be location based with Victorian recycling facilities being widely available while very little plasterboard recycling occurred in other states.

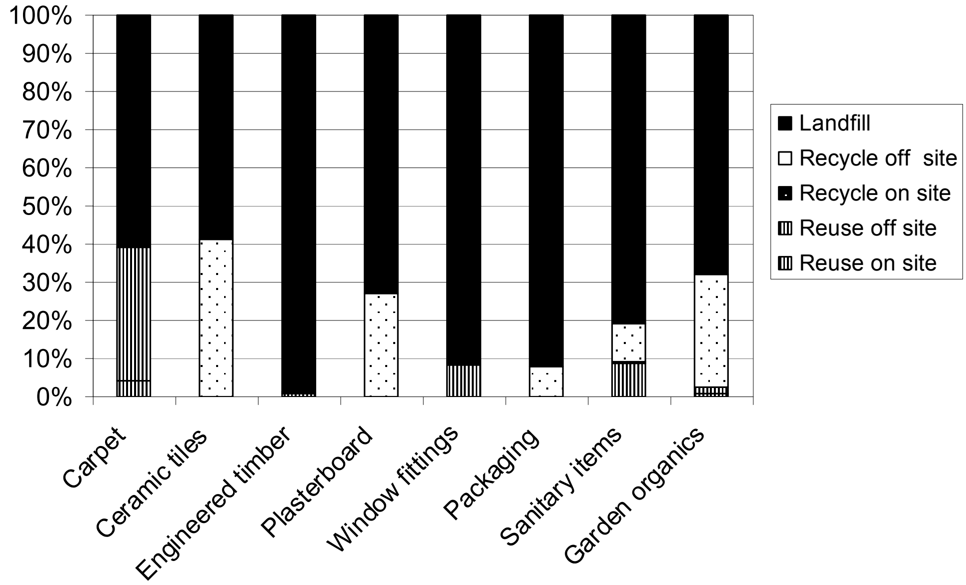

Figure 3 - Current rates for Finishes

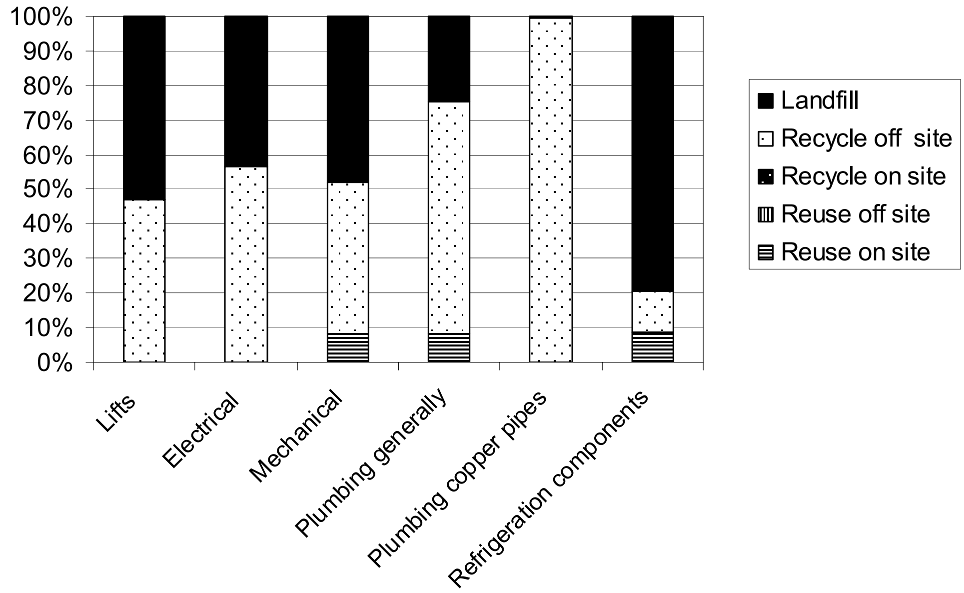

Figure 4 - Current rates for Services

Finally, high levels of recycling off site occur with most services components but there was very little reuse reported. Refrigeration components appear to lag other services components in having recycling facilities available.

Suggested target areas

Plasterboard has been identified as a material that receives different treatment in different regional areas. Making best practice in this area standard practice throughout Australia is a matter of spreading both information and recycling facilities.

The reuse of components such as sinks, basins, cupboards, benches and other fittings from commercial refurbishments still seems to be occurring at fairly low levels. Perhaps an internet based system which advertises these items for sale or removal at the strip-out stage of projects might be worth consideration on a city or state-wide basis. They may also be donated to community or charitable groups.

Case study project – Preliminary findings

While the expert consultation process was taking place it was decided to seek some measurable verification of the data being gathered through means of a case study project. This proved to be problematic as those responsible for large office buildings undergoing major refurbishments tend to want to keep their records private so that confidential commercial information relating to construction contracts is not revealed to competitors. The researchers did manage to get permission to track the waste outcomes from the refurbishment of a 22 storey government office building in Sydney. The building was constructed in 1979 and had had no major refurbishment since that time. The building was to remain continually occupied during the refurbishment and consequently the project was staged over a five year period. It is expected to be completed by the end of 2010.

