A SUPPLY CHAIN MANAGEMENT SELF ASSESSMENT FRAMEWORK FOR WASTE MINIMISATION FOR THE RESIDENTIAL SECTOR

FRAMEWORK DEVELOPMENT

June 2013

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Research Program: Cash funding by EPA Victoria through the Beyond Waste Fund

In kind contributions by Metricon, Australand, RMIT, FMG Engineering, MBA V, Boral

Date: June 2013

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1.0 Executive Summary

This report on the development of the framework is a milestone report for the research project entitled 'A Supply Chain Management Self Assessment Framework for Waste Minimisation for the Residential Sector'. The project is funded by the Environmental Protection Agency Waste Fund and is managed by Sustainability Victoria. RMIT University is the lead organisation for this project on behalf of the Australian Housing Supply Chain Alliance. Members of this Alliance who are partners for the project include Metricon, Australand, FMG Engineering, Boral, Master Builders Association Victoria and RMIT University. The project is being undertaken from December 2012 to February 2014. The report documents Stage 2 of the research project which was the first phase of data collection. The overall aim of the project is to develop and test a new management framework that can be used by volume residential construction organisations to develop staff benchmarking profiles, initially, then potentially to develop a model for SME's in relation to:

(a) Practitioner/staff awareness/knowledge and capabilities of best practice in integrated SCM across design, procurement, tendering and construction functions to achieve organisational objectives for waste avoidance and reduction;

(b) Practitioner/staff capabilities to respond to changes in supply chain environments at a project level; and

(c) Organisational capacity at a portfolio level to support policy, systems and procedural changes to adapt to future waste avoidance and reduction strategies.

The outcome is to assist the building industry in Australia to reduce and avoid construction material waste. In Australia, as with many other developed countries, waste from materials and the building process is a significant environmental and economic issue. Over the past two decades, supply chain management (SCM) has had increasing attention within the construction management literature. However, there is has been little real evidence of its adoption at a systemic level in the industry in any of the construction sectors including; residential, commercial and civil. The purpose of this document is to provide an update on the action research project aimed at using supply chain management principles to develop a management tool for an organisation to use to reduce materials waste transported to landfill as a result of housing construction. The framework development commenced through 2 focus group interviews followed by 14 in depth individual interviews undertaken with key Metricon and Australand staff who were involved in design, estimating, occupational health and safety and site construction management. These interviews provided an understanding of the perceptions of barriers and enablers to minimising waste onsite across the organisations' policies, processes and practices. The key barriers were:

Organisation A	**Organisation B**
Poor organisational communication across units to facilitate change	Poor organisational communication across units to facilitate change
Direct costs vs. Whole of life costs	Knowledge of problem vs. Lack of action
Poor organisational communication of strategic objectives	Direct costs vs. Whole of life costs
Lack of cooperation/maturity from suppliers to minimise waste	Ordering error, over ordering, under ordering
Lack of strategic procurement & Partnership	Resistance to change (lack of incentives)

Following this engagement with the research participants, the research team then developed a draft framework that reflected the understandings gained from the interviews around waste minimisation challenges. The framework was then presented back to the research participants for verification and modified accordingly. The framework is being developed for two priority areas which were determined with the two organisations at the project launch meetings in February and are: External Supplier Management and Internal Supplier Management (Workflow Integration/Value Management). This information will provide a clear understanding of knowledge gaps, barriers and drivers of change in waste minimisation practices within the 2 priority areas of Metricon and Australand's supply chain. The Self Assessment Framework is presented for the External Supplier Management in this report. The report is organised in the following sections a) Data collection and analysis methods; b) Results: barriers and enablers and c) Self Assessment Framework.

2.0 Data collection & analysis methods

This section outlines the data collection methods used on this study. The specific data sources will be described in the following sections.

2.1 Data sources

Focus Group Interviews (FGI) and individual interviews were conducted to collect data on the experiences and perceptions of staff members from the two case study organisations.

2.1.1 Focus Group Interviews

One Focus Group Interview (FGI) was conducted with each of the case study organisations. The aim of the FGIs was to officially launch the project and obtain buy-in from key champions of each organisation. The FGIs were chaired by the project leader and attended by the research team, research project coordinator and a number of staff members identified as champions by the research project coordinators (refer to Table 1). The FGIs were divided into four main parts:

- Background: Introduction of the research team and the project to the staff members.
- Waste reduction and avoidance: General discussion and brainstorming of issues around waste minimisation in the organisation based on the staff members observations and experiences. Participants were asked to comment on their roles in relation to waste minimisation as well as the organisation's current capacity in minimising waste.
- Supply chain management: The participants were presented with a Supply Chain Management Blueprint diagram which represents a holistic integrated framework for the management of project-based industries (refer to Figure 1). The Blueprint was developed as a result of a previous study (London, 2008) and can be used towards developing the Self Assessment Framework for waste minimisation for this study. The FGIs sought to identify the supply chain activities from the Blueprint which each organisation was to focus on through this study. During the FGIs it was decided that each organisation will focus on the following activities:
    - Organisation A: Supplier management and value management
    - Organisation B: Supplier management and internal workflow management

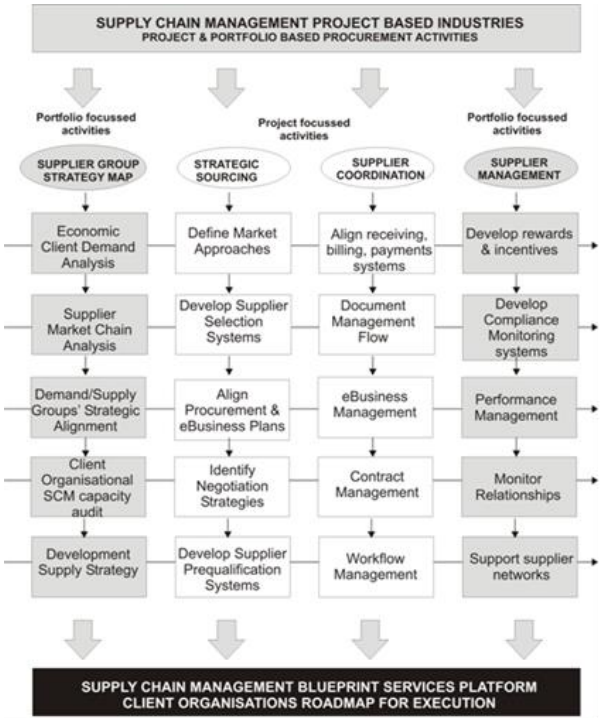

Figure 3 Blueprint Supply Chain Management project based industry (London, 2008)

- Self Assessment Framework: A generic Self Assessment Framework which was developed for the project was presented to the participants. A more detailed Self Assessment Framework will be developed in consultation with the staff members through interviews and forums to suit each organisation [for eg individual or group level, etc].

Table 1 FGI Attendees

Organisation A	**Organisation B**
National Purchasing Manager	GM National Building and Business Improvement
Building Supervisor	Senior Residential Home Designer
Victorian HSE Manager	National OH&S Manager
Estimating Manager – Victoria	BOQ & Estimating System Manager
Project Design Manager	Procurement Category Manager
Sustainability Manager. Commercial & Industrial Division	Area Manager North - Greenfields
Corporate Sustainability Manager	
National HSE Manager	

2.1.2 Individual Interviews

A total of 12 interviews were conducted across the two case study organisations between one and two hours duration (refer to Table 1). Participants were asked questions in relation to four main topic areas including:

- Their role within the organisation
- Their views on waste reduction and avoidance
- Their understanding of supply chain activities
- Their thoughts on how to bring waste management and supply chain management together in developing the self assessment tool

Table 2 Overview of participants interviewed

Organisation A	**Organisation B**
National Purchasing Manager	GM National Building and Business Improvement
Building Supervisor	Senior Residential Home Designer
Victorian HSE Manager	National OH&S Manager
Estimating Manager – Victoria	BOQ & Estimating System Manager
Senior Design Manager	Procurement Category Manager
Corporate Sustainability Manager	
National HSE Manager	

2.2 Data Analysis

This section outlines the data analysis methods employed on the study.

2.2.1 Coding Schema: Barriers and enablers

All interviews will be recorded and transcribed. Following the transcription of all interviews, the first stage of analysis involves the identification of barriers and enablers related policies, processes and practices for waste minimisation and supply chain management in the two organisations as revealed by the interviewees are identified and categorised.

The general approach in the C&D waste management literature has been to classify the causes and sources of waste into either/or categories for example, waste is caused by “Error in contract documents” in the design phase or “Ordering error, overordering, underordering” in the procurement phase (refer to Table 1). Our proposition is that the sources and causes of waste and the challenges associated with achieving waste minimisation is more complex than this, however, our analysis will begin by mapping the barriers revealed by the interviewees to the barriers as identified in the literature.

