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## ABSTRACT

In the past quarter century there has been a focus on the benefits that Lean can provide to an organization. Much of this work has focussed on the process and content of Lean with little work that focuses on its implementation. This research is conceptual and theorizes about the implementation of lean. It draws on organizational theory - mainly sociotechnical systems – to create a number of propositions for the implementation of Lean.

## INTRODUCTION

Lean practices are generally shown to be associated with high performance in a number of studies of world-class manufacturing (e.g. Sakakibara et al., 1997). The most commonly cited benefits related to Lean practices are improvement in labour productivity and quality, along with reduction in customer lead time, cycle time, and manufacturing costs (Schonberger, 1982; White et al., 1999).

The popularity of Lean can be attributed to the promise of continuously increasing productivity, improving quality and reducing costs, while at the same time allowing for expanded product variety. (Fullerton, 2003). Nonetheless, not all Lean implementations have yielded this promise (Browning and Heath, 2009). Bhasin and Burcher (2006) state that less than 10% of UK organisations have accomplished successful Lean implementation because, instead of these organisations to embrace Lean as a philosophy, they view it as a process. Shah and Ward (2003; 2007) argue that Lean production is multi-dimensional, covering a wide variety of management practices. The absence of a consensual definition for Lean presents several difficulties for academics and practitioners (Andersson et al., 2006; Pettersen, 2009). This includes Lean impact assessment and interpretation (Parker, 2003).

However, while there has been a substantial amount of research on the precepts and content of lean, its implementation is scarcely covered in the extant literature (Bhasin and Burcher, 2006). And this is despite the latter being stated by managers as a key concern.

Voss (1995:24) suggests that high impact research will come by linking processes to outcomes, conducting large-scale, empirical and international research, theory development and employing a multi-disciplinary approach. Van de Ven (2007) extends this by stating that as scholars we must become ‘engaged’, and link theory to practice. We argue that this can be achieved through linking the study of implementation (practice) with the concepts and techniques (theory). Moreover, Cua et al. (2001:680) posit that “the concept of fit is not well enough developed in operations management to prescribe exactly what set of practice/techniques will lead to low cost or for that matter what set will lead to any other measure of performance”. As noted by Mehri (2006) and Spear and Bowen (1999), few studies investigate the application of lean. Evidence of implementation success is also limited, and conclusions rather limited (Young and McClean, 2008; Proudlove et al., 2008).

As discussed above, there is little consensus on a definition for lean. Shah and Ward (2007) define Lean production as “an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability”. This differs from the narrower definition of Hopp and Spearman (2004) who define Lean as the production of goods or services that minimizes buffering costs associated with excess lead times, inventories, or capacity. We posit that lean, as a philosophy and as well as bundles of practices, is a combination of both social and technical dimensions that also encompasses internal and external dimensions to the individual unit (this may cover business unit, plant, firm, or indeed chain).

However, some firms cannot implement Lean fully, both in terms of level and width of implementation. This may be because of a range of underlying reasons, such as lack of resource, capability or Lean understanding. But regardless of the reason for the inability to fully implement, the main question remains: what should management do about the Lean implementation if there is little

chance of full implementation? **Lean is reliant on implementation of the complete bundles of practices** (Shah and Ward, 2003), and the implementation of some of these bundles (i.e. TQM) is classified as a **radical change** (e.g. Reger et al., 1994; Sitkin et al., 1994). Therefore executives within companies who wish to implement Lean need to ask themselves that if the implementation takes 10-12 years and may take several years to show real improvements - and many firms do not have this time – what can they do? Will implementing a few of the bundles of principles (or indeed only parts of them) limit productivity improvements? It also raises questions on the implementation process itself. For instance, are the bundles employed in sequential order or not?

**There may be limitations to the universality of Lean** (Pettersen, 2009). This would help explain why **Lean is not uniformly applied across industries**, not even in Japan. Instead it is typically implemented and employed piecemeal. Similarly, Keys and Miller (1984) and later Cooney (2002), argue that the possibility to become Lean (through JIT in particular) is highly dependent upon business conditions that are not always met, thus limiting the universality of the concept. **The argument goes that, contrary to the evangelical stance of Womack et al. (1990), true or full Lean producers are primarily, if not exclusively, confined to the automobile industry.** This furthers the need for an understanding of necessary elements and fit for a successful Lean implementation.