The study is ongoing but there are some preliminary findings which have correlated with the comments made by several of the experts in the consultation process. Firstly, the presence of asbestos insulation in the inter-floor and duct spaces in the building severely constrained the scheduling of the refurbishment and limited the amount of material recycling that ended up being done. Secondly, the continued occupation of the building during refurbishment had the result of stretching the project progress over a long period of time. Major work had to done in short bursts over the holiday periods and there was very little opportunity for on site sorting or for storage of items for later reuse elsewhere in the building. Thirdly, due to scheduling difficulties because of the need to accommodate continued operation of the building and continued public access the decision was taken to break a very large project into discrete small contracts for the various stages of the work. This has meant that there is little incentive for individual contractors to sort, store and salvage material in small quantities. Each of these issues will be discussed in greater detail.

Presence of Asbestos

Office buildings constructed in the fifties, sixties and seventies commonly have some asbestos based products which were formerly used for insulation and fire protection purposes. If left undisturbed this material is unlikely to be a hazard but when airborne fibres are released by renovation work they represent a significant risk to human health. As a result asbestos removal is covered by strict regulation and remediation protocols (National Occupational Health and Safety Commission 1988). The presence of asbestos in a renovation was nominated as a factor which affects the feasibility and cost by eleven out of twenty four members of the expert consultation group in response to an open ended and unprompted question. Some experts reported that mere proximity to small quantities of hazardous materials such as asbestos can render otherwise recyclable materials as contaminated. One waste contractor reported that the suspicion of asbestos being present in the source material could rule out the crushing of concrete for road base. This was confirmed by the case study project where, in the initial refurbishment stage, all the waste was classified as containing asbestos. This included timber, floor coverings, sanitary fittings and built in furniture which were highly unlikely to have contained any asbestos fibres.

Continued occupation

The disruptive effects of continued occupation during a refurbishment project have been closely studied from a valuation perspective (Chau *et al*. 2003). There are also significant effects on construction scheduling and safety issues. More frequent and costly late design iterations are likely to occur as occupants watch the progress of the renovation work in other parts of the building (Mitropoulos and Howell 2002). The expert group consulted for this research had mixed views on the continued occupation of a building during refurbishment. Thirteen experts considered it a significant issue. They stated that it would add time to the project and would restrict space for stockpiling of sorted waste. The renovation works might also affect the indoor environment quality for the occupants and result in complaints to the contractor. On the other hand five experts felt that continued occupation of the building did not affect the viability of a project. They were aware of the issues raised by other experts but felt that any such problems could be handled with good management processes.

Separating a large project into small parcels

The case study building provided the third significant inhibiting factor for waste minimisation in office refurbishments. Although the building being refurbished is a large office building of twenty two storeys in height with floor average area of 2010m² per floor the renovation project was not let to one managing contractor. For the convenience of the building management the project is being split into small, staged and discrete contracts for restricted areas. Consequently the waste stream generated from each individual contract is small and it is not economical to put time into careful disassembly and sorting as it will only yield minor salvageable quantities of materials. The project managers have expressed a desire to see construction waste minimised and Waste Management Plans prepared for each project stage have declared that timber and metals will be recycled. However the tip receipts from the early project stages reveal that all waste was sent to landfill and no measurable quantities separated from the waste stream. Lack of space to sort and store is no doubt also a contributing factor. Economies of scale make recycling practical and profitable. Small separate contracts for parts of a refurbishment project make these economies of scale difficult to achieve.

Conclusions

Most experts consulted for this study agreed that practices in relation to waste generated in Australian commercial refurbishments have improved over recent years. Most experts could identify specific markets that have emerged in the reuse of various materials. However, few respondents could put a value, either cost or benefit impact, on minimising waste. The presence of hazardous materials and specifically asbestos fibres was clearly flagged as a barrier to recycling of the wastes generated from refurbishment. It is evident that wherever possible remediation of asbestos from buildings scheduled for refurbishment should occur before refurbishment takes place and not concurrently with the renovation works. Scheduling of refurbishment in a building that must remain occupied during the construction work also severely limits rates of recycling and reuse. This is due to the time, space and social restrictions likely to occur in the occupied building. Trying to avoid some of these issues by breaking up a large project into small discrete contracts is likely to be unsuccessful in waste minimisation terms as it will likely remove from the contractor's available options those economies of scale which make recycling and reuse profitable.

The construction industry generally remains a high generator of solid waste products and refurbishment projects are a significant part of this waste stream. Waste minimisation strategies in office building refurbishment can potentially make a significant contribution to the sustainability of the built environment as a whole. The refurbishment process is part of the loop of resource consumption. Refurbishments extend the useful life of a building thereby allowing continued use of the resources initially expended in its construction. If future life cycles are allowed for by means of design for deconstruction and disassembly, then the savings generated by refurbishments can be ongoing. Something approaching the cyclic processes of systems in the natural world may eventually be achieved. This can certainly be aimed for as a worthwhile goal. Many of the experts consulted for this study were aware of future possibilities in waste minimisation, it only remains for industry and regulators in partnership to develop a more systematic approach to the dissemination of best practice ideas in construction waste management.

Waste minimisation specifically in refurbishment projects has not yet been widely studied and benchmarks and best practice guidelines are yet to be established. Further research is needed to identify the most appropriate practices and targets for this growing sector and critical area of sustainable construction.

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