CIRIA, C726 London, 2013

Implementing Lean in construction

Lean and the sustainability agenda

Claire Corfe, BRE CLIP

Feedback

CIRIA and the project steering group welcome your feedback on the documents in the Lean series.

However, before reading this guide, and without reference to the contents list, please write down five areas or specific questions that you are hoping the guide will help you with.

We invite you to list these points, and the extent to which they have been covered, in the Lean questionnaire, which can be found at: **www.ciria.org/service/lean**

Implementing Lean in construction: Lean and the sustainability agenda

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CIRIA

C726 © CIRIA 2013 RP978 ISBN: 978-0-86017-728-9

British Library Cataloguing in Publication Data

A catalogue record is available for this book from the British Library

Keywords	
Lean construction, change management, construction process, improvement, innovation, knowledge management, productivity, supply chain	
Reader interest	**Classification**
Supply chain business improvement, project management	Availability: Unrestricted Content: Advice/guidance Status: Committee-guided User: Business improvement managers, senior management, Lean champions, HR and skills managers

Published by CIRIA, Classic House, 174–180 Old Street, London, EC1V 9BP, UK

Why read this guide?

The built environment offers many challenges and opportunities in terms of sustainability whatever your role might be. No matter what your previous knowledge is with regard to Lean this guide will show you how a Lean approach can support the areas of sustainability that you will encounter, making your role simpler and more effective.

Appendix A1 contains a series of workbooks, which gives you the opportunity to reflect and review on points made in this guide. There are references to these workbooks throughout the guide.

Background to topic

Interest in the Lean and sustainability agendas is increasing. Both have a contribution to make in resource efficiency and economic savings, environmental impact and within social matters such as health, safety and well-being. However, they are frequently addressed separately within different communities, creating extra work and leading to missed opportunity. This guide reviews work currently being done within the built environment to create synergies between the two normally separate disciplines.

CIRIA Lean guides

This guide is one of a series of publications and, together with an overview document, can be found at: **www.ciria.org/service/lean**

C725 Lean and BIM (Dave, B, Koskela, L, Kiviniemi, A, Owen, R, Tzortzopoulos, P)

C726 Lean and sustainability (Corfe, C)

C727 Lean benefits realisation management (Smith, S)

C728 Lean client's guide (Chick, G)

C729 Selecting a Lean consultant (Fraser, N)

C730 Lean tools – an introduction (O'Connor, R and Swain, B)

Acknowledgements

This guide was written by BRE and Collaborative Improvement Ltd under contract to CIRIA.

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This document was written jointly with Collaborative Improvement Limited (CIL) as part of a wider alliance between the organisations.

Funders

BIS, BAM Nuttall, Construction Skills, Highways Agency, Sellafield Ltd, Skanska

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1

Setting the scene

1.1 THE SUSTAINABILITY CHALLENGE

Sustainability as a system

Sustainable development has been defined in many ways, but the most frequently quoted definition is from the Brundtland report (Brundtland, 1987):

> *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*
>
> *The definition contains within it two key concepts (www.iisd.org/sd) the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organisation on the environment's ability to meet present and future needs."*

Definitions of sustainable development require that we see the world as a system with social, economic and environmental dimensions that has many influencing factors. Much of what we do contributes, in some way, positively or negatively to sustainability:

- as individuals
- within our organisations, whatever our roles
- in a national or international context.

Sustainability in the built environment

When coming to terms with sustainability issues, many people have looked to relate them to the processes over which they have influence. The UK Sustainable Construction Strategy (HM Government, 2008) identified the issues (the 'ends') and the processes that we go through to achieve them (the 'means') for the built environment industry (see Figure 1.1).

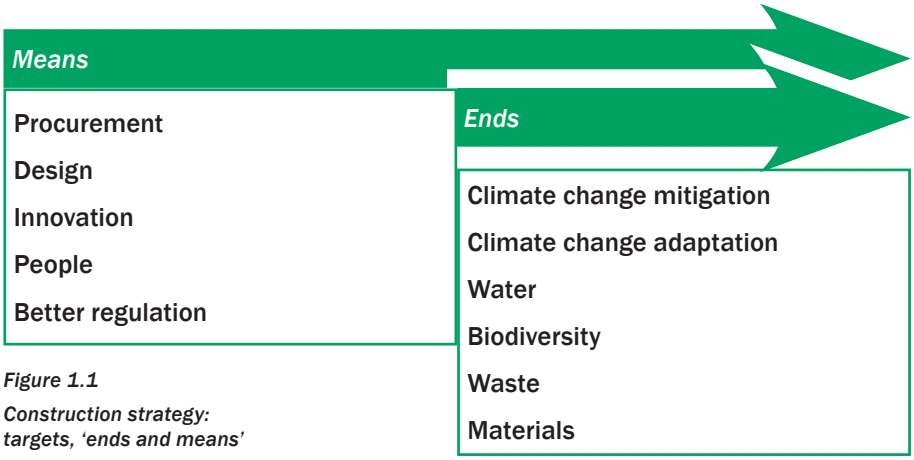


Figure 1.1

Construction strategy: targets, 'ends and means'

Other important factors include:

1 Lifetime considerations: whether measured in terms of cost, carbon, social impact or benefit. This is particularly relevant in this sector where buildings and infrastructure are operated for decades, or sometimes centuries.
2 Holistic considerations: while there is presently a considerable focus on reducing carbon, the implications of processes on the wider range of environmental, social and economic impacts should be considered.

Sustainability challenges and the applicability of a Lean approach

The challenges and opportunities in the context of sustainable construction are set out by the UK Green Construction Board's report (UK GBC, 2012).

The industry stands on the threshold of five great opportunities to:

- carry out a huge programme of work stretching out over at least the next 40 years
- make use of that workload to reform the structure and practice of the industry
- export the products and knowledge of a modernised industry
- play its part in readying society and the economy for a resource efficient future
- excite future generations of new recruits.

The industry needs to use these opportunities while at the same time facing other targets and challenges from government legislation, local authority planning, changes in the Building Regulations and the Code for Sustainable Homes (CLG, 2006), to client led initiatives and stakeholder demands. This adds greater pressure on organisations, and those who are tasked with driving the sustainability agenda within them.

There is a growing awareness of the link between a Lean approach and sustainability. The UK Government has recognised this for some years and has sought to raise awareness. Lean is first mentioned in the progress report by HM Government (2009):

> *"there is growing recognition that 'Lean' thinking, with its focus on delivering real value whilst simultaneously achieving improved competitiveness of the sector and delivering many sustainability objectives, now needs to be considered as a key instrument for the delivery of objectives set out in the Strategy for Sustainable Construction. It follows that Lean thinking should form a central part of organisations' sustainability strategies."*

Adopting this philosophy can help in several areas and specifically within the processes that have an effect on the targets and goals of sustainability as listed in the introduction of this guide. Key areas where Lean can help include:

- engage project teams and supply chains in the sustainability agenda
- encourage design and build processes for minimum waste
- fuel innovation in process and products to minimise energy, carbon and material resources in construction and use
- create a focus at all stages of a project to preserve and enhance biodiversity
- foster greater respect for people
- enable benchmarking and focused performance improvement.

1.2 OVERVIEW OF LEAN PRINCIPLES

As someone with a role that influences sustainability in the built environment, what do you need to know about Lean? This guide explains Lean's basic concepts and then builds into more

detail, helping you to make your own links between Lean, sustainability and your role. If you are already in part familiar with Lean, we would still encourage you to start here, as you may find some varying views that may help develop your understanding. We also encourage you to visit the workbooks in Appendix A1 when prompted.

Lean philosophy

Lean is a philosophy through which to approach and carry out any process or project. One definition of Lean quoted by Terry and Smith (2011) is it is:

> *"a way of thinking and delivering value, innovation and growth by: doing more with less – less human effort, less equipment, less materials, less time and less space aligning effort closer to meet customers value expectations at the heart of Lean are flexible, motivated team members, continuously solving problems."*

You should already see parallels with our description of sustainability in the previous section. How does the definition of Lean align with the aims and objectives of your role? Take a moment to think about how they align and differ (see Workbook 1). If we changed or added a few words, this makes a stronger link to sustainability:

- doing more with less – less negative impact on humans, resources, carbon, material waste, and less accidents
- aligning effort to meet the needs of the present without compromising the ability of future generations to meet their own needs (see Brundtland, 1987)

The five principles of Lean

There are five principles of Lean, which can be thought of as the route map to embedding Lean practice. These are shown in Figure 1.2 (page 4) with a sustainability focus.

The first principle, addressing customer value and the final one on perfection (or continuous improvement) are likely to be concepts already familiar to you. Lean sets out to define these and then offer a path between the vision and the outcome, introducing potentially less familiar concepts of value stream, flow, and pull.

It is important to recognise that 'value' is viewed from the end users perspective and comprises several of criteria one of which is sustainability. If we think of the three elements of sustainability (environment, economic and social) in terms of the 'three legged stool' analogy, then this implies that each needs to be considered and to be in balance. Without this the 'system' becomes unstable. In a similar manner, Lean encourages a sustainable, balanced approach to creating value.

The following sections discuss Lean more in depth from a sustainability perspective. Traditionally, Lean would use value defined in terms of quality, programme delivery, cost and health and safety (H&S). As you will appreciate, not delivering on value in these areas has sustainability implications, for instance:

Cost	Wasted materials and disposal costs, disruption through poor planning, pollution fines etc
Time	Plant and workforce on site for longer, delays in achieving benefits (economic, social) from facility
Quality	Defects and rework requiring extra resources, poor in use performance leading to excess energy use etc
H&S	Accidents or incidents affecting workers, local community or the environment

Value

Before you can start, you need to understand what the end customer actually wants and needs.

It defines what your project or process needs to deliver.

Value may be expressed in terms of any one of, or a combination of:

- performance
- function
- timescale
- quality impacts
- whole life requirements
- life cycle costs
- environmental impact
- economic impact
- social impact.

Value stream

This is the map of the process by which you deliver the defined value.

It includes every step in the process, which could be from concept to demolition.

It is here you develop your understanding of what really happens, who does it and why, and how they do it, for example when does sustainability get considered in design and during construction and detail reduced design development life cycle effective capture and flowdown of intent reduced rework increased iteration for value improvement improved predictability of investment and life cycle costs.

Flow

Once you understand the value stream, you can now start to move forward.

Here you define the steps that add value, those needed for support and those that are defined as waste.