This research aims to address the gap in the extant literature by using theories from a range of sources, including general management, to generate propositions on the implementation of lean.

## LITERATURE

**Lean can be perceived as an approach that encompasses a wide variety of management practices, including just-in-time, quality system, work teams, cellular manufacturing, supplier management in an integrated system** (Shah and Ward, 2007). The extant literature dealing with Lean does not provide concrete definitions on what Lean really constitutes (Browning and Heath, 2009; Pettersen, 2009). Womack et al. (1990:13) write that Lean production is Lean because it uses less of everything compared to mass production - half the human effort in the factory, half the manufacturing space, half

the investment in tools, half the engineering hours to develop a new product in half the time. For successful Lean implementation the context has to fulfil three criteria: offering standard goods/services; having relatively high volume but not necessarily mass production; and having relatively long product life-cycles without major changes that affect production routings (James-Moore and Gibbons, 1997; Arlbjørn et al., 2008). Similar observations have been made of Lean application in service environments such as in hospitals, administration and in service organizations (Swank, 2003; Piercy and Rich, 2009). Hensel et al. (2008) argue that implementation of Lean is challenging because of three main factors: high variability, volatile demand, and dependence on a highly skilled and motivated workforce. However, evidence suggests that the Lean manufacturing techniques have been successfully applied in service operations, suggesting a degree of sector generalisability. But even with an appropriate product or service context, considerations need to be taken on the role of practices and their implementation.

Hines et al. (2004) claim Lean exists at both strategic and operational levels, while Shah and Ward (2007) and Shah et al. (2008) argue Lean primarily has a philosophical and practical orientation. Meanwhile, Bhasin and Burcher (2006) claim that Lean primarily is a philosophy rather than a set of tools. Authors such as Pil and MacDuffie (1996), Ichniowski and Shaw (1997), argue that Lean rests on a set of practices and tools used in eliminating waste. Womack et al. (1990) define Lean as a production philosophy that shortens the time between order placement and product delivery by eliminating waste from the product value-stream, while Naylor et al. (1999) describe Lean as a value stream to eliminate waste, including time, and to ensure a levelled schedule. In addition, the literature indicates a split between internally and externally focused goals on one dimension, and between social and technical on the other. (e.g. Hallgren and Olhager, 2009).

As such, Lean can be viewed as having both a philosophical and processual element. Lean philosophy is characterised by end-user or end-customer focus and total system efficiency, employee involvement and respect for people, and continuous improvements, and waste elimination. (Liker, 2004). The latter is also emphasised by Ohno (1988). Under these philosophies sit a range of principles, such as JIT

systems, TPM, and a focus on flow. Some authors cluster these principles into social and technical dimensions (e.g. MacDuffie, 1995; Shah and Ward, 2007; Hallgren and Olhager, 2009), thus classifying Lean as a socio-technical system. **The argument goes that for Lean to be successful in any organisation, a combination of hard (e.g. technical) and soft (e.g. organisational) tools or conditions need to be in place.** (Bhasin and Burcher, 2006). The principles themselves are realised through the use of a range of tools and techniques, such as single minute exchange of die, and functional flexibility of the staff. This is best illustrated by Toyota, where Lean principles, and consequent tools and techniques, are used as workarounds to expose particular problems. They do not necessarily solve underlying problem causes. The various Lean principles are applied on identified muda, muri and mura wastes to expose problems systematically.

There is empirical research on Lean that covers individual practices (Pil and MacDuffie 1996, Narasimhan et al., 2006; Shah and Ward 2003, DeTreville and Antonakis 2006), **but several authors (eg MacDuffie, 1995; Shah and Ward, 2007; Hallgren and Olhager, 2009) advocate conceptualizing Lean as bundles of practices as a better way to realise the Lean principles. Working through 22 identified Lean practices, Shah and Ward (2003) classify them into four practice bundles: quality management (TQM), pull or just-in-time production (JIT), total productive maintenance (TPM) and human resources (HRM).** Similar categorisation is found in other research (e.g. Samson and Terziovski, 1999; Flynn et al. 1995; Cua et al., 2001; McKone et al., 2001; Shah et al., 2008).

