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


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Lean and agile in small- and medium-sized enterprises: Complementary or incompatible?



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Background: This study explores the relationship between the implementation of lean supply chain management and the agility of manufacturing small- and medium-sized enterprises (SMEs). Although some studies have suggested that these two approaches are mutually exclusive, other research finds that they may be applied to different parts of the supply chain or may be compatible through the common elements of process integration and supply chain-wide collaboration.

Objectives: Through an investigation of two companies at different stages of lean implementation, this study sought to establish which of these paradigms might be applicable in the context of South African SMEs.

Method: Semi-structured interviews were conducted with managers at both companies, and the progress towards lean manufacturing was probed.

Results: Company B was found to have made considerably more progress towards a lean system than Company A. Neither company had achieved just-in-time purchasing, and this was identified as a challenging aspect for SMEs. Both companies experienced stockouts and long lead times. The volatile nature of their markets indicated a need for greater agility. Company B was found to have a greater potential for speed, flexibility and response. It is proposed that this may be a direct consequence of greater progress in lean implementation.

Conclusion: It was concluded that strategies to implement lean are a necessary prelude to achieving an agile enterprise. This article presents a model incorporating the lean principles that SMEs should adopt in order to achieve agility.

Introduction

There has been considerable interest in the potential for strategies such as lean supply chain management and agility to contribute to increased efficiency and profitability of South African manufacturing firms. Although lean is well established and components including six sigma, total quality management (TQM) and just-in-time (JIT) are widely known in local industry, agility is a more recent concept. Furthermore, the relationship between lean and agile is not clear, and there is considerable disagreement in the literature as to whether these two strategies are mutually supportive or mutually exclusive.

Small- and medium-sized enterprises (SMEs) form a crucial part of emerging economies (Abor & Quartey 2010:218), and these businesses can also benefit from the implementation of lean ideas. In a rapidly changing marketplace, SMEs may also need to display agility to meet changing customer expectations.

This study sought to develop a framework within which to investigate the implementation of lean in South African SMEs and to discover whether lean implementation in SMEs is associated with improved or compromised agility by assessing if leaner organisations are better or worse placed to respond to volatile demand.

Literature review

Lean had its origins in the Toyota Production System which was developed in the mid-20th century as an alternative to mass production in the automotive industry (Womack, Jones & Roos 1990). The concept of the Agile Enterprise was introduced by the Iacocca Institute at Lehigh University in 1991 to provide 21st century manufacturers with a strategy to address volatile markets (Naylor, Naim & Berry 1999:107; Purvis, Gosling & Naim 2014:107).

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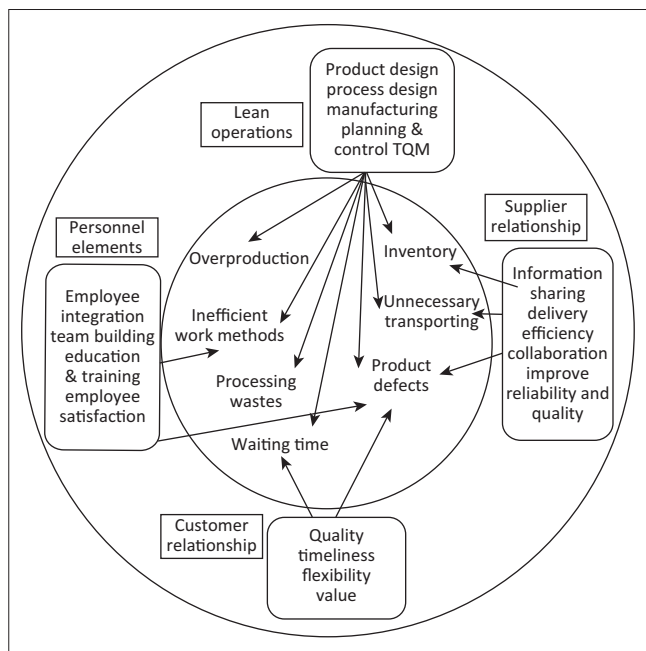
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Lean principles

The fundamental principles of lean are the reduction of waste and the development of a production process that operates on a pull force from the customer (Womack & Jones 2003:24). For Toyota, this approach to manufacturing allowed them to reduce their cost of production and to develop markets both within Japan and internationally.

Lean literature often cites seven wastes to be eliminated. These are *muda* of manpower, production, inventories, excess processing, defects, waiting, transport and facilities (Dahlgard & Dahlgard-Park 2006:264). Early literature suggested that this could be achieved through JIT, automation, a flexible workforce and capitalising on worker suggestions (Monden 1983:2).