Table 3 Sources and Causes of Construction Waste (Source: Table 8 Extended List of Sources and Causes of Waste based on Tables 4 and 8 Table 4: Source and Causes of Construction Waste Gavilan and Bernold, 1994; Craven et al, 1994 as cited in Bossink and Brouwers, 1996)

Source	Cause
Design	**Error in contract documents**
Design	**Contract documents incomplete at commencement of construction**
Design	**Changes to design**
Design	**Choices about specifications of products**
Design	**Choice of low quality products**
Design	**Lack of attention paid to sizes of used products**
Design	**Designer not familiar with possibilities of different products**
Design	**Lack of influence of contractors and lack of knowledge about construction**
Procurement	**Ordering error, over ordering, under ordering, and so on**
Procurement	**lack of possibilities to order smaller quantities**
Procurement	**Use of products that do not fit**
Materials handling	**Damaged during transportation to site/on site**
Materials handling	**Inappropriate storage leading to damage or deterioration**
Materials handling	**Throw away packaging**
Operation	**Error by tradesperson or laborer**
Operation	**Equipment malfunction**
Operation	**Inclement weather**
Operation	**Accidents**
Operation	**Damage caused by subsequent trades**
Operation	**Use of incorrect material requiring replacement**
Operation	**Required quantity of products unknown due to imperfect planning**
Operation	**Information about types and sizes of products that will be used arrives too late**
Residual	**Cutting uneconomical shapes**
Residual	**Offcuts from cutting materials to length**
Residual	**Over mixing of materials for wet trades due to lack of knowledge of requirements**
Residual	**Waste from application process**
Residual	**Packaging**
Other	**Criminal waste due to damage or theft**
Other	**Lack of on site materials control and waste management plans**

A coding schema was developed for the analysis of the interviews which adapted and built upon Table 3.

The process in which coding schema was developed involved the following:

- each research team member took at least one transcript and coded this
- each transcript had two research team members coding

- we met to compare coding
- similarities and differences identified and new codes were added
- coding schema expanded based on the discussions
- research assistants then proceeded to complete all coding

Each organisation was analysed as individual case studies [within-case analysis] prior to a cross case comparison across the two organisations [cross-case analysis].

2.3 Rules of the game

The second stage of analysis involved Professor London and Jessica Siva revisiting the data towards developing the External Supplier Management Framework which is included in this report. This Framework was then presented to Organisation B including all participants who had been interviewed for verification. Modifications were then made to the framework and this will now be further validated in the next phase of the project with Organisation A original research participants as well as with additional short interviews with new research participants in each organisation.

The Framework was organised in 4 levels of implementation ranging from a lack of implementation to systemic implementation. It was also organised in three key categories: 1) Know the Rules; 2) Apply the Rules and 3) Change the Rules. These are simplified expressions for awareness and knowledge of organisational policies; implementation of the policy and general processes and practices and mechanisms to change the policies and procedures within the organisation.

3.0 Results

This section presents the results of the individual interviews and is divided into two main parts:

- Barriers
- Enablers

3.1 Barriers

The most common barriers were identified from the interviews with the two case study organisations when research participants were asked to identify challenges related to policies, processes and practices for waste minimization and supply chain management in their organisations. These were the five most common and significant causes of physical materials waste onsite as perceived by the research *participants. In Appendix 1 Table 1 Summary of Barriers to Waste Minimisation in Organisation A* and *Table 2 Summary of Barriers to Waste Minimisation in Organisation B* a complete list of all the barriers which were identified is provided. Each barrier is mapped to the phase in the project delivery process as the source.

Clearly in both organisations communication between functional units is a significant barrier as it was considered in both organisations to be a major cause of waste. The following are some examples of quotes that illustrates this:

That's classic. About 100 site managers in Victoria, probably about 15 to 20 construction managers and 5 building managers in Victoria, it's a big ship. I guess having an agreement on something and having that being transposed all the way down the line is very difficult. So that for leadership management, I think it's a lack of our ability to communicate effectively as well so we have the building managers sitting in a room and all agreed on something and then they may be unable to communicate that to construction people.(GM, Org B)

We haven't gone through a review process yet. You've heard throughout the project that some things have been popped up. But it's not a very formal process. (HSE Mgr, Org A)

Yeah it really comes back to the estimators. Well it starts with the sales people. Sales people don't understand sometimes what variations mean and sometimes they don't actually get put into the job, and then that makes an error to the site. And then you get your estimators and again you get those variations. If the estimators aren't hitting those variations or they don't understand them, then they'll miss-estimate the site and you'll end up with varying amounts of material on that. (National OH&S Mgr, Org B)

An attitude of only considering direct costs as important versus whole of life costs was also perceived in both organisations as being a major cause of waste. Organisation B staff considered the inertia of the organisation to be a problem as well and suggested that there was often a knowledge of the problem but difficulties were experienced in changing the situation coupled with a perception that there was a resistance to change due to a lack of incentives to make change. Clearly in Organisation A the strategic direction was also considered an inhibitor for change.

Managing the external supply chain was also considered to be important by organisation A in particular with lack of cooperation/maturity from suppliers and lack of strategic procurement and partnerships as key inhibitors.

Organisation A	Organisation B
Poor organisational communication across units to facilitate change	Poor organisational communication across units to facilitate change
Direct costs vs. Whole of life costs	Knowledge of problem vs. Lack of action
Poor organisational communication of strategic objectives	Direct costs vs. Whole of life costs
Lack of cooperation/maturity from suppliers to minimise waste	Ordering error, over ordering, under ordering
Lack of strategic procurement & Partnership	Resistance to change (lack of incentives)

3.2 Enablers

The most common enablers were identified from the interviews with the two case study organisations when research participants were asked to identify enablers related to policies, processes and practices for waste minimization and supply chain management in their organisations. These were the five most common and significant ideas/actions/strategies that would reduce physical materials waste onsite as perceived by the research participants. In Appendix 1 *Table 3 Summary of Enablers to Waste Minimisation in Organisation A* and Table 4 *Summary of Enablers to Waste Minimisation in Organisation B* a complete list of all the enablers which were identified is provided. Each enabler is mapped to the phase in the project delivery process as the source.

Organisation A	Organisation B
Strategic procurement & partnerships	Strategic procurement & partnerships
Knowledge of problem and take action	Knowledge of problem and take action
Supplier development	Supplier development
Organisational communication across units to facilitate change	Direct costs vs. Whole of life costs
Senior management support to drive change	Off site manufacturing & prefabrication

Clearly there is a perception that the most important enabler for waste minimization is the activity of strategic procurement and the development of partnerships with suppliers as both Organisation A and B considered it highly significant. Interestingly knowledge of the problem and being able to take action was also considered an important enabler by both organisations. It is also not surprising then that supplier development is an important catalyst to minimise waste.

Organisational communication and knowledge of a problem and ability to take action are closely related in relation to enablers for change. There is a perception in Organisation A that a culture of breaking down internal silos and developing well integrated internal workflow between functional units , ie developing well integrated internal supply chain management practices is conducive to catalysing behaviours that would minimize construction site waste materials.

Although Organisation B was in favour of off site manufacturing and prefabrication one wonders if this may simply shift waste to another group to solve and manager. However it is suspected that the control within a factory and such a structured environment is more than likely to be conducive to minimizing waste materials.

4.0 Maturity Assessment of Adoption of Supply Chain Management Practices

What does this assessment mean?

The practice of supply chain management (SCM) is supported within an organization by establishing and implementing four key principles including: a) Supplier Group Strategy Analysis b) Strategic Procurement c) Supplier Coordination and d) Supplier Development. This assessment determines the extent to which these principles are adopted within your organization with respect to minimizing construction waste materials onsite. This will help to inform people at an individual level or a manager of a work group the extent of adoption of the key supply chain management principles. Importantly it will give direction to individual staff performance work plans and organizational strategic planning. An important underlying assumption to this self-assessment management tool is that waste minimization typically requires an integrated supply chain approach.

How do I perform this assessment?

The assessment can be performed individually or within a group or unit. If completed within a group then the tool can be useful to trigger discussion. Such discussions will enhance more widespread sharing of knowledge and improve awareness and understanding of the organisation's approach to supply chain management in relation to waste minimization. There are various ways that the assessment tool can be used and individual self-assessment can highlight areas to pursue to improve skills and capabilities. An individual assessment might be a pre-cursor to a workgroup discussion that could also include staff from other units so that consensus on key activities can be reached. Shared understanding of the organisation's approach to each of the key activities is critical to an organization maturing in its capacity to adopt supply chain management practices aimed at minimising construction materials waste. There are two key Assessments: External Supplier Management and Internal Supplier Management. This is the first matrix. Each row in the matrix on the right represents an important activity in adopting supply chain management practices towards supplier management. Work through each row and establish at which level best describes the status of your organization. When each cell is complete you will then be able to see to what has been achieved and what needs attention. You can then put an action plan in place to make improvements. Some activities are not within your immediate control but you may be able to influence others.

How do I apply what I have learnt?

Once you have completed both Self-Assessment Frameworks you will be able to ascertain to the extent that supply chain management practices have been adopted towards waste minimisation in your organization and you can determine which activities need attention to improve advancement in your organisation.

