THE POTENTIAL FOR LEAN THINKING IN THE REFURBISHMENT AND REPAIR OF DWELLINGS IN THE REGISTERED SOCIAL LANDLORD SECTOR

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Construction, demolition, refurbishment and material supply processes are responsible for a significant amount of waste; whilst estimates vary, the UK Government uses the figure of 70 million tonnes. The construction industry accounts for some 17% of the total waste produced in the UK (RICS, 2004). It is not known exactly how much of this is produced by refurbishment activities in the Registered Social Landlord (RSL) sector, but there is little doubt that refurbishing housing offers opportunities for significant waste generation. RSL housing is refurbished by a number of triggers when a dwelling is left vacant after a tenant departs. Such a property is known as a "Void". This paper investigates the types of void works (i.e. repair and refurbishment activities) undertaken, the potential for waste in those works and the potential for lean thinking to reduce that waste. The approach taken to the investigation is the analysis of literature and current working practices. The conclusion is that properties located in estates and built post 1980 are the most likely to benefit from lean principles.

Keywords: lean thinking, refurbishment, social housing, waste.

INTRODUCTION

Whilst reducing waste can save money and therefore makes sound business sense, waste minimisation also means reducing the environmental impact of the waste generated, which can be achieved by reducing the quantity of materials consumed and therefore the energy required to produce them in the first place – the embodied energy. Registered Social Landlords (RSLs) need to take environmental, as well as social, responsibility very seriously.

The RSL sector accounts for approximately 1.37 million dwellings (EHCS, 2001). The average number of voids in the sector as a whole is estimated at 7% -10% per year. A simple calculation therefore points to an overall annual void figure of at least ninety-five thousand dwellings. Given these large numbers, a reduction in waste should result in significant financial savings across the sector.

DEFINING A VOID

The term "void" is applied to a property when it is empty. There are two main points at which void status can occur; 1: A tenant leaves a property without giving notice, and 2: A tenant leaves a property after giving notice that they are terminating their tenancy. Note that in both cases, a void cannot be predicted *per se*. A RSL will not know when a tenant will leave (other than a short notice period where that does

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actually occur). A further term, "Void works" is used when repairs and refurbishments (i.e. works) are carried out to a property that has become void.

MAINTENANCE POLICIES

Void works may be placed in two broad categories; 1: Planned works and 2: Reactive works. Planned work is mainly informed by a condition survey methodology, that is, properties are surveyed at regular intervals to produce a record of current repair requirements and an estimation of future requirements. Conversely, reactive works are mainly generated by a tenant reporting a problem with their property e.g. a faulty boiler, water ingress etc. In terms of a void, both planned and reactive works could be undertaken. A planned programme of works may have been developed previously for the particular property and, obviously, when it is empty, gives an opportunity to undertake intrusive major refurbishment works e.g. replacing a bathroom. However the reactive works would be a reaction to the state of the void at the time it was inspected, rather than reacting to a tenant *per se*.

There are a number of regulatory and corporate drivers for void works. These drivers can have a major impact on the priorities for void works, and therefore the potential for waste reduction. Perhaps the biggest driver is the UK Government's "Decent Homes Standard" (DHS), which was launched in 2000, as part of the Housing Green Paper (DETR, 2000). This means that all RSLs bring their housing stock to a minimum physical standard by the year 2010. The DHS requires that a dwelling meets four main criteria, including thermal efficiency, repair standards, health and safety, and level of amenity provision. The Government's requirement for RSLs to meet the DHS may have implications for both planned and reactive works to a void. RSLs have prioritised meeting the DHS, and expend resources on that, rather than on other works. In terms of reactive repairs, those repairs that link to the DHS may get priority over others, or RSLs may cut back on the quality of non-DHS void works so that they can finance the Decent Homes Standard requirements.

BACKGROUND TO LEAN THINKING

Lean manufacturing (or production) has the underlying philosophy that, by eliminating waste, quality can be improved, and production times and costs reduced (Ohno, 1980; Womack *et al*, 1991; Imai, 1997).. There are seven main waste categories - collectively referred to as "muda", a Japanese word meaning waste. The seven causes of muda are described in Table 1. The causes of muda can be further divided into two categories, Type 1 and Type 2 Muda – those categories based on whether an activity (or resource) 1: Adds value or adds waste as perceived by a customer and 2: The realistic potential for the cause of muda to be eliminated. Type 1 and Type 2 muda are described in Table 2. To reduce muda a set of key lean manufacturing principles may be employed and these are described in Table 3.