Many companies have learnt from experience that applying Lean principles and techniques in isolation from the underlying Lean philosophy does not lead to sustained improvement of efficiency in their processes (Spear and Bowen, 1999; Shirouzu and Moffett, 2004; Liker and Morgan, 2006; Browning and Heath, 2009). Firms often incorrectly apply Lean tools and techniques, which reduces Lean effectiveness as well as faith in its capabilities. For instance, similar to other operations elements, JIT has both a hard and a soft component (Shub and Stonebraker, 2009). Ballé (2005) argues that Lean implementations often fail because managers underestimate or even ignore the behavioural aspects of lean. In addition to these suggestions, Reger et al. (1994) suggest that Lean

implementations often fail due to the cognitive dissonance of the members of the organization who have to work in the new, Lean organization. This is particularly problematic in a Lean environment, since **Lean is a bottom-up approach where management plays a supportive and facilitating role in engaging shop-floor workers to form cross-functional self-directed work teams and apply Lean tools.**

So, there is an issue whether Lean elements should - or indeed could - be implemented individually. Moreover there is a lack of consensus on the content of each bundle. The various Lean tools and techniques have been clustered into four bundles by several researchers, such as Shah and Ward (2003, 2007). The content within respective bundle is a debated topic, with other authors claiming variations on the theme. For instance, Sakakibara et al. (1997) claim that the human resources component is an element of JIT, while Fullerton and McWatters (2001) state that it is not. Given the prominence of both the respect for people principle of Lean and the emphasis on continuous improvement and staff involvement, it does suggest that human resources is too prominent throughout to solely belong to JIT.

### **Two conceptions of lean: mutually supportive vs. sociotechnical system**

**The conceptualisation of the Lean bundles falls into two views. The first Lean view is foundation based, where the clusters are mutually supportive.** (See Figure 1). This incorporates elements such as firm alignment, culture, and the use of Lean accounting (Fullerton and McWatters, 2001; Waddell and Bodek, 2005; Schonberger, 2007), all of which are required for successful implementation or management of set processes. However, whether each of the bundles has to be equally developed for successful Lean implementation remains unclear, as does the order of bundle implementation.

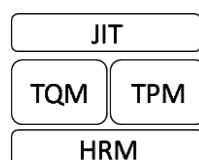


Figure 1. Lean practice bundle.

**The second Lean view suggests that the Lean tools and techniques fall into two dimensions – technical and socio-technical** (Shah and Ward, 2003). The first view covers technical processes and

routines, while the second view comprise of the social element needed to make these processes and routines viable. (Cua et al. 1999; Shah and Ward, 2007). Conversely, Dankbaar (1997) suggests that Lean is not a 'full' sociotechnical system and instead they share only certain practices (e.g. self-directed work teams). An example of a technical element is quick changeover techniques, while a socio-technical element is illustrated by workforce suggestions into process improvement initiatives (Womack et al., 1990; Hopp and Spearman, 2004; Treville and Antonakis, 2006).

Sociotechnical systems (STS) as an area of interest began in the early 50's with Trist and Bamforth's (1951) study of the within work group impact of a new method of mining in the UK. STS, by its very nature, implies that an organization (or sub-unit of an organization) comprises both technical and social systems which are interdependent and form the greater sociotechnical system (Cherns, 1976). The social system comprises the actors within the organization and the relationships between the actors (Davis, 1971). The technical system comprises the tools, techniques, routines, skills, knowledge and technology used by the actors within the social system to achieve fulfil the organizations tasks (Pasmore et al., 1982).

