DEVELOPING LEAN SUPPLY IN CONSTRUCTION

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Since the Latham Report in 1994 the UK government has been active in urging the construction industry to improve how it manages its supply chains. Yet despite these efforts, research has shown that sophistication of supply chain management (SCM) in construction, in general, is still at a low level in comparison to that in many other industries. Often citing the manufacturing industry the government has largely focused on encouraging construction organizations to make their supply chains leaner. However, the construction industry has a unique working culture, a project-based feature, and high levels of fragmentation, which together differentiate it from mainstream manufacturing. This makes lean supply for most constructed products a different proposition to that of most factory manufactured products. This paper presents a Soft Systems Methodology (SSM) approach which is developed for addressing complex, multi-disciplinary project problems. Research is proposed to examine the use of SSM in construction projects undertaken by a large UK contractor. Such use should enable project managers and SCM practitioners to view the process of developing lean supply in a holistic manner and also to take into account the 'soft' cultural and project-based features of construction, leading to more effective solutions for delivering their project.

Keywords: construction project, culture, fragmentation, lean supply, soft systems methodology.

INTRODUCTION

The UK construction industry is often characterized by its inefficiency and antiquatedness (Egan 1998), and as a result there have been a number of initiatives over the past 20 years, most with government endorsement, to help address these issues. Constructing Excellence (the government body born out of the Egan Report) estimate that the products and services in the typical construction supply chain account for 80% of the cost of a project (www.constructingexcellence.org), so many of the initiatives partly or wholly focus on improving Supply Chain Management (SCM) and in particular, making supply chains "leaner". Born out of the Toyota Production System (TPS) the main aim of becoming "lean" is to give the customer total satisfaction with their product or service by maximizing value. The key to maximizing value is the identification and the management/removal of waste within the respective system (value is the converse of waste in "lean thinking"). Ideally this means that the customer will get exactly what they want, at exactly when they want it, with perfect quality (Womack and Jones 1996).

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A highly influential endorsement of "lean thinking" is "Rethinking Construction" (Egan 1998). Citing the success of TPS in Japan and in particular its ability to replicate this success in its overseas operations, Egan proposed that lean and lean supply could be adopted in UK construction practices as a means of "sustaining performance improvement". He assured that despite conventional opinions, construction has many similarities to industrial manufacturing, for example, a high occurrence of "repeat products" and "repeat process(es)". Figure 1 highlights the benefits of lean in construction according to Odgaard (2005).

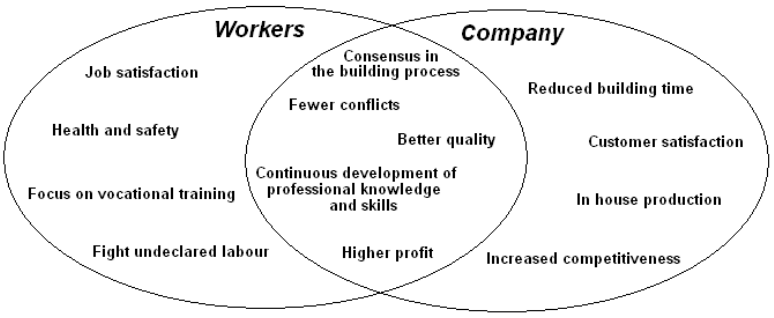

Figure 1: The benefits of lean in construction (Odgaard, 2005)

To what degree lean supply has diffused into the construction industry as a result of what Naim and Barlow (2003) called "government exhortation" is hard to fully quantify and is the subject of ongoing research, all be it relatively limited. In terms of company size, according to Mossman (2009), much of the take-up of lean has been by privately owned medium-sized firms. This phenomenon is suspected to be a function of their "form of ownership" (rather than their abundance) as directors of private SMEs are not subject to the "short-termism" of shareholder reporting and the stock exchange, and therefore can take a "longer view" with respect to a sustainable lean strategy. In terms of the number of take-up, a national survey of UK house builders by Barker and Naim (2008) showed that approximately 37% had not heard of Lean Supply principles, 36% had heard of them but had never used them, 21% had used them sometimes, and only 6% had used them extensively.