Table 1 Seven Causes of Muda (Sources: Ohno, 1980; Imai, 1997)

Cause of Muda	Explanation
Transportation	Unnecessary transport of materials e.g. moving products between factories. Can also damage stock causing waste
Inventory	Stocks take up floor space – and can also cause problems with movement around that space (i.e. logistics). Damage to stock
Motion	Human motion that is unnecessary e.g. searching for parts or tools, reaching for materials etc

Waiting time	Waiting for the next process step, wasting productive time
Over-production	This can expose an organisation to risks in changing demands from customers, and ties up capital and resources
Defects/ Scrap	Defects can result in e.g. waste, unnecessary rework, loss of customers and corporate reputation
Over-processing	Exceeding customer product expectations where the cost of product accuracy exceeds the profit achievable

Table 2 Type 1 and Type 2 Muda (Sources: Ohno, 1980; Imai, 1997)

Type	Explanation
Type 1 Muda	Creates no value, but is currently unavoidable, due to current technology, laws, and/ or other barriers.
Type 2 Muda	Creates no value, and is immediately avoidable

Table 3 Key Lean Manufacturing Principles (Sources: Ohno, 1980; Imai, 1997)

Lean Principle	Explanation
Perfect first-time quality	Achieve zero defects, revealing and solving problems at the source
Waste minimisation	Eliminate all non value adding activities and maximise the use of resources
Continuous improvement	Reduction of costs, increase quality and productivity
Pull processing	Products pulled from the consumer end, i.e. not pushed from the production end
Flexibility	The production of different mixes and/ or greater diversity of products, without compromising efficiency
Relationships	Building and maintaining long term relationships with suppliers

The idea of waste being inherent in tasks was noticed by the time and motion expert Frank Gilbreth (b.1868: d.1924). With particular relevance to construction, he observed that masons bent over to pick up bricks from the ground. Gilbreth noticed that a mason was lowering and raising his entire upper body to pick up the brick; this inefficiency had been built into the task through long practice. The introduction of a scaffold, which Gilbreth patented in 1894, which delivered the bricks at waist level, allowed masons to work three times as quickly (The Quest, 2002). "Lean" is essentially about getting the right things, to the right place, at the right time, in the right quantity whilst minimising waste and being open and responsive to change.

However, the ideas behind what is now termed "lean thinking" are originally considered to have been developed by Toyota - the Toyota Production System, which spread throughout the organisation's supply chain in the 1970s (Ohno, 1980), and its sales and distribution operations in the 1980s (Womack *et al*, 1991).

Womack *et al* discuss the significant performance gaps between the Japanese and Western automobile industries in their book, "The Machine that Changed the World" (Ibid). They further describe the key elements accounting for these performance gaps as lean production – the word lean used because they found that the Japanese organisations used fewer inputs to the production process, for example, time and labour. In later a later publication (Womack and Jones, 1996) they consider that lean production comes from fundamental "lean thinking", which very much includes management processes.

The construction industry has become interested in the lean thinking agenda in recent years. Much theoretical and practical research has been undertaken, and influential research organisations and think-tanks have been created focusing on lean principles (such as e.g. the Lean Construction Institute). This research has covered a range of

construction activities, including design (Freire and Alarcón, 2002), management (Alarcón and Calderón, 2003), supply chains (Mathews *et al*, 2000; Dainty and Brooke, 2004; Tommelein and Ballard, 2005) and operations and labour (Thomas *et al*, 2002). In terms of this paper, however, it is felt that an analysis of a void from the perspective of the original "production" ethos will provide a useful starting point in assessing the possible application of lean thinking to void works and therefore the potential to reduce waste.

VOID WORKS AS A PROCESS

So the lean thinking agenda was born from manufacturing/ production processes. To apply those original principles then, a "product" must be "manufactured" by a "process". If we are to hold lean thinking as a methodology to reduce waste and increase value in void works, we must be able to define those void works as a process - but is this the case? A process is variously defined, examples are shown in Table 4.