Taylor laid many of the foundations for Lean (Anderson et al., 1994; Voss, 1995) but focussed wholly on the technical side of the organization of work (Taylor, 1911). Much of the work that popularized the 'Japanization' of manufacturing that appeared early 1980s mentioned the need for self-directed, cross-functional workers and teams (e.g. Ohno, 1988, Schonberger, 1982). This is an implicit suggestion that Lean is a sociotechnical system - the intentional melding of technological processes with the social aspects of work. These works also implied that the addition of a social element to the technical processes could improve worker effectiveness. This is in contravention to early studies on STS (e.g. Trist and Bamforth, 1951) which examined how the removal of the social aspect of work reduced worker satisfaction and productivity.

There is ongoing debate around whether the implementation of Lean leads to worker demotivation. While much of the research on successful Lean implementation discusses the role of self-directed

work teams (e.g. Snell and Dean, 1992; Youndt et al., 1996; White et al., 1999; Shah and Ward, 2003), there is beginning to be greater understanding of the nature of ‘self-direction’. De Treville and Antonakis (2006) posit that self-direction – or autonomy – comprises two distinct facets. The first is choice, which is more limited in Lean work, while the second, accountability or empowerment, increases.

Some of the practices are overtly sociotechnical and take into account both the technological systems and social structure of work (e.g. Cherns, 1976; Pasmore et al. 1981; Batt, 1999). These overt sociotechnical practices include self-directed work teams and cross-functional training (e.g. Dankbaar, 1997; White et al., 1999; Shah and Ward, 2003). Other practices that can be classed as sociotechnical include Total Productive Maintenance (TPM), safety improvement and continuous improvement. TPM can be defined as a sociotechnical system due to the autonomous, self-directed nature of the work (Cua et al. 1999; McKone et al. 1999), and the involvement of many organisational functions and levels (e.g. Hipkin and De Cock, 2000; Chan et al. 2005).

It has been stated that the practice of Continuous Improvement is based on behavioural routines (e.g. Choi, 1995; Choi and Liker, 1995; Bessant and Francis, 1999), indicating that there is a social as well as technical (e.g. tools, practices and processes) aspect. It has even been suggested that the majority of accidents are a confluence of social and technical aspects (e.g. Perrow, 1984; Snook, 2000). These authors suggest that there are organizational climactic and cultural factors that influence the people who work within it in a negative way. Thus, improvements in shopfloor safety can be classified as sociotechnical (Brown et al. 2000).

We suggest that the second view sets principles and techniques into a framework of social and technical on one axis, and internal and external dimensions on the opposing axis. (See Figure 2). The categorisation of each Lean practice is based on their nature, purely technical or primarily reliant on a significant human element.