Once defined, then you can start to:

- remove waste
- increase effectiveness
- smooth the progression of activities to avoid delays or disruption
- ensure whole life performance is considered at each step.

Pull

Having started to remove the waste steps, the focus moves to smoothing the process.

Doing a task only when required by the next person in the value stream, means that work is done by the right person, at the right time, and only when needed.

As a result excess resource use is avoided as waste such as excess travel or material usage can be avoided.

Perfection

This is where Lean moves from an initiative to an embedded part of how you work.

Lean is about the continuous search for, and elimination of waste, so there is always a strive to look for the next improvement.

Think in terms of getting to zero carbon as a current perfection goal, we are not there yet, but people are moving in the right direction.

Figure 1.2 The five principles of Lean

As clients and the industry are further embracing sustainability, defined value may also include specific sustainability criteria such as:

Environmental	Embedded carbon, zero waste to landfill, biodiversity etc
Social	Accessibility (eg to public), minimal disruption during construction
Economic	Low energy and other operating costs

Lean principles offer a framework for identifying how these aspirations of value can be achieved in a balanced way.

1.3 LEAN APPROACHES TO SUSTAINABILITY

In Section 1.2 Lean is described as a philosophy, and it is equally defined as a practice to enable organisation or systemic change. This practice can be adopted through a variety of approaches that can be broadly divided as follows:

- planning and risk management
- collaborative working
- problem definition and solving
- workplace and process efficiency
- value stream efficiency.

A common thread through all of these approaches is the mission to find and take out waste (in its many forms) from the activities and processes involved in a project or organisational operations.

1.3.1 Seven Lean wastes and associated sustainability benefits

When we talk about 'waste' in a Lean context, it has a specific meaning that is wider than material waste alone. Any process or project that we undertake can be divided up into three categories:

- **value:** what the customer or end user is prepared to pay for
- **non-value (often known as essential non-value adding, ENVA):** all of the activities that we have to do, under our current conditions to make the value happen, for example, this may be inspections or reporting, or statutory breaks
- **waste:** everything else, ie activities that are carried out, but add no value to the process and will have an adverse effect on cost, time, quality or sustainability, for example design rework.

Take a moment to think about things in your day-to-day work that stop you doing what you need to do, cause you frustration and make you feel as if you have just taken two big steps backwards. That is what waste feels like (see Workbook 2).

Lean is a process that eliminates waste through delivering continuous improvement in a collaborative way, where the principles can be directed at sustainability objectives to good effect. These can occur at any stage of the process/value stream. The waste includes time, energy, resources, carbon, whole life cost, physical waste, poverty etc. To help people become aware of the waste in the process, it helps to use the seven wastes. Table 1.1 sets out the seven wastes using an acronym TIMWOOD to try to remember them by.

Table 1.1 The seven wastes

The seven wastes	Definition	Sustainability examples	Benefits of removing waste
T *Transportation*	Excessive movement of physical or virtual things	◆ double handling of materials on site due to poor planning of deliveries and storage areas ◆ excessive mileage due to non-local suppliers being used ◆ excessive deliveries to site because of poor planning.	◆ reduced cost and emissions of handling equipment, eg cranes ◆ reduced risk of handling damage, so reduced physical waste ◆ safer site ◆ lower energy consumption.
I *Inventory*	Storing too much or too little of something, poor storage conditions, excessive work in progress	◆ ordering too much concrete and having to dispose of it ◆ lengthy reports where the information you need is hidden in the middle ◆ using more space than is necessary for a building due to poor design.	◆ better cash flow for supply chain ◆ improved safety ◆ reduced material handling and transportation, with associated emission and fuel cost reduction ◆ less risk of damage, excess waste and resource use.
M *Motion*	Excessive personal motion or difficult working conditions	◆ static site welfare facilities only available at one point on a large site ◆ site engineer repeatedly driving around a site to sign off permits ◆ poor ergonomic design of a space.	◆ less work related injuries and absence ◆ safer working environment ◆ improved productivity ◆ reduced fuel use through reducing unnecessary travel.
W *Waiting*	People or equipment inactivity, flow of a process stopping because the right information or resource is not available	◆ waiting for the design detail for an airtightness tape around a window, delaying installation ◆ delayed results of an ecology survey ◆ site stoppage due to an accident or incident ◆ waiting for materials because of late ordering or poor planning.	◆ improved productivity ◆ reduced energy use from more efficient working ◆ improved flow of work ◆ less frustration.
O *Over-production*	Doing too much too soon, or out of sequence	◆ fully completing a design before considering specialist input ◆ mixing too much mortar for the shift ◆ downgrading insulation causing over specification of the heating system ◆ excessive packaging material being used.	◆ reduced waste rates ◆ reduced transportation of original and replacement materials ◆ reduced cost associated with excess materials ◆ reduced rework and potential for damage, reduced resources used.
O *Over-processing*	Using an overcomplicated or incorrect process for a task, not having the right resource, equipment or plant breakdown	◆ installing complex, maintenance heavy systems ◆ failing an air test through not having adequate quality checks throughout ◆ lengthy pre-construction lead in ◆ complex deconstruction requirements ◆ exceeding specified requirements for no benefit.	◆ reduced resource and energy use in unnecessary processes ◆ improved quality and repeatability ◆ safer working methods ◆ work planned at right time to take into account all ecology impacts.
D *Defects*	Having to repeat an activity more than once before it is to the right quality	◆ poor workmanship ◆ completed drainage failing a test ◆ damage to materials or completed work ◆ re-running energy calculations because of poor air pressure test results late in the build process.	◆ improved customer satisfaction ◆ project on time with no faults ◆ lower rates of waste disposal ◆ less environmental incidents ◆ reduced transportation of original and replacement materials.

Alongside these seven wastes, there is often quoted an eighth waste:

Skills misuse	The waste of not utilising the skills and knowledge of people within your team, organisation or community to get the best solutions If we ignore this key element, we can inadvertently introduce significantly more waste into the process	◆ consider the last time you were told that you had to change the way you were doing something and compare that to the last time someone asked your opinion and worked with you to come up with a solution. They were most likely very different outcomes and you may well have been more inclined to work with the latter ◆ respect for people is a key principle both for Lean and sustainability, and should never be overridden by the desire to adopt Lean tools regardless.	◆ better buy-in to improvement activities, and ultimately better, and more sustainable solutions.

Has that explanation led you to rethink any of the wastes that you thought of earlier (see Appendix A1 Workbook 3)? When you are next in your office or on site, every time something causes you to stop or you need to resolve an issue, note it down and review it at the end of the day to see what kind of waste is coming up most often. You may find that some waste you see will not fit neatly within one of the categories, but will be a combination of many.

1.3.2 How can Lean make your role simpler?

From Section 1.3.1, you can start to see that a Lean approach can help you and your organisation, work towards meeting some of the challenges around sustainability. A key role of Lean is to help do this as simply as possible. Processes at work are frequently unnecessarily complicated. Using an holistic and collaborative Lean approach means that we can build in simplicity as well as effectiveness.

It is worth thinking at this stage about your own particular needs, the challenges that you feel you face on a regular basis and the balance between:

- identifying the sustainability issues that are important and establishing appropriate targets and measures
- focusing decisions on whole-life consideration
- getting stakeholders and the team involved and aligned.

Avoiding waste?

One real life example is a contractor who ordered all the kerbs for a project at the start, as the site manager wanted to set the site up and the procurement team recommended that one delivery was cheaper. The kerbs came in, were set out by the engineer and concreted in place. All except the pallet of special curved sections that were stored. As the job progressed, the kerbs were run over by plant, broken or dislodged, and come snagging time, there was a lot to do to put things right. But the long lead time specials were fine, or they would have been if they had not been moved five times around the site to allow working room before they were run over by the dumper and put in the skip!

This short example illustrates seven types of waste:

- transportation (excessive vehicle movement on and off site)
- inventory (excess raw material use and emissions from transport to site)
- motion (H&S risks due to excess physical movement of kerbs)
- waiting for the reordered specials (more disruption to local community as site overran)
- overproduction waste (excess energy use to batch concrete and excessive on site vehicle movement), and over-processing (ordering and delivering the kerbs earlier than necessary, excessive vehicle movements near site)
- defects (greater volumes of waste and more materials being manufactured).

Simplicity

An example of this is the increasing complexity of construction details as we strive to improve thermal performance of buildings using split lintels, wider cavity walls, airtightness tapes, thermally isolated balconies etc. A Lean, collaborative team working to create a solution can simplify this design and build process, without compromising performance, rather than designing then leaving it to the site team to resolve the build sequence.

Table 1.2 offers suggestions, as to how Lean might help you within your role.

Table 1.2 How Lean can help you

Your challenge	How a Lean approach can help
Identifying the sustainability issues that are important to your client and/or to your organisation	Creating the drive to identify the issues and offering a framework to build the understanding.
Improving results against your sustainability measures or KPIs	Gaining a real understanding of what the results are, why, and the root causes of issues. Using that information to collaboratively improve those results.
Better understand the increasing focus on building or asset 'performance in use'	Understanding the whole process including services commissioning and occupant management of the building, to avoid the potential of designing an efficient building but not being concerned, or aware of what it actually delivers. It is expected that from 2016 the Building Regulations for domestic construction will include an 'as built' performance criteria, so testing and quality control will become an increasing area of focus. Also by 2016 there is the drive for zero carbon domestic new build, adding further emphasis to collaborative working and quality.
Gaining supply chain buy-in into sustainability goals	Helping define and set the vision for sustainability as an integral part of the overall value of a project that everyone can buy into. Fostering collaborative working to maintain buy-in. Refer to Chick (2013) for more information on this challenge.
Including performance and whole life criteria at the start of a project	Providing a mechanism for all disciplines to come together at the earliest stage and create an overall vision for the project, then use that to guide decision making. If possible, involve the end user to find out what they require from the project, ie what is their value. A key challenge is getting everyone to understand what aspect of the process/construction affects the energy/ sustainability performance. Improving this understanding and communication reduces the risk of last minute design changes, product substitution or errors on site that people do not realise are significant.
Getting site teams to take responsibility for sustainability	Creating appropriate and effective measures, and management behaviours that lead to actions, and enabling communication of these and individual responsibilities. These can also help to enable sustainability criteria to sit equally alongside traditional site measures such as programme and quality. This can also help to get teams thinking about all aspects of waste, not just physical waste.