Shah and Ward (2003:129) divided lean operational practices into four 'bundles': JIT, TQM, total preventive maintenance (TPM) and human resource management (HRM). Their study was concerned with operational performance relating to lean practices, but JIT has a strong element of supplier management, while TQM is based on the idea that quality is defined by the customer. Some authors are particularly concerned with lean supply networks (e.g. Bortolotti et al. 2016; Lamming 2005) or lean distribution (Reichhart & Holweg 2007); but in their landmark work, *The Machine that Changed the World*, Womack et al. (1990) emphasised that lean is a supply chain-wide concept, encompassing suppliers and customers. This conceptualisation of the linkages between the four themes and the elimination of the seven wastes of lean is depicted in Figure 1. This study follows this approach and identifies lean practices under four broad themes: supplier management, operational practices, personnel and customer relations. Although the first and



TQM, total quality management.

FIGURE 1: Four themes of lean supply chain management and their influence on the seven wastes of lean.

last are concerned with stakeholders external to the focus company of the supply chain, the other two are concerned with the two broad aspects of lean operations: machines and people.

Agile capabilities

Christopher (2000:37) described agility as a business approach that has flexibility as its fundamental principle. This enables a manufacturer to respond rapidly to changes in the volume and variety of goods required by the market.

In order to develop agile capability, a firm needs to develop a supply chain that is focussed on the customer and that exhibits cooperation between stakeholders and effectively deploys people and information to manage uncertainty (van Hoek, Harrison & Christopher 2001:129). These authors developed a framework to assess agility in supply chains. The four key characteristics of an agile supply chain that they identified were customer sensitivity, virtual integration, process integration and network integration. Some key strategies of agile supply chains which are identified by Yusuf et al. (2014:552) are the virtual supply chain, a knowledgeable workforce and enterprise planning systems.

Various authors have identified agile enablers that facilitate the development of agility in an organisation. These are summarised in Table 1. The consensus seems to be that technology plays a vital role in facilitating better communication between stakeholders. Customers become involved in product design, as do suppliers. Employees are empowered and self-managed, and the hierarchy of the organisation is flattened.

TABLE 1: Factors facilitating agility in various aspects of the supply chain.

Supply chain aspect	Agility enabler	Example of source
A. Supplier relationships	<ol style="list-style-type: none"> 1. VMI 2. Information sharing (e.g. point-of-sale information, electronic data interchange and collaborative planning, forecasting and replenishment) 3. Strategic partnering 4. Product, volume and mix flexibility 5. Alliances 6. Virtual enterprise 	<ol style="list-style-type: none"> 1. Power, Sohal and Rahman (2001:252) 2. Yusuf, Sarhadi and Gunasekaran (1999:39); Pandey and Garg (2009:101) 3. Cao and Dowlatshahi (2005:534) 4. Bottani (2010:253) 5. Gunasekaran and Yusuf (2002:1363) 6. Yusuf et al. (2014:552); Cao and Dowlatshahi (2005:534)
B. Operations	<ol style="list-style-type: none"> 1. Technology 2. Enterprise resource planning 3. Robotics 	<ol style="list-style-type: none"> 1. Power et al. (2001:251) 2. Gunasekaran and Yusuf (2002:1363) 3. Gunasekaran and Yusuf (2002:1370)
C. Organisational culture and personnel	<ol style="list-style-type: none"> 1. Focus on core competence 2. Trust information available 3. Employee empowerment 4. Participative management style 5. Self-managed teams 6. Innovation 7. Continuous improvement 	<ol style="list-style-type: none"> 1. Yusuf et al. (1999:38) 2. Bottani (2010:253) 3. Gunasekaran (1999:97) 4. Power et al. (2001:251) 5. Gunasekaran and Yusuf (2002:1365) 6. Duguay, Landry and Pasin (1997:1190); Power et al. (2001:252)
D. Customer relations	<ol style="list-style-type: none"> 1. Delivery lead time 2. Product quality 3. After-sales service 4. Customer satisfaction 	<ol style="list-style-type: none"> 1. Bottani (2010:253) 2. Bottani (2010:253) 3. Gunasekaran (1999:91) 4. Zhang (2011:306)

VMI, vendor managed inventory.