External supplier management		Level 1	Level 2	Level 3	Level 4
		No awareness	Some implementation	Several examples	The way things are done
Know the rules					
Waste Minimisation Plan	Sustainability policy including a waste management and waste minimisation objectives and Waste Minimisation strategy aligned to corporate business profitability objectives and KPIs				
Strategic Procurement Plan	Strategic partnerships with waste minimisation business critical suppliers (risk vs spend: timber, plasterboard, bricks and site spoil) to develop innovations to achieve efficiencies, price reduction and/or value creation				
	Supplier and Trade Council strategy aligned with corporate objectives				
	Business critical supplier procurement methodology to account for geographical and project variances and Tender award criteria inclusive of waste minimisation objectives				
Apply the rules					
Waste Minimisation	Sustainability policy accepted into the 'hearts and minds' of all staff on all projects and Waste minimisation principles are an inherent part of 'how things are done'				
	Staff members appropriately trained based upon individual roles and responsibilities (for example in product knowledge, elite ordering skills)				
Strategic procurement	Consistent proactive approach to initiating strategic partnerships with waste minimisation business critical suppliers				
	Seamless application of business critical supplier procurement methodology aligned with staff competencies and Tender award criteria consistently applied to achieve waste minimisation objectives				
Project Coordination	Staff members comprehensively trained to work with suppliers to undertake project supplier performance monitoring during project delivery				
	Post project supplier assessment monitoring and feedback on waste minimisation performance consistently applied across projects				
	Innovative waste minimisation strategies regularly developed through integration with suppliers to share knowledge of construction products and processess				
Change the rules					
Coordination and Development	Business systems measure and analyse and make visible physical waste generated onsite and strategy to monitor agreed targets to reduce waste				
	Strategy to make waste minimisation efforts part of renewal agreements				
	Integrate construction site supplier feedback into upstream processes and regular annual value creation forum to support creation, development and implementation of waste minimisation strategies				

5.0 References

Bossink, B. and Brouwers, H. (1996) Construction waste: quantification and source evaluation, Journal of Construction Engineering and Management, Vol. 122, No. 1, pp. 55-60

London, K. (2008). *Construction supply chain economics*. London: Taylor & Francis.

Table 1: Summary of barriers to waste minimisation in Organisation A

	Barrier		Participant	Example quote
	Source	**Cause**	**(People/Times)**	
High	Organisation	**Poor organisational communication across units to facilitate change**	Senior Design Manager, HSE Manager, Building Supervisor, National Purchasing Manager (4/10)	● Senior Design Manager: Sometimes a post construction review has not been done. ● HSE Manager: We haven't gone through a review process yet. You've heard throughout the project that some things have been popped up. But it's not a very formal process. ● Corporate Sustainability Manager: We don't get involved with value management. ● Building Supervisor: Definitely because to give you an idea, we had problems the other week. Half of the people in there probably only have ever seen a building site, probably three quarters of them haven't, so when they come in and see piles and piles of timber and this and that they are going to understand this is all the stuff I have ordered and why is this happening, so I will need to get involved and say, look this is something that is really wrong. You need to look at your figures
	Feasibility	**Direct costs vs. Whole of life costs**	Senior Design Manager, Building Supervisor HSE Manager, Corporate Sustainability Manager (4/9)	● Senior Design Manager: We need to ensure that the business case for everything is sound. In Organisation A, it is not just about saying we need to have a system that is sustainable or produces more waste material. It has to be recalculated to what impact that does have on the business case really. We need to have a wall or flooring system that does everything all the competitors do, but at the same cost. ● HSE Manager: And then you get influences with pressure and money and that tends to skew people's wants because it comes down to needs. So yeah the training was OK. Phil came along for an hour and a half so you're pulling a subbie out for an hour and a half you've lost them already. So there are the battles that you're going to find and trying to help out waste management process ● Corporate Sustainability Manager: If you want to pay for it, any company will do a proper recycle for you. It always comes down to 'the more you pay the more service you get'.
	Organisation	**Poor organisational communication of strategic objectives**	HSE Manager, National Purchasing Manager, Corporate Sustainability Manager (3/11)	● HSE manager: At the moment there's nothing there. You can print off things and full pages and what I've learnt is full pages of writing no one absorbs in the industry ● HSE Manager: more of informal conversations. Nothing really formal especially with our design teams – they're the one who actually choose the products that we use…there was actually no discussion but some products they do come in and say why we've actually used it. The sit down with the actual design team in regards to waste we haven't gone through that process with training. ● Corporate Sustainability Manager: We haven't got a waste policy as such… We have an environmental one. We have draft sustainability one…we haven't communicated to all staff about that. ● HSE Manager: we do have a policy signed off by our managing director but it comes off to someone who probably hasn't even met the director you know and they've read something briefly – does that share the same enforcement as your CEO coming down to talk to you about it? All that type of stuff.
	Procurement	**Lack of cooperation/maturity from suppliers to minimise waste**	HSE Manager, National Purchasing Manager, Corporate Sustainability Manager (3/6)	● Corporate Sustainability Manager: I know that National Purchasing Manager and Corporate Sustainability Manager are supposed to be going out doing an audit on the Melbourne companies at the moment to get a bit more idea of what's going on, and try to get a better idea of what the companies can offer from our point of view. We had a national agreement with a company and they said they can do all these wonderful things. But it didn't actually happen. ● HSE Manager: We're using a product at the moment called Promat. It's a cement sheet type of base product, but very good. When I spoke to the supplier, I said 'it is a great product, thank you very much. Now what are we doing with your rubbish?" And he said "What do you mean?" I said "Well, there's going to be leftover of this, which is still your rubbish. What do you do with it?" and he stopped.
	Feasibility	**Lack of strategic procurement & Partnership**	Building Supervisor, National Purchasing Manager , HSE Manager (3/6)	● Building Supervisor: I feel I should do some more work on it and possibly work on better ways of doing things. Giving an example, I've just started using a new product up there on the floor, which is called "Promat". I think it's a James Hardie product. It is not recyclable as far as I know. So I can't recycle it. Like plastic, I got a truck and picked it up. That stuff goes into our bins at our cost and goes through to the recycling plant. Now I think it gets recycled somewhere. But I think James Hardie should be taking that off from our site. ● HSE Manager: And I know that National Purchasing Manager and Corporate Sustainability Manager are supposed to be going out doing an audit on the Melbourne companies at the moment to get a bit more of an idea of what's going on. Just to try to get a better idea as to what the companies can offer from our point of view. We had a national agreement with a company and they said they can do all these wonderful things and it didn't actually happen ● Building Supervisor: what I like is it is to get a new brick supplier over these normal brick suppliers who will not come to site and take back excess bricks because they just don't want to do it. So look, I'm happy to give this product a go they are going to want it. But I don't want to rebate or a refund but they wouldn't come and pick them up which is really bad for a company. They're happy to send it out and bill us for it but they would not take back say a wrong batch or something.

Medium	Feasibility	**Lack of resources allocated in organisation to support change**	HSE Manager, National Purchasing Manager, Corporate Sustainability Manager(3/4)	• Corporate Sustainability Manager: It is challenging when you don't have the manpower to then explore opportunities and research further into material selection.
	Feasibility	**Lack of Training/Education**	HSE Manager, Building Supervisor (3/4)	• HSE Manager: I haven't gone through the details of that process. They haven't relayed it to me • Building supervisor: Not a written policy. I've never been trained on how to minimise or how to do better this kind of stuff. I probably picked it up myself over the years, but they are open for you to implement anything if you can think of a better way to do something, then they will welcome that. So you got to ask yourself the question does the company as a whole, have a policy to give to me. We are policy driven. Everything we have is policies but that's one area we haven't tucked in to
	Procurement	**Low quality of suppliers**	National Purchasing Manager, Corporate Sustainability Manager(2/3)	• Corporate Sustainability Manager: Ten years ago, I went to a recycling company to check out the way that the company did. The answer was always like "what do you want on the report? If you want 50%, I'll give you 50%. If you want 100%, I'll give you 100%". They had a process for doing it. But when you asked them about timber. They will say "We won't recycle timber." • National Purchasing Manager: In the fifth container, the bricks were all oversized. • Corporate Sustainability Manager: It's a full time job because trades have the tendency to say "Oh, there's a bin and I'll throw it in". Of course, it becomes contaminated. So you have to have a labourer or a construction worker to get in and take out all the stuff. It becomes quite onerous.
	Feasibility	**Young industry – lack of knowledge in waste reporting**	HSE Manager, Corporate Sustainability Manager(2/3)	• Corporate Sustainability Manager: I think the industry is quite young in terms of reporting on waste. There are only a few of the main waste contractors that have a more robust reporting. But most of them only have a rough estimate.
	Feasibility	**Lack of Supplier development**	HSE Manager, Building Supervisor(2/3)	• HSE Manager: I think you have to really push through with the training. The training package is there – the slideshow. But do we get suppliers involved? Part of our tender package is to watch our DVD. Here's an information pack about our business prior to your coming to tender. But I think this training or information flow should be conversational – someone speaking to you rather than give you a DVD and say "Here's your scope of work".
	Planning	**Resistance to change (lack of incentives)**	HSE Manager, Corporate Sustainability Manager (2/3)	• Corporate Sustainability Manager: Timber automatically goes to landfill because we can't recycle it. Steel, concrete paper and plastic, we can recycle them quite easily because lots of companies are available to take it. But for timber, they can put pellets or firewood out the front. People won't even come in and take it. And it is the same with green waste. A lot of the companies now are working on green waste, so that they can recycle that part of it because there's money in it. They can sell it back to council for the gardens and stuff like that. So, if there's money in it, the industry will pick it up and make it work.
	Planning	**Lack of on site materials control and waste management plans**	HSE Manager, Corporate Sustainability Manager(2/2)	• Corporate Sustainability Manager: And as I said, at the present the practical way for us to manage waste is actually just to put one bin on site and it becomes a mixed bin, and have it taken away by a supplier who picks it up and gets them sorted, and does the recycling and gives us the report back.
	Feasibility	**Lack of knowledge about waste – recyclers / contractors**	HSE Manager, Corporate Sustainability Manager(2/2)	• Corporate Sustainability Manager: When materials leave site and go back to the recyclers, it is difficult to know how much of that stuff is actually recycled. It becomes mixed waste unfortunately, when it goes to them. So, they'll pick out, mix it and give us an estimate. That's always going to be the situation
	Operation	**Lack of quality control**	HSE Manager, National Purchasing Manager(2/2)	• HSE Manager: For the waste minimisation, I think we need to be pickier. When I say picky, we need to dabble deeper into the people we engage, rather than just taking things on face value. Unfortunately, a lot of things aren't like that because of time.
	Residual	**Offcuts from cutting materials to length**	Building Supervisor, National Purchasing Manager(2/2)	• Building Supervisor: Yes, quite a lot of offcuts [on construction sites]. We use MDF which has to be cut to fit. Lots of waste is produced.
	Planning	**Downstream response vs. Upstream solution**	HSE Manager, National Purchasing Manager (2/2)	• HSE Manager: and the thing is the waste on site it's a visual you see the results. And now in that middle that management where we need new direction change that there they don't see a physical end result. They're taking a belief that if I do it this way I'll save more on waste without even seeing the result because they're trying to avoid it. It's just trying to get them to understand that you're not doing nothing, you're actually doing something but can't compare the end result unless it's a figure of some sort but they probably won't get to that figure because they've done that proactive approach because on site is reactive. You waste on site and you reactively remove it and recycle it. Being proactive you don't see the consequence of not doing it and that's unfortunate because that's how people usually operate. You've got to see the consequence before you react so you're jumping the gun there