1.3.3 How can Lean help better integration of sustainability?

Figure 3 shows the value stream for a project. Below each of the steps, are listed some key activities and actions where taking a Lean approach will make a difference to the overall value delivered, including sustainability performance. It is worth noting that the opportunity for creating a positive impact on any project decreases significantly as you move through time to the right. Major changes delivering high value benefits in terms of cost, time, sustainability etc are normally made at the concept or design stages, although opportunities remain after work starts on site.

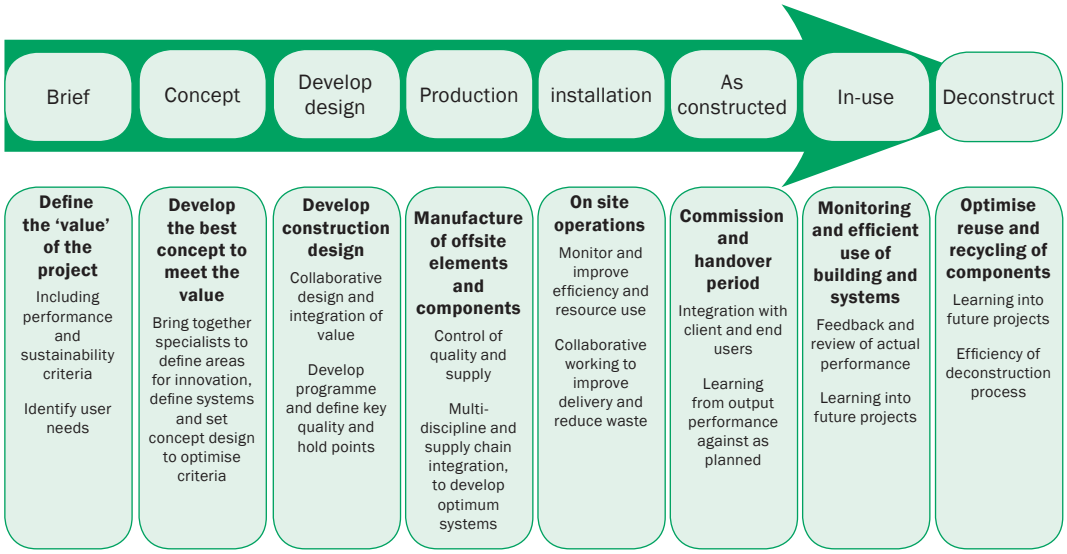


Figure 1.3 ***Built environment value stream***

Lean uses simple mechanisms and tools to allow a common understanding of the overall 'value' of a project or process from the start, so that achieving value and continuously improving performance becomes something that everyone sees as being important and an intrinsic part of their role. In a similar way, health and safety was in this position some years ago, where it was the H&S manager's job to check risk assessments and sort out accident reporting. Now, through behavioural safety initiatives and a greater focus on understanding the root causes of accidents, H&S has become much more of an integral part of everyone's job.

Communication

A useful example here is the increasing importance of a building's airtightness strategy. In some cases, the architect draws a red line on the details showing the air barrier location, but then this is not properly communicated to the site teams. As they are unaware of its importance, trades may take no responsibility for its integrity or quality, and the site manager ends up getting poor pressure test results. This causes huge problems as it is often only discovered at the point in the build when the root cause is hidden behind layers of plasterboard or fixtures and fittings.

1.3.4 Where does Lean sit with existing sustainability tools and legislation?

Currently, you most likely have to deal with a great many tools and legislation drivers and do not want to have something else added on top of all those to do. If you were worried that Lean might be another tool to add to the list, you can stop worrying. Lean should not be considered as an extra task but simply as a different approach to achieving your objectives.

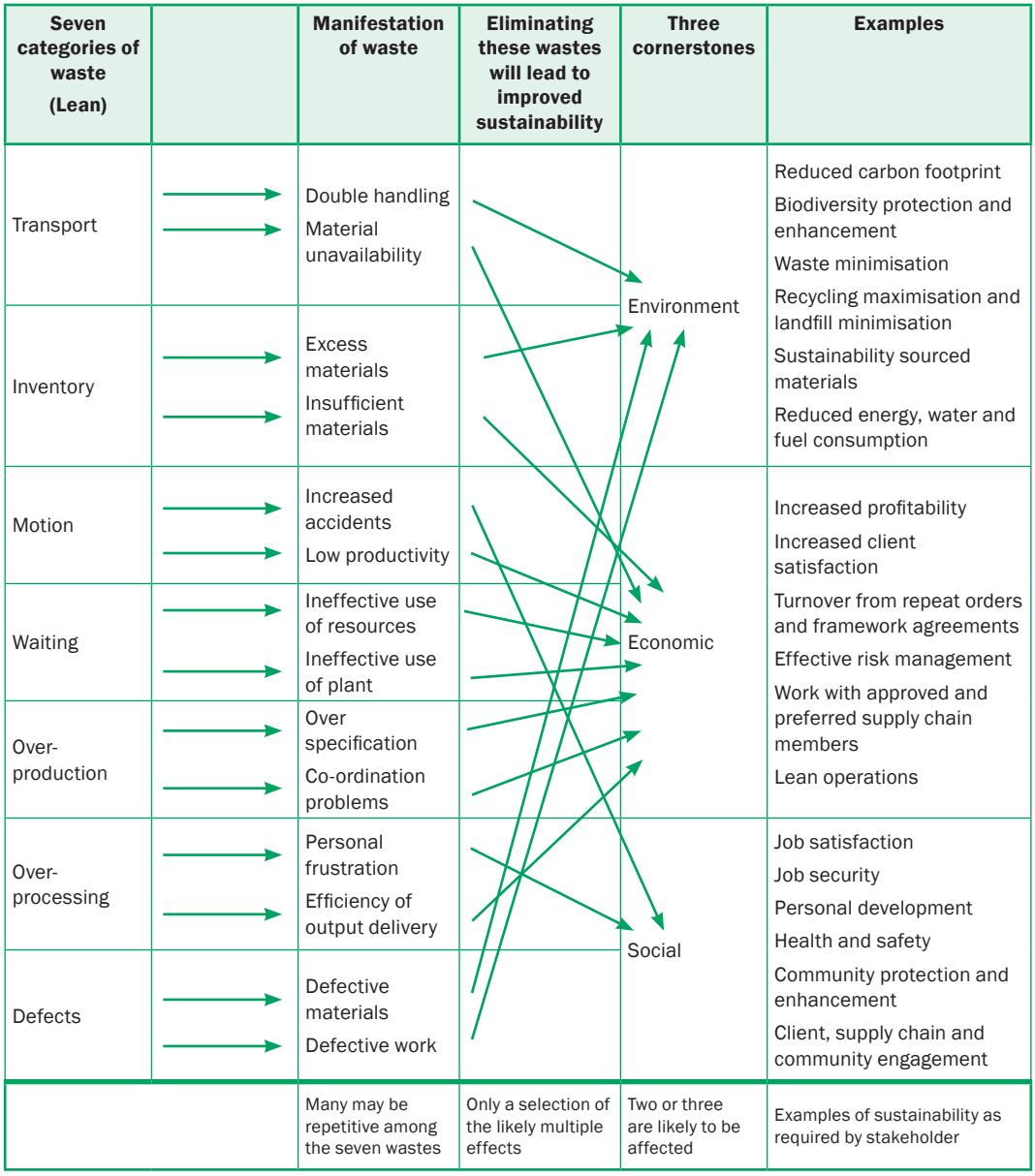
Common tools and programmes for sustainability and performance focus include BREEAM, CEEQUAL, LEED, SWMPs, Respect for People, Considerate Constructors Scheme and Building Information Modelling (BIM). They each require a process that typically includes understanding the targets or aims, feeding information in at the right time, taking appropriate actions, review outcomes and learning. A Lean approach to a process will not only improve the outputs but also buy-in through collaboration.

The message here is that Lean helps you work smarter and more effectively towards BREEAM/CEEQUAL ratings or other required legislation, or can provide the backdrop to using BIM to ensure the data going in and out of the system is of the right quality. Dave *et al* (2013) provides an explanation of how Lean and BIM overlay each other to produce effective results. Using a Lean approach should become a way of working saving effort rather than adding to it.

1.4 WASTE AND THE SUSTAINABILITY BENEFITS OF REMOVING IT

1.4.1 Eliminating the seven wastes

The case studies in Chapter 4 illustrate the benefits of adopting a Lean approach by looking at how taking a systematic approach to waste elimination could help across all aspects of project or process value. Figure 1.4 shows the wastes and how the removal of each specific category of waste affects the three areas of sustainability and some examples. A list of tools available to help remove this waste can be found in Chapter 3 and in guidance by O'Connor and Swain (2013).



Note

Lean construction = waste elimination = sustainability

Figure 1.4 The links between Lean construction and sustainability (adapted from Shepherd Construction)

1.4.2 Sustainability benefits

To expand further on the sustainability benefits that can be gained through applying a Lean approach, we take a look below at three key areas of benefit. It is also worth noting that benefits achieved through a Lean approach are maximised only when the right behaviours and culture exist and when a supply chain is fully engaged using the most appropriate contractual form and commercial model. Both Chick (2013) and Smith (2013) offer further insights into this area.

Cost reductions

Improving sustainability and reducing whole-life cost are often very closely aligned, and Lean is highly effective in helping to deliver both objectives. For example in infrastructure work, the hierarchy is often something like:

- do nothing
- do minimum
- refurbish
- replace and recycle
- replace and landfill.

The most expensive and least sustainable options are at the bottom, while the cheapest and most sustainable options tend to be near the top. To make the maximum effect on sustainability and cost, it is important to apply Lean principles as early as possible in the value stream as the ability to affect outturn cost and environmental falls away rapidly as design is progressed. All of the major decisions are made at concept and early design stage and it is vital to get the right people (from further down the value chain) involved at the start to achieve the biggest impact.

It should also be considered that the cost reductions may come at the capital cost stage and/or through whole-life costings. Where capital costs can be reduced through Lean, this may help to balance the economic case for incorporation of elements to achieve a better sustainability performance. A saving on installation costs may outweigh the higher cost of improved performance materials.

If companies can be more profitable through working efficiently rather than cutting overhead, there are potential economic and social benefits to the businesses who supply them and the morale and satisfaction of the workforce. These effects ideally are reflected all the way through the supply chain, from the client to suppliers. This fosters a sustainable supply chain and maintains the ability of organisations to invest in their staff and their resources.