Lean versus agile manufacturing

Some essential differences between the lean and agile approaches have been proposed. Christopher (2000:38) described lean as suitable for products with low variety and high volume and defined agility as the ability to respond to changes in volume and variety of demand. Nel and Badenhorst-Weiss (2012:191) contended that firms must make a trade-off between responsiveness (agility) and efficiency (leanness) depending on the nature of their markets. They asserted that lean requires predictable demand and is suitable for a low-cost strategy, while agility is appropriate where high service levels are required by the market. This is consistent with earlier work by Mason-Jones, Naylor and Towill (2000:1064) that identified service level as the market winner for fashion goods with a volatile market and price as the market winner for commodities, which have a steady demand. Thus, the nature of the product determines the appropriate strategy for the firm producing it. Naylor et al. (1999:109) identified robustness and the need for stable demand as the two key areas where lean and agile differ. They saw these as being in conflict, with a system designed to meet a stable demand (lean) lacking the robust capacity to respond to variations and disturbances in the market (agile). Purvis et al. (2014:100) proposed that the level and type of flexibility required differentiate between lean and agile supply chains.

The authors cited above suggested that lean and agile are mutually exclusive in the same region of the supply chain and at the same time. Proponents of a 'leagile' strategy propose that a decoupling point may separate two parts of the supply chain: a lean section upstream and an agile section downstream of this point (Mason-Jones et al. 2000:4065). Agile production is order-driven and accommodates highly variable demand for a wide variety of products. Lean is forecast driven with smoothed demand and reduced variety. This implies that most product differentiation occurs after the decoupling point. Stock is held at the decoupling point to allow both strategies to operate effectively (Naylor et al. 1999:114). This strategy does not contemplate superimposing agile on lean.

In spite of differences in emphasis between flexibility (agile) and level scheduling (lean), common characteristics of the two approaches may be identified (Naylor et al. 1999:110). Both approaches require process integration and collaboration across the supply chain (Christopher & Towill 2000:208; Womack & Jones 2003:24). The elimination of waste is desirable in agile systems as well as lean, and the rapid reconfiguration required for a quick response to changing markets also increases efficiency for lean production (Naylor et al. 1999:111). Gunasekaran, McGaughey and Wolstencroft (2001:25) preferred to view agility as a management philosophy that uses tools, which may include flexible manufacturing, lean production and computer-integrated manufacturing, in order to achieve the goal of producing both volume and variety. These authors did not see lean and agile as incompatible.

In their analysis of the evolution from mass production through lean to agile manufacturing (AM), Jin-Hai, Anderson and Harrison (2003:178) saw lean as the successor to mass production and the precursor of agile. It must be noted that their understanding of lean was in its narrow sense which involves only the factory floor. Hence, when they introduced the concept of real agile manufacturing (RAM), a differentiating feature was that it crosses organisational boundaries. This is also a fundamental idea of the strategic alliances built in lean (Womack & Jones 2003:277) and hence not a revolutionary idea when moving to AM. Inman et al. (2011:346) took a broader view of lean and investigated the relationship between its key element, JIT and agility. They found that JIT-purchasing supported agility but that JIT-production was not a precursor of agility. However, they did not find that JIT (and by implication, lean) and agile were mutually exclusive. They suggested that in firms which already exhibit manufacturing excellence, greater agility can be achieved principally through further supply chain integration as evidenced by greater levels of JIT-purchasing. This supports the idea that agility exists as an extension beyond lean but is fully compatible with fundamental lean principles. Yusuf et al. (2014:532) went as far as to assert that 'agility is built on leanness'.

The truly lean organisation in a lean supply chain may therefore already have in place many of the key competencies which position it to move further into an agile paradigm. Alternatively, lean organisations may lack agility because of inflexible operating practices.

Leanness and agility for small- and medium-sized enterprises

Lean thinking has permeated large-scale manufacturing in the developed world and has been successful in developing countries like India, particularly in the large-scale automotive and electronics industries (Panizzolo et al. 2012:771). Similarly, agile ideas have gained traction since the beginning of the 21st century (Naim & Gosling 2011:342). However, the literature suggests that lean implementation in SMEs has been slower (Hu et al. 2015:981). These authors found that the majority of studies of lean in SMEs took place in developed countries, and of the 28% which were studied in developing countries, the overwhelming majority were of SMEs in India. African SMEs were not featured.