Low	Planning	**Knowledge of problem vs. Lack of action**	HSE Manager (1/2)	• HSE Manager: With the suppliers, I think we have got a fair bit to go regarding how to change them, but no activities has been taken.
	Organisational communication across units	**Inappropriate communication method**	HSE Manager (1/2)	• HSE Manager: People like to have information fed through them rather than “here’s an email please find attachment”. Those people don't like to click four clicks on the intranet page to find it.
	Procurement	**Ordering error, over ordering and under ordering**	Building Supervisor (1/2)	• Building Supervisor: More than likely over ordering • Building Supervisor: we had 50 odd houses under construction at the building site and we would’ve gone through something like 4 bins a day and no doubt that could’ve been cut down a lot. That was very out of control last year and lot of stuff was just getting ordered, they were just ordering, ordering, and ordering and we had all these leftovers straight in the bin and that was very badly organised.
	Feasibility	**Lack of skilled labour**	HSE Manager (1/1)	• HSE Manager: When you’re talking to people on site, it’s a whole different ball game. It’s like a school yard. They’re kids that need to be taught the right things, and disciplined when necessary
	Design	**Designer not familiar with possibilities of different products**	HSE Manager (1/1)	• HSE Manager: So it’s really about trying to educate our senior design manager about the processes involved, because a lot of them are architects. You should study the reason behind the materials that you use, rather than just saying “OK, we need that type of beam”. They actually should understand what alternative products we can use that’s better for the environment. I don't think we actually have a trigger for that. • National Purchasing Manager: The biggest problem we’ve got was the designers sat in isolation and were oblivious to the end results of their decision making.
	Operation	**Error by tradesperson or labourer**	HSE Manager(1/1)	• HSE Manager: You’re engaging a domestic contractor who has got no idea about the way you’ve set up your sheet planning. So he comes and there is a shortfall of 4 sheets because he has cut it wrong.
	Other	**Criminal waste due to damage or theft**	National Purchasing Manager(1/1)	• National Purchasing Manager: So much stuff is stolen from construction sites it’s frightening.
	Feasibility	**No enough space on site**	National Purchasing Manager(1/1)	• National Purchasing Manager: It’s more for the future because some of the sites didn’t have enough room to facilitate the closure.
	Other	**Knowledge management/knowledge transfer**	HSE Manager(1/1)	• HSE Manager: We still need to do more training. For anything you’ve just got, you should keep using it till you understand it. Unfortunately it’s usually like that “I’ve used it once. I’ve done it and I won’t go back.” However, the next time, they forget how to use the new technology.
	Feasibility	**Absence of Mechanism to bring improvement**	Building Supervisor(1/1)	• Building Supervisor: If we want to bring an issue up, we can give a phone call. There is really nothing to oversee all that as a whole. It might be expecting management to come to me at the end of the job and ask “why did you need all those bins”. So, they later ask all those questions. It really needs a full circle.
	Feasibility	**Shifting of waste vs. Elimination of waste**	HSE Manager(1/1)	• HSE Manager: I spoke to him and asked him “what do you do with your waste? On site we’ve eliminated [the waste], but have we really eliminated?” No. we’ve just moved it elsewhere. It’s the same philosophy as safety. You can get rid of someone, but have you gotten rid of the problem? No. You’ve given that problem to someone else.
	Procurement	**Competition situation of suppliers**	Building Supervisor(1/1)	• Building Supervisor: In Melbourne there should be dozens and dozens of site plasterboard suppliers. However, there is not. You’ve only got two in Melbourne.
	Other	**Illegal dumping resulting from high levy costs**	HSE Manager(1/1)	• HSE Manager: Unfortunately, it [high levy costs] does lead to other behaviours of illegal dumping.

(4/7) means 4 interviewees mentioned this code 7 times

Table 2: Summary of barriers to waste minimisation in Organisation B

	Barrier		Participant (People/Times)	Example quote
	Source	**Cause**		
High	Organisational	**Poor organisational communication across units to facilitate change**	General Manager, Estimator, Procurement Category Manager, National OH&S Manager, Senior Design Manager, BOQ Manager (6/17)	● General Manager: That's classic. About 100 site managers in Victoria, probably about 15 to 20 construction managers and 5 building managers in Victoria, it's a big ship. I guess having an agreement on something and having that being transposed all the way down the line are very difficult. So that for leadership management, I think it's a lack of our ability to communicate effectively as well so we have the building managers sitting in a room and all agreed on something and then they may be unable to communicate that to construction people. ● National OH&S Manager: Yeah it really comes back to the estimators. Well it starts with the sales people. Sales people don't understand sometimes what variations mean and sometimes they don't actually get put into the job, and then that makes an error to the site. And then you get your estimators and again you get those variations. If the estimators aren't hitting those variations or they don't understand them, then they'll miss-estimate the site and you'll end up with varying amounts of material on that. ● Design Manager: No, they haven't. They only get back to us only if there is issue in pricing, so if we pitched a particular home and say for instance $200,000 and it comes in and says $250,000, then that's an issue that's $50,000 over the price. So we to go back at that time and have to recheck the design to sort of try to get things out to reduce the price. ● Design Manager: I would assume they would but it's never discussed between us. They haven't come back to us and said that we are wasting too much timber because of design. ● Estimator: This change may not get communicated to the production estimators in time and thus the documents will not be changed. So, quantities will still be as per the Estimators original Bill of Quantities. This can lead to over ordering. ● Design Manager: we designed the new products and we release the new product. We expect people to understand it and get it. But we don't sit with construction team and the sales team to explain why we have done certain things and how certain things come together.
	Planning	**Knowledge of problem vs. Lack of action**	General Manager, Procurement Category Manager, National OH&S Manager, Senior Design Manager, BOQ Manager (5/18)	● Procurement Category Manager: There hasn't been a lot of discussion around how to target the other two suppliers to have a similar model to Supplier X. And then, we can try and implement across Victoria. ● Procurement Category Manager: We've always talked about we get so many cubic meters of bricks that are thrown out. We should really do something about that. But there's never been a pro-activeness to change it. ● National OH&S Manager: Going back to concreting, there are two issues with concreting. Left over reinforcement, quite often you will find a sheet of reinforcement or half a dozen lengths of rebar that's actually left over on site and never really know how we actually get rid of that. Generally it's done by the site cleaner. They'll take it away or they'll cut it off and take it away. But again it shouldn't be there but it is.
	Feasibility	**Direct costs vs. Whole of life costs**	General Manager, Procurement Category Manager, National OH&S Manager, Senior Design Manager, BOQ Manager (5/15)	● General Manager: What we didn't calculate was the impact on the efficiency. It's pre-fabricated off site and delivered to site. You can stand it up probably in 2 to 3 hours and then frame will take 3 to 5 hours minimum. So we didn't calculate the time efficiency there. We didn't calculate the fact that there is a lot of waste generated from building a stick home and from a stick build frame because it's never perfect. Sometimes it's over and sometimes it's under. So people have to chase more length of material or there's too much left over. So there is very little waste on pre-fabricated. It should be put into account. ● Procurement Category Manager: It's not proactively going to be said "well, our main aim is to reduce waste". It's always cost effectiveness. Our philosophy at Organisation B is purely cost. ● Procurement Category Manager: Yeah so that's kind of like something that it's not proactively gone out to say "well, our main aim is to reduce waste". It's always cost effectiveness, but it is something which is in the back of... ● National OH&S Manager: Fixing material is not high costing. ● Graeme: Not really. I don't have the cost of course, because the prefab frames, the big issue was whether it'd be right or wrong, saying that they are about $ 3000 a house lower price than a normal frame, but that's only on the face of it and that's where people don't understand the full, the true cost, because they don't know how much waste is involved in that against the price that's taken into account, it's really the cost and the safety side
	Procurement	**Ordering error, over and/or under**	GM, Estimator, Procurement Category Mgr, National OH&S Manager, BOQ Manager (5/7)	● Estimator: Over ordering is sometimes a problem and it is a big concern in terms of waste ● National OH&S Manager: Sometimes we have too much, sometimes we have too little.
	Planning	**Resistance to change (lack of incentives)**	General Manager, Procurement Category Manager, National OH&S Manager (3/9)	● National OH&S Manager: It's not worthwhile that somebody going back and actually picking up that amount of steel. ● National OH&S Manager: Because it's so cheap, it's not something that anybody wants to save or reuse. ● Procurement Category Mgr: But let's be realistic, they've been in a boom time for the past 10-15 years. There is really not any need to move away. ● GM: Previously we actually held the procurement team. Our aim was to get the team to be a national unit. However, there was a lot of resistance around it. People in the different states like to do their own things which are pretty standard. They did a fairly good job. ● Procurement Category Manager: this whole discussion about category management and we find the way which we purchase for some people it does go over their head. I don't think a lot of people really grasped what category management was about and how you're not going to see anything for two years. You're just going to see a lot of people asking questions and going around and presenting presentations. You might get some cost savings but the reality is that after two years you have this plan in place which you can then really target and have some stronger arguments to change the way suppliers work. So, that really I believe was not grasped in the organisation. So, once procurement moved outside of GMs control that kind of changed completely. So now it's moving more to the old school purchasing of we have three different suppliers, we want paper, what's your best price?