Collaborative working

The eighth waste of skills misuse (Section 1.3.1) is one of the real keys for social benefits. Lean encourages us to communicate with and engage the 'experts' and other stakeholders to deliver value. These may be people within different departments, organisations or members of the community that a development will sit in. Lean does this as collaborative working is a fundamental element of Lean techniques, aiming to involve all sections of the supply chain and end users.

Collaborative working also decreases the pressure felt by individuals through inefficient or over-complex processes. If you have ever been in the situation where everybody on a project seems to be pulling in different directions (programme, cost, design, sustainability), you can see that not having a co-ordinated approach to delivering the project (this being an over-complex process), can cause significant stress for all involved as they fight to get their goals incorporated.

Other benefits include H&S performance greatly improved with accident and incident rates significantly decreased for contractors who work in this way, better alignment to agreed project objectives and programme, improved quality and reduced waste, bottlenecks and inefficiencies.

Resource efficiency and physical waste reduction

Environmental benefits have often been counted as a by-product of traditional Lean activities, such as:

- reduction of defects and damage to materials, leading to lower wastage rates and less vehicle movements to and from site for replacement materials and disposal
- reduced energy use through more efficient processes
- reduction in water use through welfare facility reviews
- preassembly of components leading to reduced waste and more efficient resource use
- buildability considerations at design stage leading to more efficient material use and less transportation requirements.

By bringing resource efficiency and waste reduction into the 'waste' definitions, more could be done to focus improvement in these areas. The Lean approach of understanding the current situation and root causes of issues can be applied here with great effect. Many organisations are busily collecting such data to meet SWMP or internal targets, but how many are doing something meaningful with that data to drive systematic reduction while improving their processes? This could be an obvious starting point for someone wanting to trial a Lean approach in a small way to start proving the benefits before taking it further.

2

Building the whole view

2.1 CUSTOMER VALUE

2.1.1 Who is the customer? Setting the sustainability vision

In a traditional vision of Lean, the 'customer' is many different people. To define value, we firstly consider the end user, ie the person or people that will use, maintain and be affected by the project, structure or service. After the value vision is set, we then start to consider the other customers in our value stream, namely every other person we deal with in the process. Figure 2.1 shows this concept looking at the value stream – everyone we deal with is a customer and their needs to fulfil their role in value delivery should be considered. When we move Lean into a sustainability context, does the definition of the end user need to be expanded?

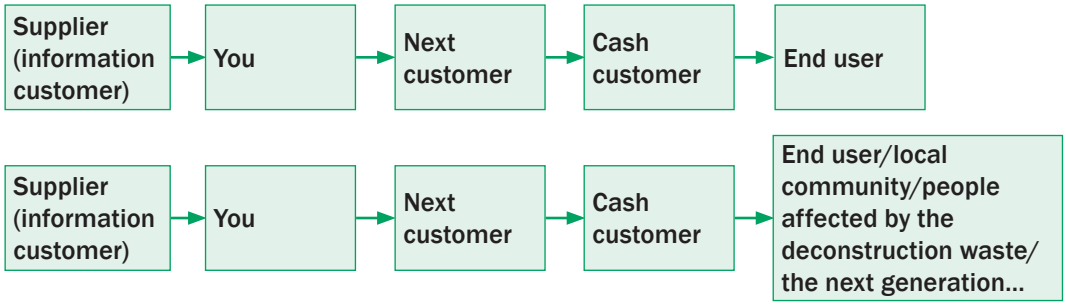


Figure 2.1 *Diagram showing the concept of customers in the traditionally Lean value stream and with a sustainability focus*

To build sustainability into the value definition, perhaps this is where we also need to consider those affected by the actions or decisions made around the building or process both now and in the future.

2.1.2 Using value to drive decisions and priorities in a Lean approach

To define the value of the project or process, involve each party, and jointly define who your end users are. Make this list of customers and the value you define visible to everyone, so it can be referred to as you go through the process. Make it part of a customer charter or the basis for some local project measures. It becomes the overall vision and guide for all decisions and actions taken. For example, you may be involved with a design process when the value engineering is being carried out and decisions are being made purely on a capital cost basis. Having an agreed definition of value allows you to bring in whole-life costs, quality or safety criteria that may take the decision in another direction.

2.1.3 Potential conflicts and silo behaviour – building links for better project performance overall

To achieve most of what we have discussed in the previous sections, it is important that project or process teams are able to work collaboratively. This means moving from what we are often used to in built environment organisations – a silo approach, to a value driven approach. A silo approach is where we find people from each department or organisation physically separated and acting independently. An example of this is walking into a site set up where the main contractor's surveyors sit together in one area, all the site managers in another and the subcontractors have a cabin on site elsewhere.

Poor planning

An example of this is a project where the curtain walling team had looked at their work and seen an opportunity to improve their programme by using both cranes on the site. This enabled them to push ahead with the intention of saving both time and money. What they had not realised was that the original programme had allowed for the fire doors to be craned onto the floors as the works were progressing, enabling simpler and quicker access for the carpenter to start work. The push on the curtain walling prevented that from happening, which added extra costs that more than outweighed the savings made by the initial decision.

Terry and Smith (2011)

The key driver for this is to foster effective communication and to ensure that project activities are not only aligned to end user requirements, but also optimised from a process perspective. Construction projects involve many stages, handovers and different suppliers who, as defined in Figure 1.4, are also customers. Inefficiencies often occur at the point of handover between processes or customers. When focusing on silo behaviour, teams may look to optimise or accelerate specific processes, with the end effect of introducing 'waste' elsewhere in the process. Keeping a wider process view can help avoid that.

Management need to take a greater role in building collaborative team working at all levels, leading through example and behaviour to foster good communication and alignment to common team goals. If you are a manager, when speaking to the team, do you ask about the area that you are specifically responsible for, or do you ask the Lean questions of:

1 What problems have you found today?
2 What actions are you taking from those?
3 Who have you involved?
4 Who have you helped to improve today?

These questions are designed to be wide enough to cover all aspects of value, but can also be tailored to one area if you need to raise awareness, but all managers need to ask the same questions to be effective.

2.2 BUSINESS TARGETS AND PROCESSES

2.2.1 Review of existing targets and measures

Everybody has targets to meet, but we should ask the question what do these targets actually achieve? From a Lean perspective, targets should help us aim for 'perfection', and so should encourage the right actions and behaviours to get us closer to the whole vision of value. Targets and measures must be shared and not the responsibility of one department or person.

Are the targets and measures that you have in your organisation set in this way or do they encourage people to look at the delivery of overall value? And are your measures and targets leading or lagging? Do they give the team something to aim for or just tell them when they have already failed? You may have the ability to influence these targets and measures and, if so, this would be the next step for you after understanding and defining the value you are delivering to

your customers. Guidance by Smith (2013) may help you with this review and give you some ideas for measures.

2.2.2 Consideration of Lean thinking in an overall project management system

The systems and standards in place for quality, environmental and safety management such as ISO 9001:2008, ISO 14001:2004 or BS OHSAS 18001 are all based on similar Lean thinking although they do not refer to it as such. By this, we mean they are there to firstly put in place a standardised way of working that increases consistency and reduces the risk, then to monitor the performance of the processes and review them for continuous improvement, which is essentially removing waste. What this means is that having a Lean approach in mind will help you to embed the standards and provide mechanisms for improving performance and compliance.

Behaviours and synergies

Consider the situation where there are departmental measures for procurement to reduce their buying costs, for operations to handover early, for health, safety and environment (HS&E) to reduce waste volumes and incidents, and for commercial to reduce the final cost. Each one of those has the ability to adversely affect the others targets and cause friction among the team if not managed carefully.

One outcome could be that procurement employ a subcontractor who, through the negotiation period has been pressed hard on cost, so arrives with reduced site management and as labour only. They need extra management time from the site team and are not as focused on quality or careful with materials as if they were supplying them. As a consequence, the site managers are distracted from their overall role and the programme starts to slip, the waste volume increases as mistakes are made and defects occur, and more labour is required on site to catch up the programme. The HS&E manager needs to spend more time on that site understanding and attempting to remedy the waste issues, taking time that needs to be shared among many more sites. The commercial manager realises the potential cost implications and starts to build claims against the subcontractors and negotiates very hard at final account. The customer ends up with a project that is a little late, over budget and with quality defects. Has this delivered value for them, or anyone?

If you do not have one or any of these systems in place, using Lean can help you work towards achieving them through understanding what processes you need to manage and improve.

One overproduction of waste that we often see around the area of sustainability and measures is the fact that many companies still have separate procedures and systems for project management, safety management and environmental management. This practice encourages a lack of collaboration and a narrow view of responsibilities. So if your role does not include 'environmental' or 'sustainability' in the title, why do you need to look at those systems? A suggestion may be to integrate these systems together to create one, which could be a challenge, but could also encourage collaboration and a culture of value focused delivery. As a minimum, developing a mechanism for joint measures and targets, and for each person to understand their role in their achievement would be a good first step.

2.2.3 Using Lean as a mechanism for a balanced approach to meeting sustainability targets

If you are not in a position to influence the measures (or if you are already on that path), the next logical step is to actually start using the measures that are most useful to you. These measures may not always be the strict sustainability measures, but could be ones that are indicators of some of the issues. When looking to create a balance and better performance in all areas, consider how your actions influence someone else's target, and how they influence yours.

Lean does not have any particular measures – it is about understanding the value that you are aiming to deliver. In most cases, measures around quality, cost, time and HS&E are there in some form, as these are the most likely elements of value. We aim to strike a balance with these measures because they are indicators that whatever Lean improvement activities are being carried out, they are having the desired effect and not damaging another part of the delivery

Understanding the overall purpose

To help you to understand this better consider the story you may have heard in this or another scenario, of an unannounced visit by John F. Kennedy to the space centre at Cape Canaveral in the mid-1960s. Kennedy toured the complex and met a man in overalls.

"What do you do here?" he asked. The man replied, "I'm earning a living." Kennedy nodded and moved on. He met another man in overalls and asked him the same question. "I clean away all the rubbish" the man said. Kennedy smiled and strode on until he met another man in overalls and put the same question again. This time a big smile came across the face of the man who replied, "Mr President, I'm helping to put a man on the moon."

Recognising that whatever part you play in an organisation, you are part of the delivery of the whole value, rather than just the delivery of your task is important.

(for example, an activity to reduce time delays should not be allowed to negatively affect safety). Think about the key measures you have for your projects or process, and consider the influence of sustainability on or by those (Workbook 4).