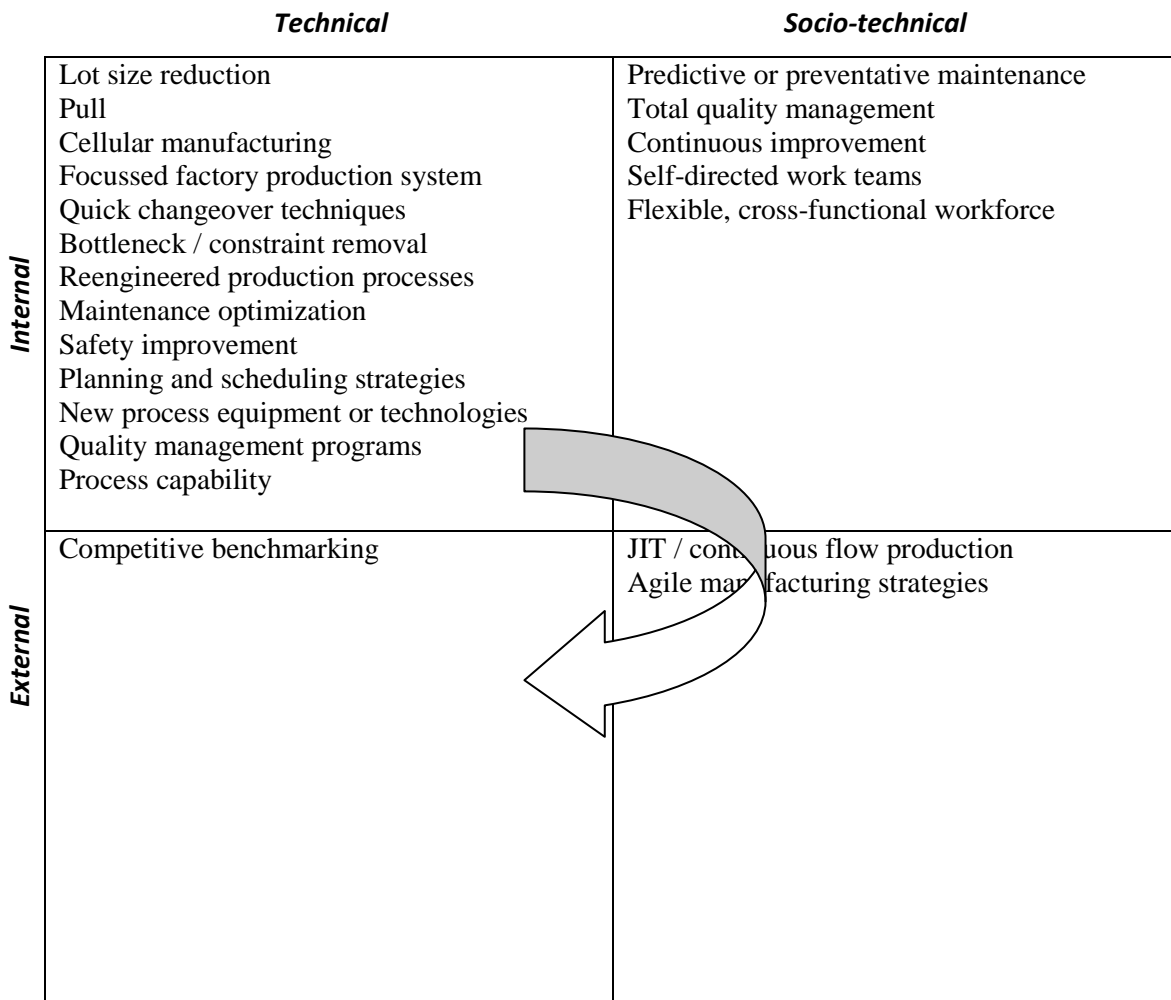


Figure 2. Clustering of social and technical practices

We further suggest that, following the rational process view, individual practices are implemented in a hierarchical order moving from internal to external and from technical to socio-technical. Internal and technical practices are implemented first, followed by human capital focused internal socio-technical practices. Once the internal socio-technical practices have been embedded, the external socio-technical practices are implemented. This is then followed by the external and technical practices. The rationale behind this sequence is that social change is more difficult than the implementation of new processes. This clustering of Lean practices and their suggested implementation leads us to the development of several propositions, which are presented next.

## DEVELOPMENT OF PROPOSITIONS

### Practice bundles and Lean implementation

Most of the empirical studies focusing on the impact of Lean implementation on operational performance are constrained to facets of lean, often limited to just-in-time (JIT), total quality management (TQM), and total preventive maintenance (TPM) programs (Cua et al, 2001). Behavioural aspects of Lean and its implementation are often neglected (Mehra and Inman, 1992).

Management commitment to Lean is important according to Fullerton and McWatters (2001) although Mehra and Inman (1992) suggest that it is not. They go on to suggest that the role of educating the workforce does not lead to successful Lean implementation (Mehra and Inman, 1992). Meanwhile, Pettersen (2009) finds that human relations management is not a definable characteristic of Lean but rather an important but not vital element of the Lean concept. In contrast, Fullerton and McWatters (2001) argue that key Lean improvements comes from enhanced, indicating a significant human resources dimension. Similarly, Schonberger (2007) suggests that employee involvement furthers the JIT and TQM aspects of Lean. Moreover, Youndt, Snell, Dean, and Lepak (1996) argue that manufacturing strategy needs to be linked to a human resources strategy that embraces the development of human capital.