Medium	Procurement	**Lack of maturity/ cooperation from suppliers to minimise waste**	Procurement Category Manager, National OH&S Manager (3/8)	● Procurement Category Manager: Where I find it's difficult to communicate with the suppliers is that when you go and sit with them and say, "Let's have a decision about waste" a lot of suppliers even wouldn't understand what the waste percentage is of their own products. ● Procurement Category Manager: So where I'm frustrated I guess is that nobody's willing to have the open conversation of, "Yeah it does cost me ten bucks in waste whatever, it costs me three bucks in waste. Come in and spend three months to show me. So we can work together maybe brain storm some ideas on how we'll reduce that waste. Should I be going back to my manufacturer of Pods and telling him makes smaller pods so I only buy smaller pods?" Whatever it is…But what is this, what's an innovative strategy?
	Planning	**Downstream response vs. upstream solution**	Procurement Category Manager, Senior Design Manager, BOQ Manager (3/7)	● Senior Design Manager: We can alter the things onsite if we build the first one of these new designs and tweak it. We go back to the original drawing, tweak that and make that measure up.
	Feasibility	**Not taking a systematic and holistic view**	General Manager, BOQ Manager (2/4)	● BOQ Manager: Customers don't want to spend their money on what goes underneath the house. They want to spend on up the road and all the flashy stuff. So, it's hard to talk about that and justify that here. So I'm not quite sure how it fits into the whole.
	Planning	**Resistance to change (champion credibility)**	Procurement Category Manager, BOQ Manager (2/4)	● Procurement Category Manager: It [Procurement Strategy] was in GM's control and now it's gone out of his control. It's reverting back to the older ways.
	Planning	**Lack of senior management support to drive change**	Procurement Category Manager, BOQ Manager (2/4)	● BOQ Manager: I think we failed in the past, because we used one of the stakeholders to be project manager. It shouldn't necessarily be the stakeholder. It should be somebody who can sit above everyone and coordinate the whole project. ● Procurement Category Manager: But I just feel that in a lot of the assignments that we've put forward so further up the chain into like a GM level sometimes up to MD or executive level. There is a bit of stalemate so you kind of go, "I thought everything was working fine." "Well it's not."
	Design	**Changes to design**	Estimator, National OH&S Manager (2/3)	● Estimator: A client might wish to have a different eaves, different windows or different opening sizes. ● National OH&S Manager: And there are a number of things that sort of happened because we are not a typical volume builder. We are sort of a more customised volume builder. We got a lot of changes in design. Now those bricks could have been left over because either the customer ordered bigger windows, or they change the actual eaves on the house ● National OH&S Manager: With what we've got, and because we got so many different designs of houses and there are so many variations. That's the nature of Organisation B that they offer a huge variety of houses to people and every house has got six different façades. So it's very difficult to get it right.
	Procurement	**Low quality of suppliers**	National OH&S Manager, Estimator (2/3)	● National OH&S Manager: The trades are all terrible. ● Estimator: Some suppliers like to overestimate.
	Design	**Lack of influence of contractors and lack of knowledge about construction**	Estimator, National OH&S Manager (2/3)	● Estimator: Sometimes the site managers are inexperienced.
	organisational communication across units	**Poor organisational communication of strategic objectives**	Procurement Category Manager, Senior Design Manager (2/2)	● Procurement Category Manager: It should be an interesting area to think about how to communicate around the reason of why we're making these decisions.
	Operation	**Error by tradesperson or labourer**	Estimator, Procurement Category Manager (2/2)	● Estimator: Plasterboard is hung differently sometimes with how the production people think it will be hung. So the construction methods are different to what are anticipated ● Procurement Category Manager: We may be ordering enough on site. But the labour is not placing it well. So, we have to order more and therefore a lot gets wasted.
	Operation	**Off site manufacturing/ Prefabrication vs. stick build**	National OH&S Manager, BOQ Manager (2/2)	● National OH&S Manager: The stick build is fixed by the carpenter on site. Pre-fab actually is that the suppliers bring the walls on site and put them up. So there is not a lot of waste in regards to that. We were experimenting with steel frames down here at the moment. The experience in Queensland is that there is a lot of waste with those steel frames.

Low	Feasibility	**Absence of Mechanism to bring improvement**	General Manager (1/4)	● General Manager: I've seen many companies working there, but the mechanism is not there.
	Other	**Local resident dumping waste on the site**	National OH&S Manager (1/3)	● National OH&S Manager: I took green waste to the transfer station and they charged me $ 57. People are just dumping waste on the side of the road. It's all on your sites.
	Procurement	**Lack of possibilities to order smaller quantities**	BOQ Manager (1/2)	● BOQ Manager: So, if you are a small builder and you want to really optimise your material usage, you would order your plate material in the length, you'd look at your wall lengths, you'd map out how you're going construct your wall lengths, and you'd order you plate material in those lengths. Now we don't have the luxury of doing that.
	Estimating	**Variation**	National OH&S Manager (1/2)	● National OH&S Manager: There's so much variation [in design of different houses]. You have a variation in ceiling heights which can go from 2.7 up to 3.3. The bricks in there have to be estimated. The estimators don't always get it right.
	Other	**Size and complexity of business**	General Manager (1/2)	● General Manager: Victoria is the biggest division in this company, accounted 60 to 70% of revenue. It's probably the most complicated but lowest performing division, because of the scale and complexity.
	Feasibility	**Strategic procurement & Partnerships**	BOQ Manager (1/2)	● BOQ Manager: In fact, it is a handshake between your purchasing manager and your suppliers. The terms and conditions are not put down on paper.
	Feasibility	**No enough space on site**	National OH&S Manager (1/2)	● National OH&S Manager: You could be able to recycle it [the waste on site], but then it's a matter of having two bins on site. That's part of the problem because of the size of the sites. We don't have all that much size [space on site].
	Feasibility	**Lack of culture of innovation**	Procurement Category Manager (1/2)	● Procurement Category Manager: I'm not really sure why we can't improve the sales process and put a display home in the middle of Balwyn which was never done before. But when we introduced a labour only model, some people would think "Why did we do it like this? Maybe we should work more with our suppliers".
	Materials handling	**Damaged during transportation to site/on site**	National OH&S Manager (1/1)	● National OH&S Manager: Now because of the design of the concrete pumps, we always get about 0.6 of a cubic meter left over.
	Residual	**Offcuts from cutting materials to length**	Estimator (1/1)	● Estimator: Cutting bricks is different for different types of bricks
	Residual	**Throw away packaging**	National OH&S Manager (1/1)	● National OH&S Manager: We're building about 300 sites. We see a lot of empty concrete bags. There's probably an opportunity there to get the concrete delivered in bulk.
	Other	**Criminal waste due to damage or theft**	BOQ Manager (1/1)	● BOQ Manager: There's theft. there's vandalism [on site]
	Planning	**Lack of on site materials control and waste management plans**	BOQ Manager (1/1)	● BOQ Manager: Plastering is a very good example. We pay for supplying and installing. So they deliver their own materials - sheets of plaster - on site. So it would be interesting to measure how economical they are on the material usage, how much waste is actually left over from their perspective and what they have done to minimise it. I don't think we really analyse that.
	Feasibility	**Lack of Training/Education**	Estimator (1/1)	● Estimator: Site managers may not completely understand what is written down on paper. They may not be able to translate that into the physical construction.
	Feasibility	**Lack of resources allocated in organisation to support change**	BOQ Manager (1/1)	● BOQ Manager: Any project overlaps a lot of departments. It needs a dedicated project manager, needs someone as an integrator.
	Design	**Complexity of design**	Estimator (1/1)	● One very important factor is the complexity of design and customisation. We are a mass customisation housing company. We are not a mass builder. We are not gaining efficiencies in repeating the same task. We do slightly different things on every house.
	Other	**Poor site management practices and poor planning and coordination due to high workload**	Estimator (1/1)	● The site managers are managing many projects at once and this could be up to 15 jobs at the one time. So, this can lead to poor practices and poor control on site
	Operation	**Lack of skilled labour**	Procurement Category Manager (1/1)	● Procurement Category Manager: [construction industry has] low-skilled labour. For example, the concreter is not licensed.
	Operation	**Lack of quality control**	Procurement Category Manager (1/1)	● Procurement Category Manager: We need to have that control, because the base of concreter isn't well developed.
	Feasibility	**Lack of awareness of waste avoidance**	Senior Design Manager (1/1)	● Senior Design Manager: At the start, it's all about aesthetics, the way of rooms feel and look, and how you walk through the home and spaces around you. But we really don't think about the waste.