Dahlgaard and Dahlgaard-Park (2006:266) noted that the basic principles of lean production are those of craft industries: the focus on delivering value to the customer and pursuing perfection predated the Industrial Revolution and should be achievable in small businesses and in less sophisticated markets. Chong, Chin and Loh (2013) suggested that lean implementation in SMEs is hampered by a focus on short-term benefits; but these authors also suggested that the smaller workforce, less complicated products and simpler organisational structure of SMEs make them ideal candidates for lean. Small- and medium-sized enterprises are well placed to achieve the agile goal of producing small batch

sizes or even batch sizes of one provided they are placed within a collaborative network which allows coordination of activities among SMEs and demand information flow (Fornasiero & Zangiacomi 2013:2111).

Despite the challenges associated with implementing lean and agile in SMEs, they will also benefit from reductions in waste and increased responsiveness to changing markets. Fening, Pesakovic and Amaria (2008) investigated the effect of quality management, an important component of lean, on SME performance in Ghana. They found that the performance of these businesses was improved in terms of profitability and employee satisfaction. Achange et al. (2006:467) described the key success factors for the introduction of lean in SMEs as leadership management, financial capabilities, skills and expertise, and organisational culture.

Hu et al. (2015:984) noted that it is important to define the scope when discussing lean, as this may range from changes made only at the operational level to a complete change in philosophy for the entire supply chain. Small- and medium-sized enterprises may find themselves lacking the influence needed to bring about supply chain-wide changes. A more limited definition of lean, which focusses on operations management, was found to be the one most often implemented in SMEs. These authors pointed out that the strategic implementation of lean at the SME supply chain level is not well understood.

Chung and Chan (2001:601) suggested that SMEs will need to use information technology (IT) to facilitate the development of alliances and networks which will allow them to develop agile strategies.

In spite of the limited literature available on agility in SMEs, those that have implemented lean may look to this strategy as a way to increase profitability or simply to remain viable in a volatile marketplace. Two companies at different stages of implementing lean and whose management was contemplating the need for agility were the subject of this study.

Methodology

This study was exploratory in nature because there is little published about leanness and agility for SMEs, particularly in developing countries, and the goal is therefore to develop theory that is appropriate to this context (Ketokivi & Choi 2014:234). A comparative case study approach was used as described in Yin (2003:14), but restricted to a convenience sample of two Pietermaritzburg SMEs so that these companies could be studied in depth. These companies were selected on their implementation of lean and interest in agility.

Qualitative data were collected using semi-structured interviews with company managers (Bruce, Daly & Towers 2004:157). An interview guide was developed to probe the operational practices of the two organisations (Boyce & Neale 2006:3). This interview guide probed the strategy and

environment of the company, as well as the flow of information through the supply chain.

This broad investigation was followed by questions that were specifically designed to assess the level of implementation of lean. Waste reduction and JIT practices in the operations were closely investigated and supplier relationships were probed. The companies' relationship with customers and their logistics systems were assessed. Respondents were asked to describe the companies' organisational cultures.

These responses were categorised into four themes which contribute to lean waste reduction: Lean and JIT operations practices, supplier relationship management (SRM), customer relations, and organisational culture and personnel. The interview transcripts were analysed using codes developed from the literature. Particular words or phrases were identified as codes which expressed the fundamental ideas of the lean categories or themes and which would allow the researcher to identify whether the company performed poorly or well on these aspects.

The ideas in each of these themes which guided the selection of codes for analysis are summarised in Table 2.

Finally, the perceived need for agility was probed in the interviews. The companies' potential for implementation of this strategy was investigated using these data as well as

TABLE 2: Ideas guiding the selection of codes for each theme.