Several studies suggest that implementation or adoption of operations practices is contingent upon specific organizational characteristics (McKone et al., 1999; White et al., 1999). To this effect, Flynn et al. (1995) argue that the first Lean step is to establish proper infrastructure. One can argue that if an organisation cannot put the appropriate foundation in place, then any Lean implementation will merely result in the adoption of fragmented employment of tools rather than the holistic system Lean is. (Mehra and Inman, 1992). Also, the importance of fit, or alignment, cannot be overstated since deviation incurs inefficiencies.

It can be argued that the presence of certain practices support the implementation of others (MacDuffie, 1995). It can also be argued that the implementation of certain practices does not have any influence on the implementation of others. For instance, Flynn *et al.* (1995) argue that TPM on its own does not have a significant impact on either TQM or JIT performance. Other researchers suggest

that there is overlap between the content of three (TQM, TPM and JIT) of the four practice bundles, but causal linkages between practices are underexplored (Cua et al., 2001). Imai (1997) and Flynn et al., (1995) suggest that TQM and TPM support JIT by providing the quality and dependability needed for a pull system to be feasible. Fullerton and McWatters (2001) and Flynn et al. (1995) even argue that JIT cannot succeed without TQM. Thus, we suggest that there is little consensus within the extant literature on the sequence and linkages between bundles and their implementation.

The implementation is limited to a 'lite' Lean version in situations with no more than partial bundle implementation in terms of practices covered is achieved. Hence, our first proposition is:

***P1: Full Lean implementation requires the inclusion of practices from all practice bundles.***

#### **Lite vs full inter-organisational implementation implications**

Change within an organisation takes two forms. These are convergent versus radical change and evolutionary versus revolutionary change (Greenwood and Hinings, 1988). Convergent change is small changes to the existing organization (Greenwood and Hinings, 1996), while radical change involves wide-scale organizational transformation (Amis et al., 2004). The evolutionary versus revolutionary aspect of change refers to the pace and scale of change (Greenwood and Hinings, 1996). Revolutionary change happens quickly and has a pervasive impact on many parts of the organization (Romanelli and Tushman, 1994). This type of change is 'top-down' as it can only be authorized and initiated by the most senior members of an organization.

It has been argued that radical change needs to occur quickly as this creates inertia, inter-departmental synergies and overcomes any internal resistance to the change efforts (Greenwood and Hinings, 1988; Romanelli and Tushman, 1994). Conversely, evolutionary change takes place over an extended period of time as it involves numerous actors and changes to their values, ideologies and technologies (Pettigrew, 1987; Pettigrew et al., 1992). And, it has been suggested that those involved need to 'make sense' of the change (Weick, 1995; Balogun, 2006).

Implementation is part of convergent change (Nutt, 1986). Much of the extant literature on Lean implementation suggests that Lean is not radical change as it acts on local processes (e.g. Hines et al., 2004). The popular management literature is filled with ‘*n*-stage’ change models (e.g. Tichy, 1983; Kotter, 1996; Buchanan and Huczynski, 2009). Such models implying that change is a neat, linear process. Amis et al. (2004), suggest that the majority of radical change efforts are non-linear and messy. Conversely, localized, convergent change (such as Lean when treated as process improvement) can be managed through a sequential process (Nutt, 1986). Instead the processes of change is characterised by high levels of uncertainty, trial and error, modification to the initial processes, delays and changes in pace (e.g. Kanter, 1984; Greenwood and Hinings, 1988; Denis et al., 2001; Heracleous and Barret, 2001).

The precepts of Lean and the conceptualization of Lean as practice bundles are within the remit of a range of functions within an organization. This includes the use of human resources policies for the recruitment and training of staff to work cross-functionally (Shah and Ward, 2003), the adoption of accounting principles that treat inventory as waste rather than as an asset (Åhlström and Karlsson, 1996; Waddell and Bodek, 2005), and the alignment of functional goals with those of the customer (Sitkin et al., 1994). This suggests that implementing Lean as a range of practice bundles requires radical organizational change. As such, we suggest that there is a fundamental disconnect between the conceptualization of Lean and the suggestions for the implementation of lean. This leads to the following two propositions:

*P2: To achieve full Lean implementation Lean must be conceived, and managed, as a radical change.*

However;

*P3: If Lean is conceptualized and implemented as a rational, linear process then full Lean implementation will not be achieved.*