(5/14) means 5 interviewees mentioned this code 14 times

Table 3: Summary of enablers to waste minimisation in Organisation A

	Enabler		Participant (People/Times)	Example quote
	Source	**Cause**		
High	Feasibility	**Strategic procurement & partnerships**	Senior Design Manager, Corporate Sustainability Manager, HSE Manager, Estimator, Building Supervisor, National Purchasing Manager (6/40)	● Corporate Sustainability Manager: In the past, we would find a supplier to supply all the roof tiles to us. The roof tiler didn't have to worry about it from a dollar factor. So if they keep breaking them, we have to order more tiles. And the waste will go to landfill at that point of time. Now what we do is that it is the tiler's responsibility to provide the tiles. Suddenly, instead of having truckloads of tiles leftover, there may be only 3 tiles leftover per house. ● Corporate Sustainability Manager: The trades like the idea of having the process of where the bins come and go. And then they will actually comply much better. ● Building supervisor: All this stuff goes to this Konstruct place. I believe they are doing the right thing, which we never used to have so that being the first step. That is a big improvement as I said. The stuff that goes to the other guy, it looks okay. It might be slightly contaminated but they are going to sift through it. ● Building supervisor: We have taken it up with Tillings. They are big-sized timber distributors. Bowens is one of the biggest for pre-fabricated of walls, foot walls, and truss manufacturers in Victoria. So we are a team now. And now we have got all this big names together. People are willing to spend time and give time to really develop and we are seeing the fruit of all these come together. ● Building supervisor: Wastage in concrete seems to be more apparent when you supply the concrete for the concreter. If you pass on the accountability and responsibility to supply concrete to the concreter, he forms up a lot straighter. So once you do that you put it back on to these guys, your concrete wastage tends to reduce quite a fait bit because we used to allow extra three cubic meters of concrete per house just to allow for concrete blow outs. But now we started engaging concreters more. Concreters may take on the supply as well. We find that we're not getting much wastage at all in that essence
	Planning	**Knowledge of problem and take action**	Senior Design Manager, Corporate Sustainability Manager, HSE Manager, Estimator, Building Supervisor, National Purchasing Manager (6/32)	● Senior Design Manager: Stick build is fraught. There is so much waste. We need a fundamental paradigm shift. ● Corporate Sustainability Manager: From a waste point of view, the other thing is that we've only just started collecting the data. So we can't start analysing the data and understanding where our waste is actually sitting. Also, we can't really put in a waste reduction policy until we really know what we're doing. So we're really early in the stage of that process. So we're just trying to figure out in the next few months. Hopefully we'll get some good reports and some good information. And then from there we can actually say 'OK we can try to reduce it by doing XYZ". ● National Purchasing Manager: Along the way, we also decided to get into ISO14001 qualification. And we received it October 2012. It is a good thing, because it shows that we have traceability in the processes and also we have more direct links to the company for outcomes. We put a lot of efforts on sustainable outcomes, not only to get the qualification, but to do something about it. It is good, because now a lot of processes, a lot of the decisions, and the activities which the qualification requires to be done are coming with a lot more authority, a lot more efficiency and a lot more professionalism. So that was a big change.
	Feasibility	**Supplier development**	Sen Designer, Corp Sustainability Mgr, HSE Mgr, Estimator, Building Supervisor, National Purchasing Mgr (6/21)	● National Purchasing Manager: We look at the suppliers and developed the supplier assessment program. One of the key elements of the measurement is in the sustainable area. Do the suppliers have a sustainable policy? If they don't, theoretically, we don't want anything to do with them. We are enforcing our suppliers to adopt a very sustainable outcome. ● National Purchasing Manager: I always use other different measurement criteria. If they [suppliers] got a tick, there's a good chance they'll be used in another project. But if they get crosses in those boxes because they created a union problem or they held us up or they didn't perform, it will affect the decision for the next project.
	organisation	**Organisational communication across units to facilitate change**	Corporate Sustainability Manager, HSE Manager, Estimator, Building Supervisor, National Purchasing Manager (5/35)	● Building supervisor: That's the process we have. It goes through the design development process and having the design team right next to us, gives us the opportunities to capture these short circuits…these things before it happens on site. Consistently, our design team talks to me about cost and construction managers about buildability. So that's good open relationships we have got internally ● HSE Manager: Since then, we've started to do some environmental awareness within our business which is a bit of in-house training sessions. We sit with the site teams and go through it. ● Corporate Sustainability Manager: The HSE managers have a really good relationship with each of the project. So I think the feedback is openly shared. ● Building supervisor: it's more the construction director and I were sort of going, how can we firstly reduce time onsite and reduce risk from an OH&S point of view on sites as well. ● Building supervisor: It's not just the design, I must say, it is also the guys from the site, this is such a labour intensive job so why we need to be doing this. So all of a sudden…ok we got two people saying similar things, let's explore. ● HSE Manager: There's a HSE working group and there's a HSE council inside of Organisation A. So if there was an initiative raised it would work its way to the working group. The working group would have a look at it. It would go through to the council and then a recommendation for change. And like all the HSE managers and coordinates that fit in to the company from all the different positions they all have a HSE Manager who says they'll communicate with each other they'll send through ideas to me and I'll back saying forget it or whatever. But it's that type of process. It's very open communication I think between everyone in the company. I don't think there's a situation where you think I can't raise that or someone will think I'm trying to cause a problem. People like to throw ideas up and 90% of the ideas don't necessarily get a leg up but you get 10% of them that you think – haven't thought of that, that's a great idea, we'll work on that.
	Planning	**Senior management support to drive change**	Corporate Sustainability Manager, HSE Manager, Estimator, Building Supervisor, National Purchasing Manager (5/30)	● Corporate Sustainability Manager: There's a lot more awareness with the guys on site. People are more aware of what we're trying to do from an environmental point of view. We've actually gone down the line of needing people to get trained for either a certificate for environmental or a diploma in environment. So, people are starting to understand that there is a full commitment to it and we've got to make it happen. ● Building supervisor: We tend to look into a lot of innovations. So my GM in XXX, he always tells us to look into more of innovative ways to build in light weight construction. And that's what me and my construction director…branching out, always looking for new material, new systems new methods of construction, we constantly do it in the background, making sure if there is anything new in the industry, that's worthwhile then we trying to adopt them into our projects. ● Building supervisor: I must say, there is a little bit of culture in Organisation A about where we are going with light weight construction so our general manager is always pushing boundaries of how we can build light weight construction.