To help put their work into context Barker and Naim (2008) reported some responses as to why practitioners believed that SCM sophistication and ultimately lean diffusion was so low in comparison to many other industries. These responses identified ignorance, cultural barriers and a general lack of appropriate resources across the sector, for example, "Company very set in its ways. p.s. most people here think 'Latham' was a cricketer" – Good luck. Green *et al.* (2005) argued the issue of cultural barriers to "transcend all other issues" amongst SCM practitioners in construction. The enduring view was that the "dinosauristic" culture was hindering the implementation of SCM, and whilst it was seen to be changing for the better, the rate of change was still too slow for construction, as a whole, to achieve the level of sophistication experienced in other industries in the near future.

Another distinguishing aspect of construction culture in the UK are reports of the use of fear as a motivator, and that it is the "modus operandi" of many construction companies (Mossman 2009). This is a serious consideration when contemplating lean supply development because the whole philosophy is firmly rooted in empowerment, trust and participation (Bicheno 2004), reflecting Deming's (1986) insistence that meaningful systemic improvement cannot happen in a fear-driven environment.

There are also the practical aspects of "going lean" to consider within the cultural context. It typically takes three to five years to embed a continuous improvement culture in manufacturing, and doing the same in construction is likely to take considerably longer (Mossman 2009), certainly longer than the duration of most construction projects.

Unlike modern manufacturing, the UK construction industry is characterized by its multi level fragmentation (Baiden *et al.* 2006). Supply chains normally exist only for the duration of a project (Vrijhoef and Koskela 1999), and as a result there is often little incentive for actors within the chain to work and learn together. This is compounded by the fact that these actors will often see the others as adversaries as a result of "traditional" procurement processes, contract arrangements (Cullen *et al.* 2005), the conflicting nature of demand and supply (Cox and Ireland 2002) and contractors only focusing on the 1st tier (Briscoe and Dainty 2005). The "partnering" movement stemming from Latham (1994) was designed to address this situation, and there have been some successes. In particular "repeaters" (for example "house-styles") and off-site manufacture have gone some way to stabilizing construction supply chains and thus reducing fragmentation. However, Mossman (2009) argues that most these successes have only really involved the "major players".

This fragmentation also manifests itself physically. The distance between the production site and suppliers changes with every new project. Not only does this pose challenges to communication, but more importantly challenges to transportation – a core focus of waste reduction in lean supply (Jones and Womack 2002).

AN INNOVATIVE WAY TO DEVELOP LEAN SUPPLY IN CONSTRUCTION

The characteristics of its culture and the fragmented nature of the UK construction industry make developing lean supply for most construction projects a much more complex task than doing the same in traditional manufacturing. The repeated "exhortations" that urge construction to learn and copy from other industries give little attention to this (Green *et al.* 2005).

Slow cultural change is not exclusive to construction. But the fact that most construction projects are of relatively short duration means that culture will not change dramatically during that timeframe and efforts to exhort cultural change would usually amount to a waste in itself (although enforced change naturally modifies culture a little (Checkland and Scholes 1990)). Previous examples of lean supply in construction have shown that bringing actors within the supply chain around to lean thinking and participating in the journey is not unrealistic (Ballard 2008). However it can be argued that for "lean supply in construction" to achieve the desired level of success, the solutions that are implemented must be as culturally feasible as possible. This coupled with the multi level fragmentation of the industry and supply chain means that a SCM approach that can view the entire problem systematically and holistically, and that can deconstruct complexity is needed. One approach that affords practitioners this capability is soft Systems Methodology (SSM).

> *'SSM is utilized primarily to gain an understanding of an organization as part of the process of determining where new technology could be used to good effect.'* Patching (1990).

SSM, as advocated by Checkland and Scholes (1990) stems from research into solving "real world problems" carried out in the late 1960s at the University of Lancaster in

the UK. It was originally seen as a business process modelling/re-engineering tool, but now it is also being seen as a powerful learning and meaning development tool (Williams and Imam 2007). SSM is firmly embodied in the philosophy of Systems Thinking – the idea that the world with all its idiosyncrasies, problems and quirks can be better understood by thinking of it holistically (Checkland 1981).

Systems thinking is a broad field, a continuum with the "hard" at one end and "soft" at the other, with "hard" being the much more accepted and practiced (in many ways similar the quantitative and qualitative research "approaches"). Literature most often refers to "hard" and essentially traditional systems thinking as being associated with testing hypothesis using quantitative data (Jacobs 2004). SSM offers an alternative, and encourages users to focus more on the fuzzy ill-defined areas of problems like the human interaction and cultural perspectives, ultimately viewing humans as "components" (Maqsood *et al.* 2006).