One large utility provider makes use of the detailed knowledge of defects and quality issues that come up on their sites on a weekly basis. This is to help everyone see all the effects of these, and to show how focused improvement in recurring areas can improve their performance in not only quality, but cost, time, and HS&E (for more information see Section 4.5).

2.2.4 How to start using your measures and processes

If you can use the measures that are gathered on site or in your process every day or week, treat those as a valuable source of information to improve your sustainability and value delivery performance. For example, snagging lists/quality issues, considerate constructors audits, programme delay or disruption information.

If you find that there are few or no measures that are potential sources of help, some of the tools listed in Chapter 3 or in guidance by O'Connor and Swain (2013) can help produce data that is vital for all. In a project situation, collaborative planning can provide real time quality and delivery information that can be analysed and used to drive improvement.

Wherever you can start, use what you have available as a first step to understanding what the key issues are and defining your next step. Use the Lean methodical approach to help meet your targets and smooth your existing processes.

3

Practical application

3.1 TOOLS AND TECHNIQUES

3.1.1 An overview of current Lean tools and techniques applicable to sustainability issues

A fuller review of tools and techniques is provided in by O'Connor and Swain (2013). Chapter 4 of this guide provides five case studies illustrating the use of several Lean tools and approaches. The five case studies are:

1 AIMC4 case study on the development of low carbon buildings for volume production.

2 Whitecross School Case study.

3 Vinci Technology Centre.

4 BAM Beyond Zero.

5 Anglian Water – @One Alliance.

There are many Lean tools and techniques that are freely available for you to use and we have mentioned some in these case studies. The main question is which are the ones that are most useful in a sustainability context?

Table 2.1 lists the most relevant Lean tools and the areas of the sustainability agenda that they have most impact upon. The list is not exhaustive or definitive in terms of the effects on the sustainability areas, as there may well be others not shown, depending on the process under consideration and the value defined. The table also shows the main tools that have impacts on a project or process level.

There is also a reference in the table to the tools that are mentioned in a case study in this guide.

Table 3.1 Table of Lean tools and their relevancy to sustainability areas

Tool type	Tool	Sustainability area of impact					Business area	
		Resources	*Ecology and biodiversity*	*Economics*	*Community*	*Well-being*	*Process*	*Project*
Problem definition and solving	Workplace observation	1		1, 2				1, 2
	Root cause analysis – five whys/ Fishbone diagrams	4, 5		5			3, 4	5
Planning and risk management	Collaborative planning	1, 2, 4	4	1, 2	2, 4	4, 5	3, 5	1, 2, 4
	Plan to protect/FMEA	4	4	2	4	4		2, 4
Workplace and process efficiency	5S							
	Standardised work	2		2			3	2
	Visual management	5		5			5	
Value stream efficiency	Process mapping	2, 5		5			3	2, 5
	Lean design/Design for Manufacture and Assembly (DfMA)	1, 5		1, 5	5			1, 5

Key

	Major impact
1	Illustrated in case studies

The tools have been simply categorised around the approaches laid out earlier in this guide to help you see the overview situations where they might be used.

3.1.2 The situations where tools may be used and their expected benefits

As you have seen, there are many tools that can be used to affect sustainability performance. In this section we will concentrate on the five most useful tools that you could use in your own work to create benefits.

Collaborative planning

Collaborative planning is usually used in a project situation and is typically used at any point from the start of design. It simply gets the people that will be doing the work to plan the work as they will best understand the opportunities and issues they will encounter. The technique brings benefits to integrated project success through team working and improved communication. Use collaborative planning to:

- bring together the whole project team at the earliest point to align around the project value, and to understand each other's needs and requirements – this may be the first point at which some people will be introduced to the defined value
- plan out the overall sequence of the design, procurement and construction phases – working to eliminate the seven wastes (including sustainability wastes)
- remove environmental, cost, quality and time risk and uncertainty

- build in efficiency to the processes, logistics and use of resources
- measure quality issues and use the data to drive out excessive resource use and waste volumes from site. This is done at the weekly planning stage where each party reports back on time and quality issues, in anticipation of removing the main issues.

Collaborative planning is a technique that can be used at any time and in any situation where some planning is involved, whether that be a complex on site civils project where you are looking at co-ordinating ecology surveys with land owner permissions and site clearance, or your own in-house sustainability team in their work across several initiatives and projects. As a starting point, you may choose to use the different aspects of collaborative planning for different areas. Some examples of how you might use the collaborative planning stages include:

- use the programme or master planning stage for the large project where you want to build awareness and highlight the risks
- use forward or constraints planning where you need to ensure that adequate notice is given to external consultants for a piece of work or the local community for potential disruption
- use weekly planning with your team to create detailed plans for daily activities and monitor progress and issues that arise
- use daily planning for high risk or critical tasks, where you need to keep very close control on the activities being carried out and any deviation from the plan.

Process mapping

This tool has similar aspects to collaborative planning, but is often used for back office processes such as design co-ordination and sign off, tender writing, procurement or customer feedback. It has the benefit of bringing together all people who are involved with a process, or affected by it, and using their skills and knowledge to improve it. Use process mapping to:

- create a true reflection of what happens now, so that everyone can see the value adding steps, ENVA and waste, and work to remove it
- collate data around all aspects of delivery in one place to focus the effort, and to show a balanced view of the performance, whether as time, quality, environmental or people
- develop collaborative processes that contain appropriate hold points, control and the right steps to deliver the end value. For example to map out the design process for a project ensuring that the sustainability team are informed and involved, the required information and inputs for CEEQUAL or BREEAM are built in and understood so that submissions and final assessments are complete and simpler, and all aspects of materials choice, build process and whole-life issues have been considered.

Process mapping can be used where you have recognised there is key process with room for improvement, or for when you are designing a new process. Some examples of use are:

- improve the stakeholder communication and information flow for report writing
- developing a process for integrating a sustainable sourcing policy
- defining processes that sit behind your business sustainability strategy
- improving the outcomes from environmental assessments.

Plan to protect

We are all used to carrying out risk assessments, but how often to you consider the commercial, delivery, environmental, and H&S risks altogether? Plan to protect (also referred to as Failure Mode Effect Analysis, FMEA) brings together key people from across all parts of the project or process and develops an integrated risk management process. Use plan to protect to:

- define all the risks that could slow or prevent the delivery of value to the end customer
- agree a prioritised risk schedule with actions to manage the highest risks
- develop measures and actions for the highest risks to monitor if they start to happen, and lessen their impact immediately
- create a team owned risk schedule that is reviewed and actioned regularly, and that maintains sustainability risks at an equal level with cost and delivery risks.

Ideally, plan to protect is used alongside your project or process plan so that you have a full understanding of the critical areas before you start. You may then choose to do this exercise for environmentally critical parts of a project or for a whole project you are managing. Some examples of where you may use plan to protect are:

- for a period of a project where there is a high risk of ecological impact through the type of operation being carried out or due to the timing of the project (eg in nesting periods)
- for the design period of a project where you must achieve a BREEAM Outstanding rating to gain planning
- where you are going through a period of cultural change and need to manage the risks associated with this.

Workplace observation

One of the key elements of Lean practice is to go and look at what is actually happening. It is easy to assume we know what is happening and to blindly plan and take actions around issues, without real visibility or evidence of the way something is happening in reality. In its simplest form, workplace observation is about the people involved in the activity observing the activity as it happens and looking for the wastes, so they can be understood better and eliminated more effectively. Use workplace observation to:

- understand why your actual data does not match the planned result
- build awareness into everyone's role so they are more mindful of how they carry out any task and the effect that has on resource use, the environment, their colleagues or the surrounding community, as well as on themselves, cost, quality and timescales
- collect data to create a focus for improvement or to show the effect of changes or improvements on a process.

Workplace observation is a simple and effective tool that can be used both on a project and within a process, some examples of its use are:

- where the volume of a particular type of waste being removed from site is significantly higher than expected, you could do some observation on the operation to see why this was happening
- in a process where it has been identified that gaining a sign off or approval takes longer than desired, use observation techniques to track the document from person to person.

Root cause analysis (RCA)

From all of the tools described here, or from your measures, you will have some form of data or a list of issues, and now you have to take some action from those. RCA is a technique that helps you to understand the real cause and find solutions that benefit the whole activity. Without RCA, we are in danger of treating the symptom and allowing the real issue to get worse, or adding layers of complexity and extra processes just to get around it. There are many tools that sit within RCA, most commonly the "five whys" and "Fishbone diagrams" (O'Connor and Swain, 2013). Use RCA tools in any situation to:

- cut through the noise around the symptoms of a problem to get to the real root cause, and allowing you to eliminate the issue and prevent it reoccurring
- bring a team together to analyse an issue, brainstorm the root cause using a Fishbone diagram and test the likely solutions using the five whys.

Which of the tools do you think could be a good one for you to start with in your situation? Take a few moments to think about it (see Appendix A1 Workbook 5).

3.1.3 Adaptability of the tools to further sustainability issues by using Lean first principles

You may have looked through the tools described in Section 3.1.2 and thought 'they are not quite what I am looking for', or 'how do they apply to what I am doing?' The good news for you is that the tools are not the aim of Lean thinking, they are simply a mechanism for helping get the philosophy of Lean embedded into a team and wider into organisations and supply chains.

If you refer to Figure 1.1 in Section 1.2 for an overview of Lean principles, you will see that all of the tools are working in the value stream to pull areas, so they are about understanding where you are, looking to remove the waste and smoothing the process. This means is that you are aiming to work collaboratively with the right people to achieve these things and the tools are there to help. If the tool as it stands is not quite what you need, adapt it or use the elements that are helpful, keeping in mind these aims.

The main things to remember if you are adapting or using elements of each tool:

- communication and collaboration – this is an essential for any Lean activity
- keep a focus on the value – do not lose sight of the overall outcome/output
- follow the whole PDCA (plan-do-check-act) cycle, take time to understand and plan what you will do, do it, check how it is going against your plan, and take action to carry out improvements and capture learning, before moving into the next cycle.

As long as you are focused on the defined value and are working collaboratively towards 'perfection', and are able to show the progress, start with what you need to take the first steps. The worst thing you can do is try to take on everything and collapse under the weight of it all. Start small and build, or get some help to take bigger strides.

4

Case studies

The following case studies aim to show how taking a Lean approach can bring benefits in many different areas. In each case, the tools used to embed Lean practice are highlighted, for example collaborative planning.