Medium	Feasibility	**Direct costs vs. Whole of life costs**	Senior Design Manager, HSE Manager, Estimator, Building Supervisor, National Purchasing Manager(5/20）	● Building supervisor: Yeah because I don’t want the stuff. I want it off the site daily, so they’ll back the truck up to this loading bay throw all their offcuts in and the truck drives away. Now it’s going to where it should be going. So for me that will be my preferred contractor on any site providing they performed as well.
	Planning	**Champion credibility**	Corp Sustainability Mgr, HSE Manager, Estimator, National Purchasing Mgr (4/12)	● HSE Manager: Our estimating manager will work with all suppliers in negotiating costs and contracts. So, I got him on board and I’ve given him the information... He did all our work. He’s part of every tender package. He’s the key person in the middle of everything. ● National Purchasing Manager: Well, in the case of Organisation A, I’ve become the champion in a lot of issues because of my authority and my enthusiasm. And I knew where to go when I hit blockers. I knew that I could go to Chris Warrell, the general manager of HR and use his influence to, because it was a sustainable problem.
	Planning	**Downstream response vs. Upstream solution**	Corporate Sustainability Manager, Estimator, Building Supervisor, National Purchasing Manager (4/11)	● Building Supervisor: We are talking a bit about supplier integration with the design, pre-concept styling, or before planning. It is also beneficial to do the design in conjunction with all parties in the beginning. ● HSE Manager: We try to give some direction as to where we’d like to go. But we can’t literally go and say you will go and do this. We can suggest and we can try to give ideas but in the end the business units are the one who will have to make the final decision. And it works well for us from the point of view that the business units like that autonomy to be able to run their business the way they want to run it. [Researcher]: and you put in that guidance role for support and direction. HSE: Yeah. It’s more ownership from them also that way as opposed to corporates dictating what they should be doing.
	Operation	**Off site manufacturing /prefabrication**	HSE Manager, Estimator, Building Supervisor, National Purchasing Manager (4/8)	● HSE Manager: Our timber wastage is reduced on site because we’re dealing with a timber manufacturer. The timber wastage has been reduced on site because we’ve given it to the specialists who know exactly what they need. ● National Purchasing Manager: Because you eliminate a lot of sustainable problems because you’re doing it in a controlled area. I think, you slave it on maybe doing it in a warehouse and not being affected by weather. And all you do is just take that completed or semi-completed product of art on a given day. And it’s put in the place like a meccano set. And that’s for certain. We looked at it very seriously and we do reports on that.
	Planning	**Identification of incentives to drive change**	HSE Mgr, Estimator, Building Supervisor, National Purchasing Manager (4/7)	● HSE Manager: We are trying to put a comparison to something that they can actually say “wow that's a lot of waste”, make them try to think about that process rather than giving them a number, and try and put some type of relationship to their lifestyle and their wellbeing. Ten gallons of waste, this is what we’ve generated. With all these waste, we could build 10 homes. How much is the cost for us to build 10 homes? ● Building Supervisor: The wastage on the floor is about 10%. But 10% out of 800 sheets is quite a lot.
	Organisational communication across unites	**Organisational communication of strategic objectives**	Corporate Sustainability Manager, HSE Manager, National Purchasing Manager (3/24)	● Corporate Sustainability Manager: We’ve run some sustainability awareness training and environmental training to the site. So, a majority of people are quite up to date. They understand we’ve got accreditation and we have to hold the accreditation. In order to do that, there are certain requirements that need to be done. ● National Purchasing manager: And it’s a document that shows, I mean it’s a document that’s being prepared. But it clearly shows that there must be and will be a waste management plan decided before people go inside. ● HSE Manager: PDR every 12 months – you sit down with your line manager and you have a chat. There is a formal process. I haven’t been privy to it. I deal with my team but with my previous direct manager it was more of an informal conversation just because of the commitment we had with each other which was positive for me because hopefully I was doing the right thing. But it talks about what you want to achieve out of your employment you know, it gives you an opportunity because it’s always us going down to tell them to do this and do that. If they want training I’m always happy to – to me it doesn’t have to be a formal process. It can just be in the form of communication. Just a bit more relaxed. But it’s a documented process and it talks about a few elements in there – safety. And I haven’t done it this year yet but there is a need to incorporate an environmental aspect to it. Previous to that there’s always say for a supervisor or someone on site its always cost, budget, smart objectives but the elements had more specific things to it and they started to put safety in it but then we’ve evolved to environmental now and its putting the environmental part and having that one on one conversation that’s the starting point. This is the direction of the business so you’ve taken away from emails or work and you really come down to our relationship and your position- their contribution to the agenda. It’s a starting point where you can sit with each person because you’re talking about their employment so they’re all ears now. They’re sweating, their palms are sweating because they think they’ve been – PDRs to me I don’t mind it. Look the general manager people might be sweating but I’m generally quite relaxed. I feel I’ve got nothing to worry about. But working down the chain of command they tend to think a bit more about it because just coming to see me –it’s about my performance so straight away it’s a worry. Unfortunately it has to go that way but it’s just a normal human reaction. Do I want to work do I want to keep my job? Yes I do. What do I need to do to keep my job? And you try and break it down but fundamentally at the back of their head they know their being interviewed on their performance so that’s one element where we’re driving a cultural change in the business.
	Feasibility	**Training /Education**	Corp Sustainability Mgr, HSE Mgr, Build. Supervisor (3/16)	● Corporate Sustainability Manager: It’s communicated through training programs. So we’ll deliver training program about the rules and guidelines. ● HSE Manager: Anything that our corporate division puts in place, policies or supporting guidelines, my role is to implement it, and train and educate through the Victorian business unit.
	Design	**Attention to sizes of products**	Corp Sustainability Manager, Estimator, National Purchasing Manager (3/3)	● Corporate Sustainability Manager: We’re looking at the type of Gyprock. We actually have a process where the supplier picks up the off cuts. It’s not done all that well but there is a process for them to pick it up. If it gets wet, they won’t pick it up. They need to think about the supply of Gyprock from the point of view. The supplier normally sends it all in 6m length sheet. They can send it in 3.6 length sheets instead, which would fit the room. So you will get less waste when you’re cutting. ● National purchasing manager: Well I think that’s, I think that the waste minimisation activity was trying to get design people a lot closer to the action so we rather say that we would design materials that are cut supply to our site in a prescribed length since nothing is in past there was a stain of length and if you want to know half of that the other half well just serves the purpose, sort of so waste minimisation was happening and we were trying to get the design claims involved in these decisions so that they were firstly nominating sustainable materials in the first place and secondly trying to minimise the amount of waste by trying to describe a length of material or an aerial material which was precisely what we required without any waste.

Low	Planning	**On site materials control and waste management plans**	Building Supervisor, National Purchasing Manager (2/5)	● Building Supervisor: Buildings are totally pre-fabricated. They may also come with lots of packs of bracing. We have a fair bit of timber leftover on this particular building because it's a big building. On a house you will be lucky to have a dozen length of timber leftover at the end of the job. They are collected and reused in every way or chopped out for rails in bits and pieces. But in the end you would not get too much gone in the bin.
	Design	**Integrated systems solutions (modularisation) vs. fragmented supply**	Estimator, Building Supervisor (2/3)	● Building Supervisor: They have already talked about having everything pre-cut in the factory that comes in modular.
	Other	**Knowledge management /knowledge transfer**	Estimator, Building Supervisor (2/3)	● Building Supervisor: I would think it is good to think of things and better ways of doing things and if you can achieve it. When I started on building 1, we had some terrible problems there. In building 4, they just don't exist anymore. We've achieved a lot in less than 3 years.
	Design	**Designer familiarity with possibilities of different products**	Corporate Sustainability Mgr, National Purchasing Manager (2/3)	● National Purchasing Manager: The designers should look at more sustainable materials. For example, we were trying to find a proper material for our cladding on a project. We're using Company X's product, which is a cement corporate. But they don't have a sustainable green product. We then adopted a Company Y's product which was pure wood. And that was 100% sustainable product. It just was cheaper than the X's product.
	Procurement	**Cooperation/maturity from suppliers to minimise waste**	Estimator (1/3)	● Estimator: We have CSP, who are the distributor of this particular product in Victoria. And we also have the plastering company to make sure that when we sandwich them altogether, it will meet our acoustic and fire rate requirements. Then we have the engineers here. So we had multiple amounts of people here. And then we say "can we do that or not?" Everyone around the table says "Yes, we can". So, we start working with individual parties to bring certain pieces together.
	Organisational communication across unites	**Appropriate communication method**	HSE Manager (1/2)	● HSE Manager: For PDR, every 12 months, you sit down with your line manager and have a chat. There is a formal process. I haven't been privy to it. How I deal with my team and my previous direct manager was more of an informal conversation just because of the commitment we had with each other. It was positive for me. It doesn't have to be a formal process. This form of communication is just a bit more relaxed.
	Planning	**Development of framework/guidelines to minimise waste**	Building Supervisor (1/2)	● Building Supervisor: Since our ISO4001 accreditation, we have to keep getting better and better. The focus of our company is on the issue of waste reduction. For the last 6 to 8 months from what we have been talking about, waste reduction is just started coming on the radar.
	Design	**Think strategically**	Sr. Design Mgr (1/1)	● Senior Design Manager: We have got to think about design and the role that smart design can play. We need to think strategically.
	Design	**Smart design**	Estimator (1/1)	● Estimator: Right now, for any future buildings, we are going to get the designs upfront with suppliers or partners and say "guys these are your parameters when we are setting out this design". And from there, you will definitely going to pick up efficiency. You might be able to cut 15% of your cost down because you're designing more effectively.
	Operation	**Product use – accurate**	HSE Manager (1/1)	● HSE Manager: Get your quality and experienced people down the line to use the product to ensure that it's used correctly.
	Feasibility	**Enough space for waste storage and recycle on site**	Building Supervisor (1/1)	● Building Supervisor: Once I worked on a site here, I built 200 homes and I was lucky that I had room for six bins.
	Other	**Information flow – providing accurate information to trade to use product**	HSE Manager (1/1)	● HSE Manager: At the moment with evolutionary of technology, they all use computer. Now if the program is on the computer, it doesn't work out the nominal amount of cuts. It could be another way of technology may help with waste reduction by simple cutting and giving better information to a trade to use a product.
	Organisational communication across unites	**Integrate into the field more**	Building Supervisor (1/1)	● Building Supervisor: They [designers, estimators, etc.] get to see the site. They get to see how the things work.
	Operation	**Equipment malfunction**	HSE Manager (1/1)	● HSE Manager: In 2008 or 2009, we had a company come through and they purchased a mulched machine from the States. They brought it over and kept it on site. We were able to churn the concrete, bricks, wood chips or tiles and used them off site. That's probably the first element in Victoria where we had some knowledge or initiative to say, "Look, let's get some recycling. Let's try to manage our waste".