So to summarize.

- Soft relates to the concept being primarily related to people and how they think and interact with one other and their environment.
- Systems relates to the need to think systemically about these people, their relationships, procedures and resources.
- Methodology relates to it being an organized way of thinking. It is a process of analysing where we currently stand, where we think we should stand, and developing the appropriate actions to get us there.

SSM is a "cyclic learning system" (Bergvall-Kareborn 2002) traditionally containing seven stages. Some address the "real" world, some the "conceptual world. The stages are: assess the problematic situation, express the situation pictorially or graphically, determine the root definitions, create a conceptual model, compare the conceptual model with the real world situation, define the changes required to address the problem and take appropriate action (Figure 2).

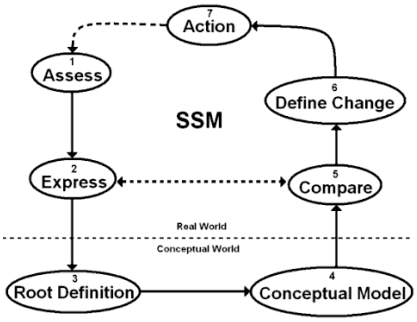

Figure 2: The SSM cycle

Stage 1: Assess the Problematic Situation

The first stage is to acknowledge and define the "problem situation", and assess why it is of particular interest. This could involve a preliminary gathering of relevant literature and other material, a meeting to discuss peoples' current viewpoints, supplier analysis, or whatever is deemed appropriate to give one an overall awareness and initial explanation of the problem. This is often an arbitrary starting point, and the initial assessment may shift as the problem situation is better understood (Williams 2005).

Stage 2: Express the situation pictorially or graphically
The second stage is to express the problem situation in the form of a "Rich Picture", where we attempt to encapsulate reality through holistic pictorial representation: for example, connections, relationships, cause-and-effect, influences etc. There are many examples where rich pictures have proved to be a valuable tool, and not just when used for a full SSM programme. For example, Jacobs (2004) reported that rich pictures "provided a springboard for in-depth analysis of the problem situation" when endeavouring to bring about performance improvements and organizational change within the English National Health Service (NHS) using SSM. Whereas Naim and Barlow (2003) used rich pictures independently of SSM to present their work on reengineering housing supply chains because they helped "to understand problems and potential solutions without becoming obscured by minutiae". Not only does the work of Naim and Barlow show the potential of rich pictures as a tool for communication of complex problems, but it also gives an example of the applicability of rich pictures when developing lean supply in construction, particularly when considering the issues of culture and fragmentation.

Stage 3: Root definitions
The third stage of the SSM process moves out of the real world and into the conceptual world of systems. This is the stage from where improvement "grows" hence the term "Root Definition". The aim of this stage is to develop a concise, logical textual (root) definition that can "express the core essence of the perception to be modelled" (Checkland and Scholes 1990). It should follow the basic formula of "a system to do X, by means of Y, in order to Z".

The development of the root definition should be further guided by a technique called CATWOE Analysis. CATWOE Analysis in order to gain a better understanding of a given situation. The CATWOE mnemonic is as follows.

- Customers: Those who benefit or suffer from the output of the named system.
- Actors: Those who perform the Transformation tasks within the named system.
- Transformation: The conversion of Inputs to Outputs for the named system.
- Worldview: What makes T meaningful. Why we are really doing it? The bigger picture. The wider impacts.
- Owners: Those with the power to stop T.

Environment: The limitations and constraints that could have an impact on the solution and its ultimate success. CATWOE is embedded in cultural and stakeholder analysis. Therefore it has the potential to play an effective role in the understanding construction and broader supply chain management issues, for example, improving Knowledge Management (Maqsood *et al.*, 2007) and Risk Management (Smith, 1999).

Stage 4: Conceptual model
The fourth stage of the SSM process is to develop a Conceptual Model. The conceptual model shows the sequence of activities and their logical dependencies that complete the transformation process described in the root definition and the CATWOE analysis.

Stage 5: Comparison of conceptual and real world
The fifth stage of the SSM process is to evaluate how the conceptual model compares to the perceived reality: what might happen compared to what does happen i.e. comparing the conceptual model to the rich picture. This process unearths activities that are poorly done (or not done at all), and ultimately provide the platform for an appropriate SCM strategy to be identified.