Table 4 Definitions of "Process" (Source: Various Websites and Chambers Dictionary, 2005)

Ref#	Definitions of "Process"
1	Deal with in a routine way
2	Procedure: a particular course of action intended to achieve a result
3	Subject to a process or treatment, with the aim of readying for some purpose, improving, or remedying a condition
4	A Process has inputs and produces outputs
5	Perform mathematical and logical operations on (data) according to programmed instructions in order to obtain the required information;

Whilst the definitions are perhaps selective, a key theme emerges – that is a process is routine, follows a particular course, is logical and is programmed. However, perhaps what defines a void is the ad-hoc manner in which they occur (i.e. non-routine and illogical, causing difficulty with programming), accompanied by a lack of knowledge of what works will be required (again, causing problems with programming).

A representation of a manufacturing "chain" versus a void chain is shown in Figure 1 below. Note that the process stage requires inputs and produces outputs (See definition #4, Table 4). Figure 1 is, perhaps, somewhat stereotypical of a manufacturing process. For example the process that produces computer chips as its output may well involve highly skilled engineers. But the Figure serves to bring out the main thesis of the rest of this paper.

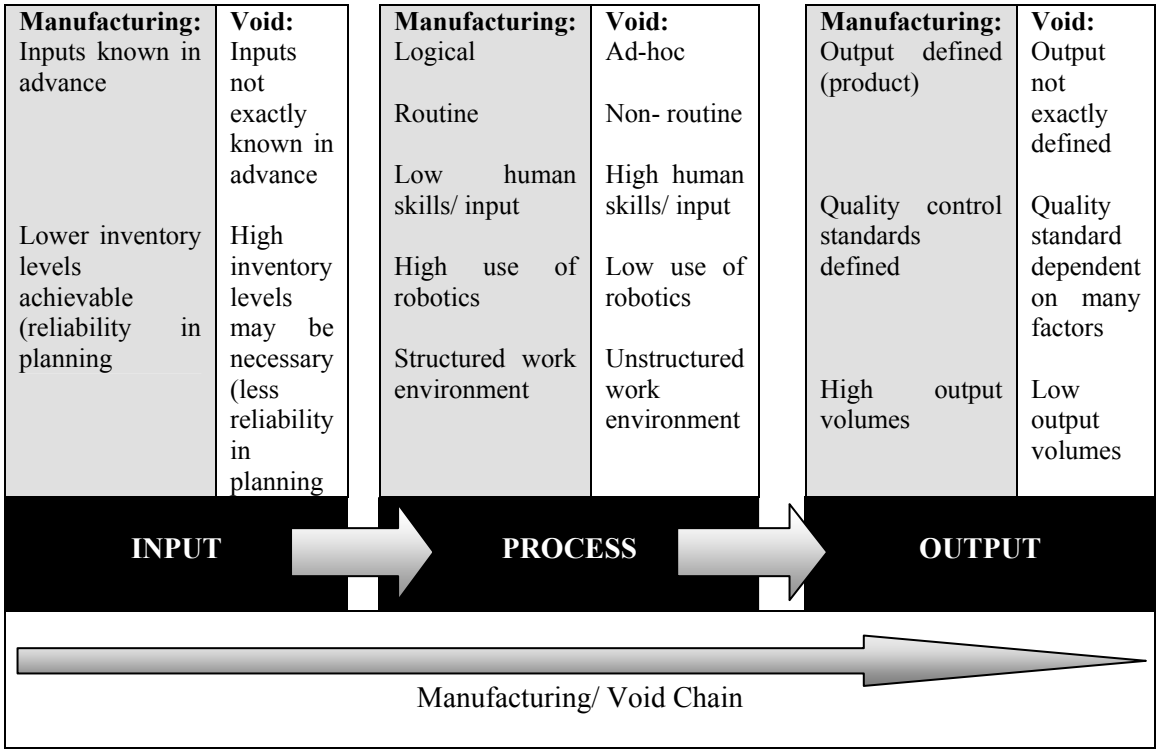


Figure 1: Manufacturing Chain versus Void Chain

In 1998 the UK government published "Rethinking Construction" (Egan, 1998) commonly referred to as "The Egan Report". The report considered a wide range of construction issues linked to performance and waste.. The report also highlighted the deficiencies in the house building process and specifically mentioned social housing. However the focus of the Egan Report was on new build housing, rather than the repair and refurbishment of existing stock. Other work has investigated the same issues in the UK (Jones and Greenwood, 2003) and work has also been undertaken in the USA on lean thinking and new build housing (Beary and Abdelhamid, 2005).The Egan Report advocates a number of measures to reduce waste in new build construction, in particular the use of Modern Methods of Construction (MMC). Such techniques are more difficult to apply to repair and refurbishment, particularly given the type/ age and location of social housing.