(5/23) means 5 interviewees mentioned this code 23 times

Table 4: Summary of enablers to waste minimisation in Organisation B

	Enabler		Participant (People/Times)	Example quote
	Source	**Cause**		
High	Feasibility	**Strategic procurement & partnerships**	Procurement Category Manager, National OH&S Manager, BOQ Manager , Senior Design Manager (4/24)	● Procurement Category Manager: A supplier just off the book could call up and say "I'm starting a roofing business. I have this new product. It's manufactured in this way. Are you interested?" We would talk to them. ● Procurement Category Manager: When we go back to the supply base and say "we're purchasing timber", a lot of the questions come up "look, what other value can you give us?" Then we talk to them about that. ● Senior Design Manager: Someone came up with the idea and said "I have seen this new product and it looks great". We approached the supplier. We spoke to the company and set up a small prototype of the small house in the backyard. ● Procurement Category Manager: Take for instance timber, which is one of our largest ones and that's not a category I take care of. But timber itself obviously we get a lot of off cuts. What we've now done is partner up with Dawsons who manufactures timber, stick built and they could actually just give us the sticks and we could build them on site. We've actually moved them to produce the frames in the factory bring them and then prop them. The idea there is that those sites should stay.
	Planning	**Knowledge of problem and take action**	General Manager, Estimator, National OH&S Manager, BOQ Manager (4/20)	● Estimator: Over ordering can occur in timber. Pre-fab frame will solve this. ● General Manager: As a practice, it's very ad hoc. The aim was to get the best practice, at least the best practice in the industry.
	Feasibility	**Supplier development**	National OH&S Manager, BOQ Manager , Procurement Category Manager, Senior Design Manager (4/11)	● National OH&S Manager: We actually changed their process to put more gravel around the pipes. Before, they all left more spoil. ● BOQ Manager: We work with suppliers quite often by brainstorming, and come up with smart ways of introducing new systems and approaching them operationally.
	Feasibility	**Direct costs vs. Whole of life costs**	General Manager, National OH&S Manager,BOQ Manager (3/7)	● General Manager: We did some hypothetical modelling of waste. It should be X amount of all these different types of waste on an average house and suppliers need to take away all this amount of waste. And yet we were taking away 3-4 times of amount what we thought we would ● BOQ Manager: Not so much about the selection, but how to optimise the use of a site. I think sometimes there are opportunities in the way of making costs a little bit more, but it may help to deliver a better site of home to the customer, better use of land, less cut, less landfill. It could really deliver a better site of home, more appropriate site of home for the customer. ● Procurement Category Manager: Okay well when you look at the value of getting Dawsons to manufacture the timber frame, you're seeing a price reduction, you are seeing cost avoidance. But other value creation is the reduction of waste on site, the training of carpenters so you have the same philosophy on building that frame across the range. So you don't have different companies doing their own thing. And also there's a base there which you can tap into and say, "This is our new initiative in Organisation B that we want you to carry through". So you're managing suppliers quite closely. That's worked well.
	Operation	**Off site manufacturing & prefabrication**	National OH&S Manager, BOQ Manager , Senior Design Mgr (3/4)	● National OH&S Manager: We are training prefab frames at the moment. And we have done them in the country. Prefab frames take away a lot of the waste, so virtually no waste left over. ● National OH&S Manager: Probably they generated a lot less waste there because they actually went into the pre-fab frames.

Medium	Planning	**Senior management support to drive change**	General Manager, BOQ Manager , Senior Design Manager (3/3)	• BOQ Manager: We are having a dedicated resource project manager on some of those big things, big initiatives because they can easily become too hard.
	Planning	**Champion credibility**	General Mgr, BOQ Mgr, Senior Design Manager (3/3)	• General Manager: Probably general manager needs to gets more engaged and involved than others and make it happen. He's the mechanism.
	Organisational communication across units	**Organisational communication across units to facilitate change**	BOQ Manager , Senior Design Manager (2/14)	• BOQ Manager: So our role is to support sales consultants, sale estimators, production estimators. • Senior Design Manager: The designers' role is creating the product, and developing and releasing it to the business. So the design falls under the product development umbrella. Within product development, there is design, interior, landscaping, display documentation and anything to do with display home. We document any new products we master. • Senior Design Manager: As a product development team and people that head up different areas would probably get together and discuss the product/process and change in the process /ideas and "what do you recommend?" And people say yes or no or give opinions, what's it looks like or feel or whatever and decisions made then and when you get ok from most of those guys and express it to the directors of the business and say, "listen, this is what we have been presented with and we got together and we think we should implement it in the business", and then we work out ways of how we can implement it. Someone says in case, let's try display steel frame in single and double story house and how would it go. Then you have some data to support the decision. In that instance of steel frame Campbell drove that project and so he met me on weekly basis and I had an issues in detailing kind of stuff and which is up in the way you need to champion the process for innovation but then also cluster of people who are willing to see on the table and discuss the new idea you need the likeminded people who are willing to give it a go ok.
	Design	**Think strategically**	General Manager, Senior Design Manager (2/6)	• General Manager: We have business units in each state. We are trying to get the best practice in the business, monitor our practices and then try to improve our thinking. • Senior Design Manager: We are involved in small parts. Basically Organisation B identified sites for potentially 40 townhouses. The brief to us would be "Can you design individual homes for this market?" It might be two levels, three levels, signal storey attached or detached housing and it just depends on size specific.
	Feasibility	**Attractive nature of innovation (iPad)**	General Manager, BOQ Manager (2/2)	• General Manager: We recently introduced the iPads into the field and that's gone very well.
	Other	**Size of the house**	National OH&S Manager, Senior Design Manager (2/2)	• National OH&S Manager: They build predominately single storey houses. So there is a lot less complexity in the actual design of the house. There are a number of reasons why they are actually lot cleaner in the country than they are elsewhere.
	Feasibility	**Training /Education**	General Manager, BOQ Manager (2/2)	• BOQ Manager: From that point of view, we need to train our estimating teams on how to use the assemblies.

Low	Feasibility	**Existence of desire to improve**	General Manager (1/3)	● General Manager: It would be really useful if we got building council to look at how we take waste out.
	Planning	**Development of framework/guidelines to minimise waste**	General Manager (1/3)	● General Manager: There will be some guidelines. I think that's a part of the job in business improvement group. They will identify and draft some processes for our waste generators or potential waste generators on site.
	Planning	**Downstream response vs. Upstream solution**	General Manager (1/1)	● General Manager: There is a classic business improvement group to look after the high risk processes and try to engage the business units and stakeholders in our best practices or the best for our business. Now it is developing in collaboration with those processes across the sales functions, drafting, estimating, customer support, building, service and warranty. We look at all those areas and the high risk processes. We try to re-engineer all those. The ultimate aim is to get the best level of customer satisfaction and profitability for the organisation.
	Organisational communication cross units	**Organisational communication of strategic objectives**	General Manager (1/1)	● General Manager: We do top-down influencing. It's actually very engaging of different lines, but it is effective. The decision is made in the end and then pushed down after engagement. Then I think it's an experience on site where they are dealing with trades and suppliers who have heavy influences over what happens.
	Design	**Integrated systems solutions (modularisation) vs. fragmented supply**	BOQ Manager (1/1)	● BOQ Manager: In terms of overall principles, the more Organisation B can modularise the construction process, the less waste will be produced theoretically.
	Procurement	**Cooperation/maturity from suppliers to minimise waste**	BOQ Manager (1/1)	● BOQ Manager: I think there are opportunities to brainstorm with the suppliers and work out the issues with brick sizes
	Feasibility	**Enough space for waste storage and recycle on site**	National OH&S Manager (1/1)	● National OH&S Manager: There should be more space and a bit more care. They [the project team] can actually build a house about once every 20 months or whatever. Because they can store the offcuts and the bits and pieces, and then they reuse them.
	Planning	**Labour only model**	Procurement Category Manager (1/1)	● Procurement Category Manager: Now we're trying to change to labour-only model. We manage and purchase rather than having one supplier to do all these things.
	Feasibility	**Understanding of modern philosophies such as Lean**	General Manager (1/1)	● General Manager: What we doing with Lean is getting more on waste, in the name of waste elimination as in physical waste. But we are expanding it to full definition of waste, value of waste.
	Operation	**Quality control**	BOQ Manager (1/1)	● BOQ Manager: You can be sure to cut a bricks just like that. It happens like quality control.

(3/5) means 3 interviewees mentioned this code 5 times