Stage 6: Defining change
The sixth stage of the SSM process is to determine what changes are to be made in order to improve or address the problems identified in stage five. This is the stage when intense discussion and debate is encouraged. Obviously there can be many solutions for any given problem, so there needs to be a way of determining the most appropriate one. Born out of its "humanistic" focus, SSM dictates that for the highest chance of success these changes must be Systemically Desirable and Culturally Feasible.

Systemic Desirability means that the changes made to improve the existing system must reflect the insight gained through the SSM process i.e. not the changes that we in isolation think we want, but rather what the system wants.

Cultural Feasibility takes into account that culture has a significant impact on change (particularly with Lean implementations (Bicheno 2004)) and every problem situation will have an associated culture. SSM defines culture in problem situations being primarily made up of social and political systems. Social systems are constantly changing interactions of three elements: roles, norms and values. Roles are positions of social importance that are institutionally or behaviourally defined, the expected behaviour is the norm, and the performance of that role is judged against established values (Checkland and Scholes 1990).

Furthermore a role is characterized by expected behaviour otherwise known as norms. Political systems are where differing interests are accommodated through expressions of power, or hierarchy. This power may be expressed in a number of ways, for example, personal charisma or membership to a particular committee (Kotadis and Robinson 2008) or union (Wilson 1984). Therefore, for change to be successful, that change itself must be as socially and politically acceptable as possible i.e. "This means something to us, it's realistic, and we can work with it".

Pragmatically, Patching (1990) suggests that Technical Feasibility and Financial Feasibility should also be considerations at this stage (although he concedes that these considerations are normal practice when developing such proposals). It should also be noted that Jones and Womack (2002) advocate that ideally, lean supply should be implemented for little or no cost.

Stage 7: Take action
The final stage of the cycle is to determine what actions are required to implement the solutions identified in stage six. These solutions once implemented, will alter the problem situation. So in principle a new cycle of SSM can begin. Consequently the problem may be continually reviewed, and therefore the system continuously improved. Also, the lessons learned and the knowledge gained can be applied to other situations, for example, designing value into supply chains, supplier performance etc.

INITIAL TESTING

The initial testing of the hypothesis was carried out in a series of workshops with an assistant to the project manager of a large construction project in Hong Kong. The aim

of this was to see if an appropriate actor who had experienced supply chain problems on a real construction project could use SSM to gain a better understanding of how to develop lean supply. The Hong Kong construction industry bears many similarities to the UK in terms of an adversarial culture (Yeung and Chan 2002) and high levels of fragmentation (Wong and Fung 1999). Using his own observation case study of a cement grout supply problem on the project and an SSM/Lean Supply workbook developed by the author, the participant worked through the seven stages. The participant found the usability of SSM a little varied. Some stages took a lot of time and practice to complete appropriately, for example, the rich picture. Others were "relatively straight forward", for example, the comparison stage. On reflection the participant concluded that SSM could be a very powerful tool for developing lean supply in construction given the idiosyncrasies of the industry. However, he felt that with guidance from a more experienced user and with a team working on it, it may have been easier and quicker to complete, and ultimately lead to more effective solutions. These are common themes amongst first time SSM users and as a result it is almost always advocated that the process should be a team effort (Checkland and Scholes 1990).

CONCLUSIONS AND FURTHER RESEARCH

It has been argued in this paper that the success of lean supply in construction is heavily influenced by the unique culture and fragmented nature of the industry. This paper has put forward the case for using SSM in order to develop lean supply in construction due to it having the scope to identify and analyse these influences at a practical level. The next phase of this research is to test the hypothesis that SSM is an innovative and effective way of developing lean supply in construction by applying it to a physical project during the construction phase and have practitioners actively attempt develop lean supply. It is proposed that the workbook (with modifications using the feedback in the initial testing phase) will be distributed to supply chain practitioners working on two projects in a comparative manner. One will be of new-build construction and the other of refurbishment. Both will be with the client of Ministry of Defence, located in Southern England. The focus of the work will be on the interface between the construction site and first tier and where appropriate, further tiers. The validity of using SSM for developing lean supply will be analysed using a combination of participant and observation case study methods incorporating semi-structured questionnaires. It is hoped that the outcome of the research will provide future practitioners with an effective, real world tool whilst laying the foundation for a new, innovative, more culturally focused, holistic approach to better understanding lean supply in construction.

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