RSLs often tend to have a variety of housing in terms of the stock's age and its locational context. Perhaps the two most pertinent attributes of housing stock in relation to lean thinking is whether it is located in relative isolation (called a "street property" in RSL parlance) or in close proximity to other stock owned by the same RSL – i.e. in an "estate" location. The other issue is the age of the housing – whether newer build (say > c.1980) or older stock. Table 5 shows the age distribution for the English RSL housing stock. A discussion of these two factors and the potential for lean principles follows.

Table 5 Age Profile of English RSL Stock (Source: English House Condition Survey 2001)

Age	Pre 1919	1919-1944	1945-1964	1965-1980	Post 1980
Count (000s)	153	102	243	324	565
%	11.1	7.4	17.5	23.4	40.7

Street Properties
An RSL owns stock in a city centre. The stock is mainly in the street property category; therefore the RSL's stock is dispersed. Allied with the fact that voids occur on an ad-hoc basis, this makes it difficult to apply the process driven principles of lean thinking to a void in terms of reactive (i.e. non-planned) works.

Figure 2 Street Scene

The street scene shown in Figure 2 is indicative of the whole area; whilst there are a few new build (post c.1980) properties, the majority (>80%) are pre c.1900 dwellings. These dwellings have been repaired, refurbished and adapted several times over the years. It is therefore very difficult to predict what will need repair when it becomes void, and what materials and methods have been used in previous works (e.g. asbestos based products) i.e. the *inputs* to the *process* may not be exactly known.

Properties in Estates
In an "estate situation" it seems that lean principles can be applied to planned works. The organisation "Constructing Excellence" which has the aim of encouraging the construction industry to adopt practices that meet the UK Government's sustainability agenda (ODPM, 2003) has undertaken a project to investigate lean principles in the replacement of bathrooms on an estate of Ministry of Defence housing. The project reported considerable success in terms of reducing waste and also in reducing the time taken to undertake those works. Success has also been reported in a long-term partnering planned works programme (Constructing Excellence, 2004).

These examples, of course, apply to planned refurbishment works, but an estate still suffers from the ad-hoc nature of voids. However for newer estates, there may be more scope for more reliably predicting what elements of the dwelling may need reactive repair at void stage, and perhaps more reliability in predicting the construction methods and materials used.

Tenant Behaviours
In both cases (i.e. "estate" or "street") another variable exists – that is the impact of tenant behaviour on the condition of a property. In cases, tenant damage is so severe it can more than quadruple the "average" void repair cost. Examples of such damage are shown in Figure 3 below. Whilst some work has been attempted to assess the likelihood of tenant behaviour on property condition (Olubodun, 2001), this variable makes it even more difficult to predict, and therefore plan for, void works.

Figure 3: Potential Tenant Impact on Voids

WHAT ARE THE OUTPUTS OF THE VOID PROCESS?

With reference to Figure 1, the final stage of the overall process chain is an output. In a manufacturing context an output is a product. The product will have control mechanisms applied to it to gauge its quality e.g. tolerances for components, robustness tests etc. This will enable the manufacturer to assess the "success", or otherwise, of the inputs and process in producing the output (product). However a problem exists in defining the output of void works. A number of factors need to be considered in deciding which works will be undertaken to which void property. For example, a property located in an area of low demand may receive less works because it is deemed not worthy of large expense (or conversely may receive more, in an attempt to make it more attractive to potential tenants). The main point here is that it is difficult to define a "quality standard" encompassing all void works.

A partial solution may be to define a minimum quality standard (e.g. the DHS discussed previously). However this is problematic as it would not reflect the "extra" works that may be undertaken, and makes analysis of the overall process difficult in terms of mapping it to lean principles. Another potential solution may be to define a series of quality standards, depending on the void e.g. a minimum, basic and enhanced quality standard. However, one of the guiding principles of "lean" is simplicity. Defining multiple standards may well negate such a principle and make management problematic.

DISCUSSION, FURTHER RESEARCH AND CONCLUSIONS

The author interviewed a Senior Maintenance Manager at a London based RSL. Whilst the interview does not constitute in-depth research *per se*, the key points are worth reporting. The Manager stated his main sources of waste (muda) generated by void works, as shown in Table 6.