4.1 CASE STUDY 1: AIMC4

Tools and approaches used	◆ workplace observation ◆ collaborative planning ◆ Lean design/design for manufacture.
Sustainability benefits achieved	◆ working with groups of innovative producers to develop new ideas for volume manufacture ◆ reduced the build cost of more efficient housing so that both purchase price and running costs are lower ◆ creating framework for mass build energy efficient homes.

AIMC4 is a consortium that is researching, developing and building low carbon homes for the future. Its members consist of housebuilders Stewart Milne Group, Crest Nicholson Ltd, and Barratt Developments, building material manufacturer H+H UK Ltd, and BRE.

The project remit is to research, design and deliver exemplar homes, to meet the energy requirements of the Code for Sustainable Homes Level 4 (Building Regulations, Part L, in press) (CLG, 2006). Core to the project is this adoption of innovative fabric solutions that incorporate reduced carbon emissions into the building, eliminating the need for additional low and zero carbon technologies with application to volume delivery.

The AIMC4 project has used a Lean design approach to initially develop new design processes that have driven innovation in the supply chain. This has also focused on ensuring buildability, efficiency and driving out costs and waste. Lean approaches to meet the sustainable efficiency aims have included:

- a greater use of elements produced off site, to allow benefits in cost savings from a more efficient build process, reduced development and finance costs through a faster product turnaround on site and building in quality and safety, through factory produced elements and improved on site assembly
- employing Lean tools such as collaborative planning and work observation to ensure efficient design and construction processes. This is critical to AIMC4, which is integrating innovative solutions for the first time, and these have been carried out both in the factories and on site.

Aside from the obvious environmental benefits, the Lean approach has also brought benefits in economic and social aspects of sustainability, for example:

- the supply chain has been encouraged to work together to develop products to meet the needs of AIMC4 to form a part of the volume building programme. This has the potential to develop and support smaller businesses

- detailed work observation has enabled a focus on reducing physical and time waste
- collaborative planning has created links between the designers, manufacturers and installers of the building products that have reduced issues encountered on site and improved quality
- on one project site, gathering the contractor, subcontractor and design teams together and creating a detailed plan through using collaborative planning has achieved almost halving the build programme for the innovative new house design over the standard house type. This created savings that help to offset the extra cost of meeting the higher standards.

4.2 CASE STUDY 2: WHITECROSS SCHOOL

Tools and approaches used	◆ workplace observation ◆ collaborative planning ◆ plan to protect/FMEA ◆ standardised work ◆ process mapping.
Sustainability benefits achieved	25 per cent forecast energy saving

Construction contractor Stepnell Ltd found themselves in a situation where they had to meet a demanding brief to develop a school that would combine a very low energy demand with a high quality teaching environment, in a tight timescale. They wanted to focus on improving the durability and energy consumption of the Whitecross School project by encouraging excellent communications and partnership working between designers and constructors on the build.

Their initial ideas for focus were to:

- develop a new set of room data sheets (RDS)
- assist in the formation of an effective external envelope
- co-ordinate the M&E fit out phase.

The drivers for these were to ensure that the RDS were easy to use, that they achieved a competent external wall construction and that there were zero defects in the fittings.

Their first Lean step was to bring the whole team together to discuss and understand the aims and value of the project in a workshop environment. The next workshop used process mapping as a diagnostic tool to map the build process from start to end, determining where the value and waste was. They populated the map with their thoughts around risks, issues and opportunities (see Figure 4.1). Areas that were found to be of specific concern during the diagnostic stage were the roof and wall construction where thermal performance and airtightness were key issues.

To ensure that these areas were addressed, they undertook a series of workshop days. During these they used the collaborative planning tool with their designers, consultants and subcontractors, to define the right sequence for all the robust details. On a weekly basis they held meetings with their subcontractor teams to develop a detailed plan of the following weeks work, defining the 'what', 'when' and 'where' for the works they would be doing. The tool highlighted issues that otherwise would only have come to light once the team were on site and as a result, they were addressed beforehand reducing site problems and the need for re-working.

They also developed standardised worksheets to define the step-by-step best practice for each of the key elements of the airtightness barrier and internal spaces. These sheets enabled them to monitor the quality of the work and also to ensure consistency across the project.

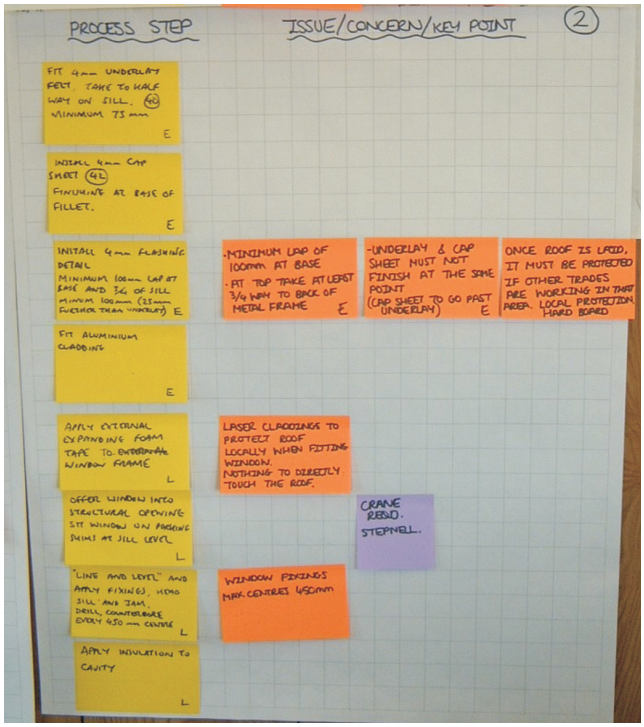


Figure 4.1

Showing part of the process map and the team's issues and concerns

Plan to protect and work observation tools were used to help ensure that they were managing the risks associated with the plan and that what was planned was able to happen on site. They also used these tools to pick up issues with quality as they progressed.

Because they used a Lean approach on the Whitecross School project, Stepnell managed to achieve air integrity test results of between 3.5 and 4.0 $m^3/m^2/hr$ on a complex building envelope, which gave a design saving of 25 per cent of the forecast energy consumption. This was achieved alongside several other benefits:

- reduced defects significantly
- delivering a very tight programme within the cost parameters that were initially set
- agreed and paid all final accounts with subcontractors within six months of practical completion because of excellent partnership working.

Their learning from the project was to:

- include all involved parties when dealing with problems – this helps them to manage their risk and deliver exceptional results
- bring the subcontractors and designers together at an early stage to highlight the issues and define working sequences at the start of every project/project phase
- make sure everyone on the site knows and understands the agreed working sequence. For example, get each subcontractor to properly brief their workforce, and use visual management boards/display of the documented sequences and weekly meetings to review progress.

4.3 CASE STUDY 3: VINCI TECHNOLOGY CENTRE

Tools and approaches used	◆ root cause analysis ◆ collaborative planning ◆ standardised work ◆ process mapping.
Sustainability benefits achieved	◆ better quality BREEAM/Code for Sustainable Homes assessments ◆ greater assessment capacity.

The Vinci team were a group of consultants who worked both internally and externally on several environmental assessment projects. Their own measures were indicating that they needed help in identifying, developing and implementing improvements to their work stream, and with the BREEAM process in particular.

As a starting point for their Lean improvement project, they held a cross-disciplinary team workshop where they identified their areas of concern. These areas included report production, project administration, control of variations, winning work and the environmental assessment work stream, with the latter being chosen as the starting point. During the diagnostic stage, the team used process mapping to assess their position with respect to BREEAM and the Code for Sustainable Homes (CLG, 2006) and identified both their internal and external customers. Together, they fully mapped their current state process as it was – not how they thought they should be working (see Figure 4.2).

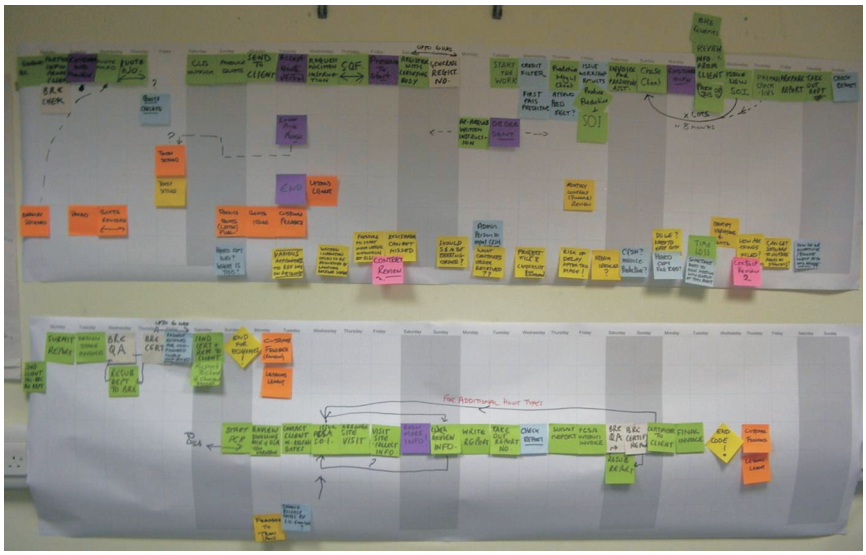


Figure 4.2
Showing the current state process map

They progressed to identifying the waste, value and non-value adding activities within that process, which allowed them to get a better understanding of the areas for focus that would give them the biggest benefits. Actions were agreed and these included data collection and a review of alternative processes.

At the next workshop, the team used the 'five whys' technique to carry out root cause analysis of the issues identified through the mapping and data collection. They also spent some time on defining customer value so that the solutions they developed would meet that value. They detailed the issues at the top of a flipchart, being specific about the problem, then divided the page into five rows of 'whys', then worked down the page completing their answer to each 'why' as they went. At the end of the exercise, they were left with the root cause of the issue and created some options for how to remove the root cause from their process.

The team reviewed their suggested improvements and used a simplified form of collaborative planning to assist them in deciding the importance of requests from the client and to plan how and when to take the appropriate response action. They mapped their future state process, including all the improvements they wanted to make together with the expected benefits. From this a clear and concise action plan was developed and included using standardised work to develop:

- an agenda and predictive reporting for Code for Sustainable Homes (CLG, 2006)
- standard templates to facilitate obtaining the right quality of BREEAM evidence from the client
- a finalised checklist for Code for Sustainable Homes (CLG, 2006).

Going through this process, the team identified the following benefits:

- less iteration in the process, meaning the team had more free time to take on more projects
- decreased their financial risk
- better client understanding of the requirements and timescales for achieving their assessments.