### **Lite vs full inter-organisational implementation implications**

For successful Lean implementation, it can be argued that Lean needs to be extended across organisations. For instance, exploring the impact of Lean on performance, Shah and Ward (2007) use

the categorisation of supplier, customer, and internal. Similarly, investigating the use of information integration to improve, Ragatz et al. (1997) remark that integration of information and planning with suppliers reduce time cost of designing and solving problems. Benton and Krajewski (1990) report supplier's lead-time and quality affect manufacturer production, if supplier cannot meet the lead-time and quality requirement of manufacturer. However, contrary to the findings of Shah and Ward (2003), Pettersen (2009) finds that supply chain management is not a definable Lean characteristic but rather an important but not vital Lean element.

For Lean implementation across organisations, JIT is of primary concern since it is a core Lean practice and directly relates to inter-organisational relations. The successful application of a JIT system requires alignment between firms within a supply network, incorporating elements such as an accounting system that takes into account JIT-related inventory costs. However, Mehra and Inman (1992) imply that effective implementation of JIT is an internal process rather than the linking in of suppliers. This suggests that JIT has both intra- and inter-organisational characteristics, both which may require realisation for it to be employed successfully. Similarly, it has been suggested that large organisations have greater success in the implementation of TQM, JIT and TPM due to higher levels of formalization and centralization (Cua et al., 2001). As such, organisational capability may have a direct influence on Lean implementation due to resource availability and indirect through higher levels of centralisation and formalisation. (Cua et al., 2001; Fullerton and McWatters, 2001). We suggest that this formalization and centralization extends to the wider network as it stabilises and matures within the organisation.

We suggest that while the Lean implementation needs to extend across the supply network, there are two conflicting routes to this. The first approach is to extend the radical change effort across the network concurrently with the implementation. The second is for the focal firm to implement Lean wholly, and assist the implementation of 'lite' Lean in the network. This leads us to the following propositions:

*P4: For successful Lean implementation, the practice bundles must be implemented across organisations.*

*And:*

*P5: For successful Lean inter-organisational implementation must be radical and formalized.*

To summarise, based on the literature, we have established several propositions relevant for investigating Lean implementation, encompassing Lean philosophy and techniques (Proposition 1), implementation within the organisation (Propositions 2 and 3) and implementation in the extended enterprise or along the value chain (Propositions 4 and 5). Figure 3 shows the proposition flow.

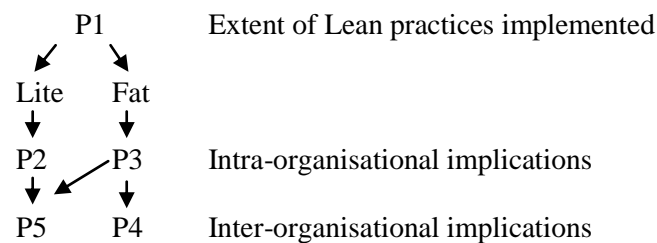


Figure 3. Proposition flow.

## SUMMARY

To summarise, this study explores conceptual fundamentals of Lean implementation. It investigates Lean concepts and practices and their role in realising a successful Lean implementation. For successful Lean implementation, Hensel et al. (2008) claim that there must be top management commitment, appropriate training in Lean tools and techniques and change management in place that supports sustainable change, as well as an overall Lean plan. We argue that the latter needs to consider both the type of Lean practices pursued and the nature of their introduction if a full, rather than partial, Lean system is to be realised. The full implementation itself is important for overall expected effectiveness of the introduced Lean system, since the concept itself is holistic with integrated and mutually reinforcing elements, unlike more simplistic and free-standing tools or techniques focussed processes.

Womack and Jones (1996) famously advocate using five Lean principles to achieve lean, identified as value, value stream through the supply chain, making the value-creating steps flow, employing a pull

schedule, and seeking perfection through making improvement a continuous effort. However, we posit that **for successful and full Lean implementation it is necessary that both social and technical elements are given equal consideration**, and that institutions not doing so fall short of the desired target and only realise a ‘lite’ and tools-focussed Lean version.

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