Table 6: Sources of Muda given by Manager

Ref#	Source of Muda as given by Maintenance Manager
1	Damage to materials by mishandling and inadequate storage
2	Vandalism that required rework and/ or additional works
3	Procurement methods
4	Seller's market –a lack of contractors and general skills shortages
5	Unprofessional attitude to work shown by contractors

Perhaps it is interesting to note that Refs# 3, 4 and 5 in Table 6 are closely related. Ref# 3 highlighting procurement was explained by the Manager as using a Schedule of Rates (SoR) to procure contractor services. The Manager stated that he found this

procurement method made it a "cat and mouse" game whereby the contractor tried to extract the maximum number of SoR jobs for the maximum cost, where the Manager tried to ensure that the minimum number were used to reduce costs. His comment that he thought that contractors had a seller's market (Ref# 4), because of a shortage of contactors and skills, tied in with his final comment – that contractors often had a unprofessional attitude to work (Ref# 5). The Manager stated that, because they knew that they were in short supply, the contractors felt that they could: *"Get away with sloppy service… basically there are too many jobs and not enough contractors to do them"*. Sanders and Wynn (2004) carried out research into contractor attitudes to waste and also found that *"They [contractors] do not feel that primary responsibility lies with themselves"*.

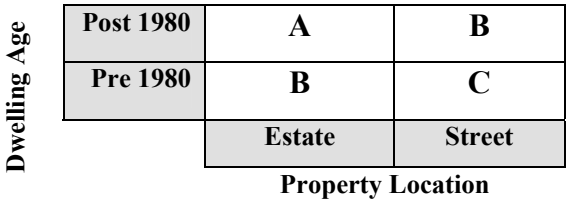
The Egan report (Egan, 1998) noted that Modern Methods of Construction (MMC) may help to overcome the skills shortages in the UK construction industry, and this has been more recently echoed by the Deputy Prime Minister, John Prescott, when he initiated the "Sixty Thousand Pound House" competition for house builders – and held MMC as one way of achieving that aim. Further, the Egan Report has advocated the use of partnering contracts as a mechanism to build good relationships between contractors and clients – which is also one of the fundamental lean principles.

The manager was also asked whether any elements from void works were recycled to reduce waste. The manager replied that because of the ad-hoc nature of voids and the difficulty of sorting, moving and storing materials e.g. window frames etc, recycling was not undertaken, *"certainly not in any significant way"*. Another problem therefore is logistics – particularly in built up urban areas. Bearing in mind that the manager was responsible for properties located in central London he stated that:

"We have enough problems getting materials to the place, and the workmen too; we drop them off in the morning and pick them up in the evening. There is nowhere to park. We just want shot [dispose of] of the stuff".

This paper has investigated the potential application of lean thinking to the repair and refurbishment of voids (i.e. void works) in the social housing sector. The paper's scope and scale means that only a relatively brief look at the issues involved has been undertaken. The paper is further constrained in as much as it has concentrated on the original lean production oriented ethos, and management issues have not been specifically addressed *per se*. However, issues have emerged that warrant further research.

Given the discussion earlier on the critical dimensions of age and location as the primary factors in applying lean thinking, future research may be best focused firstly on those properties in estate locations and aged post 1980. This is shown in Figure 4 below (Quadrant A).



Where: **A:** Highest possibility for lean principles. **B:** Lower possibility for lean principles. **C:** Least Possibility for lean principles

Figure 4: Focus of Future Research

As discussed *supra*, lean thinking may have more success in being applied to planned works which follow some pattern of a logical, informed process, and where housing can be grouped to enable economies of scale, logistical advantages etc. The potential impact of tenant behaviour on the condition of a void, such as damage and unauthorised repairs and improvements, makes prediction and planning even more problematic. This issue may have a higher impact on older properties where previous repairs and refurbishment works have been carried out over a number of years, using different materials and construction methods. This could be further exacerbated because work records have been lost, recorded inaccurately- or the work was never recorded in the first place, as discussed due to unauthorised works, or poor administration procedures. In addition, "street" properties tend to be dispersed in their locational context. This can make logistics difficult, and can also mean more variability in terms of the housing stock – i.e. for newer build housing some fundamental factors could perhaps be more reliably predicted. Newer RSL stock tends to be located in "estate" locations.

The then Deputy Prime Minister, John Prescott (2005), stated in relation to housing that *"Innovation and imagination is the name of the game"*. And, perhaps, with further research, innovation in void works may be achieved, using lean thinking as a springboard. However, as stated earlier, the production process needs to be investigated in tandem with the management process if lean thinking is to be applied to void works with a reasonable chance of success.

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