4.4 CASE STUDY 4: BAM NUTTALL 'BEYOND ZERO'

Tools and approaches used	◆ root cause analysis ◆ collaborative planning ◆ plan to protect/FMEA.
Sustainability benefits achieved	◆ saved over 7500 return vehicle trips ◆ waste cooking oil is turned into bio-diesel ◆ 30 per cent reduction in the total quantity of waste ◆ 75 per cent reduction of total waste sent to landfill ◆ 10 per cent increase in construction waste recycled.

'Beyond Zero' is BAM Nuttall's holistic vision for a sustainable future, incorporating H&S, quality and environmental aspects. It uses Lean principles of collaboration and continuous improvement to drive exceptional standards that go beyond compliance. It is an approach that aims to be driven from senior management to those on-site.

BAM Nuttall Beyond Zero:
www.bamnuttall.co.uk/Beyond_Zero.html

The initiative started with a safety approach, but they realised that they were missing opportunities by not covering a broader spectrum. 'Beyond Zero' relies on a culture where everyone takes responsibility for their part in delivering value and is proactive in improvement. It encourages everyone to challenge current situations or assumptions and work with the right people to have a positive effect in Lean terms, removing waste and increasing value to the end user.

Engaging every employee and the supply chain

The heart of 'beyond zero' is engagement and collaboration of their employees, supply chain and customers. They ensure that everyone is aware of the shared goals and how they can have an effect on them. In the sustainability area, a key part of their strategy is to ensure all employees attend a training course to be aware of the links between commercial and environmental benefits. They use exercises in the training to highlight the value through the eyes of end users and customers, so that everyone understands it.

This approach also extends to their supply chain where over a four year period they have reduced suppliers from 8000 to 5000 to form a core group of like-minded partnerships. A large part of the supplier selection process was based on sustainability and a commitment to reduction targets relating to landfill and removal from site.

Monitoring and reporting

Monitoring performance against targets is a key element for BAM Nuttall, as this helps them to strive for their defined 'perfection' and highlight areas for improvement. In 2002 a SWMP was developed in-house, six years in advance of legislation in England and Wales. In 2009 it was developed to further improve waste reporting at site and corporate level. All operating depots, sites and offices were required to use the SWMP and report waste figures on a quarterly basis. As a result waste reporting improved, they were able to understand the areas of significant issue and use root cause analysis techniques to create a significant reduction.

Project example: Glendoe Hydro Scheme

This example illustrates how the strategy works at a project level. Each solution outlined was achieved by staff and suppliers thinking creatively to find site-specific solutions.

The Glendoe Hydro Scheme is in a remote part of the Scottish Highlands, between Fort William and Fort Augustus – at the top of a mountain. It was a challenging project, not only in terms of location but also technically and safety wise, so main aims for the project were to minimise the effects they would have on the surrounding communities, environment, flora and fauna. The vision of perfection defined for the project was that of 'zero waste' and this drove the decision at the outset of the project to make it as self-sufficient as possible. Communication of this vision to everyone involved in the project was a key element of its success. This vision became the mind-set for the project and influenced all decisions made on the way it was managed.

Although the project team did not specifically refer to the use of Lean tools, their approach was inherently Lean in that they had a clear vision of perfection. This was used to enable everyone involved to understand the part they played in meeting that vision and they used a collaborative approach to understand the current situation and take steps to improve it. They also had a clear understanding of the need for customer satisfaction, and that their customers were not only the paying client, but also the local communities and their own project teams.

A key part of this Lean approach was the use of the principles of collaborative planning and plan to protect from the start. They considered the upfront planning stage of the project to be crucial in achieving success. The team worked together to plan the project in detail and to understand the risks and opportunities that it presented. Once they understood the areas of risk, they involved their specialist supply chain to work on the plans, working together to define the specialised plant, methods and sequencing of work for the high risk activities. As a part of the plan to protect principles, they considered not only how to remove the high risk elements but also what to do should the risk actually start to occur. The team had back-up plans identified for each activity, so that should a problem occur, they could quickly and efficiently get back on track with minimum impact on the delivery of the project and to the community and environment. An example of this was the creation of two workshops within the site that meant if any plant breakdown occurred they could repair it and return it to service within a very short window, rather than waiting for an external provider to come to site and make the repair.

They created a mini-village for the project that had its own sewage works, concrete batching plant and minibus shuttle service, designed to minimise the number of vehicle journeys to and from the site. This also meant they could foster the collaborative and team working element, and make better links with the local community, with one example being that all the health and safety posters on the site were drawn by the children at the local primary schools.

By taking this Lean approach from planning, risk management and community engagement, the project was a success in terms of delivery, and sustainability. Some examples of the maximised reuse of waste generated on site were:

- >120 000 tonnes of rock recovered saving over 7500 return vehicle trips
- all waste cooking oil is turned into bio-diesel for use in suppliers' vehicles
- safetykleen oil recycling system adopted in workshops to minimise waste oils
- aerosol degasser was used onsite to decant hazardous substances from aerosol cans reducing hazardous waste
- all waste generated onsite was segregated (plastics, timber, metal, paper and cardboard, mixed municipal) and sent for recycling/recovery. This resulted in 97 per cent of total waste generated being diverted from landfill.

Overall benefits achieved

Through a single message, consistent Lean approach to understanding the issues and working collaboratively to resolve them, BAM Nuttall have achieved very positive results in H&S, quality and sustainability terms as a whole. Sustainability highlights between 2008 and 2011 include:

- a 30 per cent reduction in the total quantity of waste produced representing 483 249 tonnes
- 15 per cent of total waste sent to landfill versus 60 per cent in 2008 and 39 per cent in 2010
- 10 per cent increase in construction waste recycled (2011 versus 2010).

4.5 CASE STUDY 5: ANGLIAN WATER – @ONE ALLIANCE

Tools and approaches used	◆ root cause analysis ◆ collaborative planning ◆ visual management ◆ process mapping ◆ Lean design/design for manufacture.
Sustainability benefits achieved	◆ 52 per cent saving on embodied carbon ◆ recycling rates increased from 38 per cent to 54 per cent ◆ waste to landfill decreased to 0.7 per cent.

The @one Alliance is a collaborative organisation, formed to deliver a large part of the Anglian Water capital investment programme. They have taken a view that a Lean approach is an integral part of how they work and have linked their sustainability targets with Lean initiatives, considering waste reduction as a key part of that.

Resource efficiency

One of their main aims has been to make waste and sustainability visible and they have used visual management techniques to communicate their strategy and drive action on projects. One example of this, linked with their sustainable design initiative to encourage designers to eliminate waste, is their sustainability hierarchy diagram, shown in Figure 4.3.

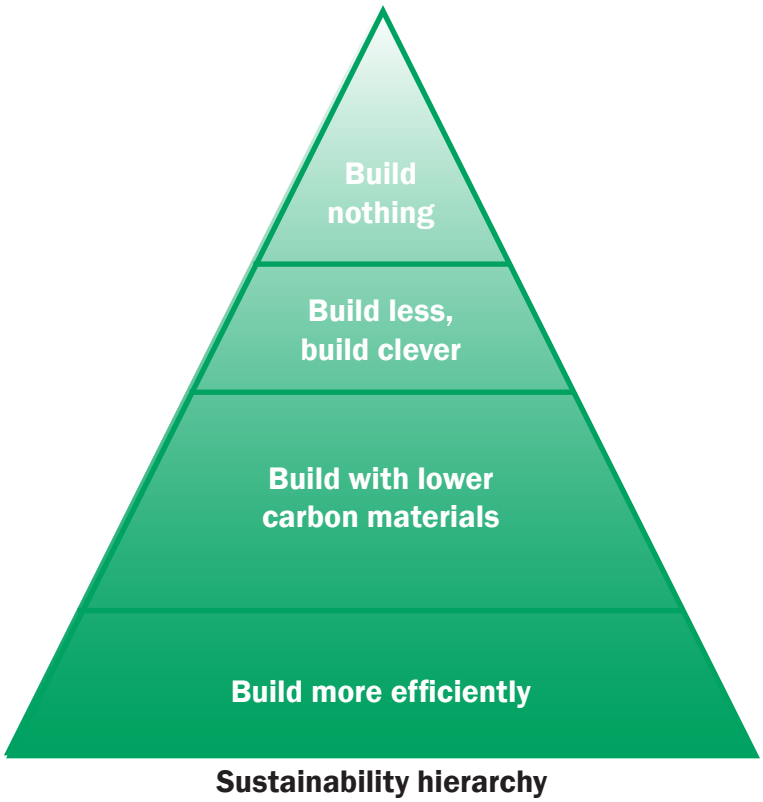


Figure 4.3
Showing the sustainability hierarchy for design

A further example is the way they capture their defects. On each project, the site manager is responsible for maintaining a 'Punchlist' from the start of the works, which records any quality issues that occur on a daily basis. Anyone who finds a quality issue, whether that is damaged materials delivered to site or a piece of defective work, adds the detail of that issue to the displayed list. The list is populated with the action that needs to be taken to remedy the issue, the person that is responsible for that action and the date when it must be completed by.

The Punchlist information is used on the project to manage and reduce the number of defects that occur, and is also collated at a central point so that any trends can be recognised and appropriate action taken.

One such trend was identified in the operation of building manholes. This led the team to hold a process mapping workshop to identify the current process to build a manhole and identify the waste and its root causes, and then to look at solutions. During the process mapping exercise, they found that the approach was for one team to dig the hole and construct the manhole using traditional concrete rings, then for the inspection team to come in. The inspection team were finding leaks in the manholes in the majority of cases, and they would then deploy a third team to come in and fix the leaks before a final inspection. This current way of working involved four separate visits to the manhole location and three teams of people, with a significant defect rate.

When they did some root cause analysis on the defects identified, they found that they were coming from issues with the quality of the concrete rings and their assembly on site. The identified solution was to change the method of construction to a composite plastic design, which eliminated the possibility of leaks and meant that their improved state consisted of one team to dig and place the manhole, and one final inspection. This improvement significantly reduced the defects associated with the operation, reducing the number of vehicle journeys and the amount of resources used.

This example shows that using a measurement for one focus of improvement (in this case defect reduction) also enables benefits to be achieved in many other areas including resource efficiency.

Building offsite to reduce waste

One of the first improvement activities that the @one Alliance undertook was considering what they could do to reduce the amount of design time spent on repetitive work packages. They started by using data to look at what elements of work were highly repetitive and had significant risks. They identified wastewater UV channels as being one of those elements, as they were often on sites with limited space, required road closures and many deliveries of components, with frequent occurrences of those being lost or stolen from site.

When they considered the wastes that came with building the channels on site, the idea of building the channels offsite was suggested to remove them. They started to collaborative work with a supplier who had experience of manufacturing offsite mechanical and electrical units to develop an approach to do things differently. They worked together on the design development to ensure that the units were still meeting the needs of the projects they were serving, while also being straightforward to manufacture, test and deliver to site. An example of the modular UV channel design is shown in Figure 4.4.

The design was trialled on one project and created such huge benefits that it began a programme of looking at all other repetitive elements to carry out a similar Lean, collaborative design exercise.

This move from traditional, onsite, concrete construction to volumetric offsite construction created many benefits for the ongoing repetitive projects, including:

- 52 per cent saving on embodied carbon
- reduced construction time from 16 to eight weeks

Figure 4.4
Modular UV channel being positioned on site

- no requirement for planning permission
- 56 per cent cost saving across five projects
- significantly reduced waste.

Improving the process

The benefits have been brought about through Lean design principles and collaboratively working with their supply chain. This has also extended into the construction phase where they use collaborative planning techniques to create efficiencies, control resource use and monitor quality issues.

Every week the project engineers review their collaborative plans and identify where the activities have been completed on time, and where they have not. With the latter, they also identify the reasons why the activities have not been completed. At any one time, the @one Alliance has around 200 projects in design and a similar number in construction, so the collation of this reliability data has enabled them to identify key areas for improvement. One of these areas was the way they were actually running their collaborative planning workshops. The data showed that there were many activities that were not completed on time because people were overestimating what could be achieved. This led them to look at how they supported the project teams with collaborative planning workshops and now they are training the relevant people in workshop facilitation and the base principles of Lean so that they are more able to run effective workshops, and improve their projects further.

Long-term benefits

There have been many benefits identified and mentioned in this case study and it is important to realise that this is not a short-term initiative. The team at @one Alliance have been working on embedding Lean principles and techniques for five years, learning and adapting their approach as they have found what techniques work for them and how best to apply them to their work. They are keen to stress they have made a long-term commitment to this way of working, and although they have successes, they also have areas where they know they can do more and are learning all the time. If you want to create successful projects and sustainable benefits, it is not a case of replicating several steps, but by learning from others and then trialling what works for the individual company or organisation.

Through this committed approach to Lean, they have seen benefits of:

- creating a better understanding of the waste reused both on and off site and increasing that from 32 per cent to 46 per cent of all waste
- increasing recycling rates from 38 per cent to 54 per cent of all waste
- reducing waste to landfill from 28 per cent to 0.7 per cent of all waste.

5

Moving forward

5.1 CHECKLIST FOR A LEAN SUSTAINABILITY APPROACH

As another way to help you on your journey into Lean sustainability, we have compiled a checklist of things you might like to consider:

- upper management support for a Lean sustainable approach – if you are not the person who can say 'this is the way we are doing this', then you need the support of that person otherwise you may face a struggle with initial buy in and decision making
- a test area where you feel safe to try out a new technique, or start to work on defining the value – this could be with your own team, or with a project team who may have done some Lean work before
- pilot project results or case studies – consider how you will get people interested and curious about what you are doing. Consider doing a pilot activity to produce some results that you can publicise or talk to others who have case studies that they would be willing to share
- honesty and openness – to truly embrace Lean you need these qualities in yourself and across the team, organisation or supply chain that you are working in. This is a long-term aim, so start with you and that will start to encourage it in others
- collaboration is vital – true collaborative relationships take work and are not just about keeping each party happy. They are about being honest and saying 'no' or 'that is not acceptable' when needed, and then offering help to bring things back on track
- start to build and maintain trust – to get the best from your Lean collaborations, you need to build trust with those people, do what you say you will do, offer them help achieve what they need to do to deliver the value and work as a team to remove joint issues
- do not be afraid to ask for help – if you find you need some assistance with what you are doing, find someone in your organisation that can help, or look at one of the many social networking groups (for example via LinkedIn if you search for Lean), or find a consultant that may be able to help
- use measures and data – use what you already have to focus and build the case for improvement, and to show the results the changes you make have to build momentum
- do not stop – if you start to bring Lean alongside sustainability to help you in your role and to help your organisation, keep the search and elimination of waste going, even if each step is only small. When you stop and say 'great, we've done Lean now' that is when you stop doing Lean and go back to 'business as usual' and benefits can start to fade
- make Lean just part of what you do – you do not need to badge things with 'Lean' if you think that might be a blocker in your organisation, just make the approach and tools part of your sustainability system or your project management system, so that it becomes a more sustainable way of working rather than an initiative
- understand some of the frequently asked questions about Lean (see Box 5.1).

Box 5.1 Lean – frequently asked questions

Is Lean just for big projects?

No – Lean principles can be applied to everything you do, from a simple process like recording actions from a meeting or laying a brick, to a complex process such as creating and implementing a sustainability strategy, or a project from inception to demolition. The way you approach the process and use the appropriate Lean tools may differ depending on the size and complexity, but the root principles remain the same.

Does Lean only work for repeatable projects?

Lean is a toolbox approach that can be applied to a variety of projects and processes. Where a project or process is repeatable, a Lean approach can work quickly and more visibly as you can see the improvement with each cycle of the process. For example, for a routine maintenance task that you perform several times a month, any improvement done in the first month can be seen by the second month and can be continually improved. Track the improvements month by month. For a large project or a process that is either a complete one-off or only repeated once every few years, this does not seem as obvious. However, consider all the processes within your long-term project or process. There will be many smaller processes that repeat, for example reporting, procurement, monitoring progress, environmental audits etc. These are the processes that improvements can be focused on, making them more efficient and visible.

Is Lean only for the construction phase?

The philosophy of Lean has been applied successfully in many industries over the years including car manufacturing, aeronautics, textile manufacturing, health services and financial services, as well as construction. So whether your role is in a civil engineering, design, building, facilities management, or consultancy organisation, the principles of Lean can help in your sustainability role. As has been discussed in this guide, use the idea of improving delivery of value as the main goal, through continuously looking for and removing waste, then you will find it hard to go wrong.

Should I insist on a combined design/construction team to achieve true Lean?

Collaborative working is at the heart of Lean, so for real embedded Lean practice you will need to have a core team made up of representatives of each part of the project delivery team at every stage of the project lifecycle. More than just bringing these people together, they will also need to understand Lean philosophy and the behaviours and culture required to make it an integral way of working. In practice, this may be a long way off standard practice for your organisation, so you may be able to bring a team together wholly, or you may need to start by bringing together the people for critical areas of the project first. Use this to prove the benefit to the project in the long-term by comparing performance and measures with projects where this has not happened. As you are able to prove the benefits you are building a business case for this to become your standard way of working.

How long will it take me to 'Lean' my organisation?

Lean, as with sustainability, is concerned with the long-term vision and goals. Accordingly, expect Lean working across an organisation to take a minimum of five years – it is not a quick fix. However, starting in concentrated areas and spreading best practice and learning will start to bring benefits quickly in the areas of focus, so use those to keep momentum up. Do not expect perfection straight away and be prepared for a few disappointments and hard work along the way. If Lean was easy, everyone would be doing it well. It is a hard route to take, but the results are sustainable and worthwhile.

5.2 LEARNING AND NEXT STEPS

All of the case studies discussed in Chapter 4 are very different in where and why they started, what they did and the results they achieved. They are also very similar in that they all incorporate learning from their actions and the data coming from their activities as a key aspect of what they do. As Charles Darwin said "it is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change".

So, what have you learned from reading through this guide and the case studies? You may have learned a little about Lean and how it can help you, or you may have discovered a technique that has inspired you to do something different (see Appendix A1, Workbook 6a). Whatever you have learned now is the time to put it into action. Perhaps you will start to look at your own work process and think about the definition of value, or maybe you want to work with a project team to see how Lean can make a difference holistically (see Appendix A1, Workbook 6b).

The key to putting action in place is to start with something you control or have a very strong influence over, as this can give you the confidence that it works and how to apply the thinking or a tool. Once you have done this, you can use it as a demonstration of the opportunities and start to spread it wider.

There are many places where you can find out more information on Lean or can get some external help to implement Lean practically in your organisation. Some helpful suggestions are given in Fraser (2013), which may help you with your search.

A1

Workbooks

Use this workbook to add your own thoughts and notes as you go through the guide. There are prompts throughout where you may choose to record your ideas here.

WORKBOOK 1

1.2 OVERVIEW OF LEAN PRINCIPLES

How does the definition of Lean align with the aims and objectives of your role?

How they align...	How they differ...

WORKBOOK 2

1.3.1 Lean seven wastes and associated sustainability benefits

Note down what you feel might be the top three waste activities you encounter most in your current role or project.

1	
2	
3	

WORKBOOK 3

1.3.1 Lean seven wastes and associated sustainability benefits

Having read the section on the types of waste, re-consider the wastes you encounter. Write them here and note the waste category (or categories) you think they sit in.

	Waste	Waste category/categories (TIMWOODS)
1		
2		
3		

WORKBOOK 4

2.2.3 Using Lean as a mechanism for a balanced approach to meeting sustainability targets

Think about the key overall measures you have for your projects or process, and consider the influence of sustainability on or by those. Make a note of those here – we've added an example to get you started:

	Measure	How sustainability is an influencer of this
Quality	Defects at handover	Training and working conditions of workforce – leading to poor quality work. Snagging causes unnecessary waste and resource use
Quality		
Cost		
Time		
HS&E		

WORKBOOK 5

3.1.2 The situations where tools may be used and their expected benefits

Which of the tools do you think could be a good one for you to start with in your situation? Take a few moments to think about it, note down the first tool that seems to fit with you best, or that would help an issue you have at the moment and why you think that would benefit you. Also note down who you might want to get involved or what help you might need.

Tool	Why this one first?	Who do I need to involve and what help do I need to get started?

WORKBOOK 6A

5.2 LEARNING AND NEXT STEPS

Whatever you have learned, write it here and use it as a reminder and to spur you into action if you start to relax into 'business as usual':

I have learned...

WORKBOOK 6B

5.2 LEARNING AND NEXT STEPS

What action will you now take from this learning? Write down two things that you will do after reading this guide:

My first action is...	My second action is...
To do these I need to find out more about or get some help with...	

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