Lean and JIT operations	Supplier	Customer	Personnel
<ul style="list-style-type: none"> Product design: <ul style="list-style-type: none"> Standardised parts Modular design Quality Concurrent engineering PLM 	<ul style="list-style-type: none"> Information sharing with suppliers: <ul style="list-style-type: none"> Reduced transaction processing POS information Computer-assisted ordering 	<ul style="list-style-type: none"> Quality: <ul style="list-style-type: none"> Management of returns Communication channels 	<ul style="list-style-type: none"> Employee integration and information flow: <ul style="list-style-type: none"> Problem solving Feedback to employees Transparency
<ul style="list-style-type: none"> Process design: <ul style="list-style-type: none"> Small batches Reduced setup time Work cells Fail safes Reduced inventory 	<ul style="list-style-type: none"> Delivery efficiency: <ul style="list-style-type: none"> Frequent deliveries to Reduce inventory Small versus large deliveries 	<ul style="list-style-type: none"> Timeliness: <ul style="list-style-type: none"> Order cycle time waiting time Speed of delivery 	<ul style="list-style-type: none"> Team building: <ul style="list-style-type: none"> Motivation Cross-functional Job rotation
<ul style="list-style-type: none"> Manufacturing, planning and control: <ul style="list-style-type: none"> Visual systems Pull systems Level loading and reduced bottlenecks or work-in-process Layout for process flow and flexibility 	<ul style="list-style-type: none"> Collaborative relationships: <ul style="list-style-type: none"> Joint NPD Fewer suppliers Long-term relationships 	<ul style="list-style-type: none"> Flexibility: <ul style="list-style-type: none"> Emergency order procedures Choice of lot size Variety Customisation 	<ul style="list-style-type: none"> Learning organisation: <ul style="list-style-type: none"> Continuous improvement Change management Training and retraining
<ul style="list-style-type: none"> TQM: <ul style="list-style-type: none"> Continuous improvement Six sigma TPM Housekeeping (five S's) 	<ul style="list-style-type: none"> Improved quality and reliability: <ul style="list-style-type: none"> Quality inspection Supplier responsiveness 	<ul style="list-style-type: none"> Value: <ul style="list-style-type: none"> Customer needs assessment 	<ul style="list-style-type: none"> Employee welfare and satisfaction: <ul style="list-style-type: none"> Disciplinary action Health and safety Absenteeism compensation Promotion Incentives

Note: Eliminating seven wastes of lean: Overproduction; Inventory; Unnecessary transporting; Inefficient work methods; Processing wastes; Waiting time; Product defects. JIT, just-in-time; PLM, product life cycle management; NPD, new product development; TQM, total quality management; TPM, total productive maintenance.

indicators of agile capability arising from the data collected on lean. Under each theme, an assessment was also made of its contribution to the agility or potential for progress towards an AM paradigm. Words implying speed, flexibility and response were identified as codes for this analysis.

Data were verified by observation of work activities and through the study of documentation provided by the companies.

The data collection process started with interviews with the CEO of each company followed by snowball sampling as each respondent recommended further candidates. A maximum of seven respondents from each company was interviewed but an effort was made to ensure that this included all relevant members of top management using a purposive sampling approach.

Research findings

The two companies are medium-sized manufacturing companies (400 – 500 employees) in KwaZulu-Natal. Company A manufactures electrical fittings using a plastic injection moulding process. Company B produces high-speed steel (HSS) cutting tools such as drill bits and reamers with two factories, one producing HSS tools and the other carbide tools.

The results of the lean assessment of the two companies are summarised below under the themes identified above.

Supplier relations

The performance of both companies with regard to lean supplier management is summarised in Table 3. Neither of the SMEs has been successful in introducing JIT supply, but

TABLE 3: Summary of lean supplier management performance of the two companies.

Supplier	Company A	Company B
Information sharing with suppliers		
1. Reduced transaction processing	Yes – with local suppliers No – international suppliers	Yes – electronic communication
2. Information sharing	No	Yes
3. Computer-assisted ordering	Yes – short processing times	Yes – MRP with Cispro
Delivery efficiency		
1. Frequent deliveries to reduce inventory	Yes – local suppliers No – international suppliers	Yes
2. Small versus large deliveries	Large	Small
Collaborative relationships		
1. Joint NPD	No	No
2. Fewer suppliers	No	No – ABC classification
3. Long-term relationships	Yes – good communication	Yes – especially raw material suppliers
4. Outsourcing	No	Yes
Improved quality and reliability		
1. Quality inspection	No	Yes
2. Supplier responsiveness	Average	Good – local items Poor – imported materials, unexpected delays common

NPD, new product development.

both have progressed towards lean by reducing the size and increasing the frequency of delivery of supplies. Company A still has a transactional relationship with suppliers, apart from a few long-term suppliers. There was no evidence of lean practices such as outsourcing of non-core competencies or information sharing through IT. Company B has progressed to JIT supply with some local suppliers but still experiences unreliable supplies of imported materials. Ordering and communication with suppliers has been improved through IT, but there is as yet no evidence of collaborative new product development (NPD) or outsourcing.

Lean and just-in-time operations

The two companies are at different stages of lean implementation in their operations and this is reflected in their performance in lean and JIT operations management, which is summarised in Table 4.

Company A carries high levels of work-in-process inventory. It has long setup times and as a result produces large batches to avoid setting up a machine more than once a week. These are then transported to the assemblers which introduces further inefficiencies. High levels of finished goods inventories are held in an attempt to meet the demand but stockouts still occur.

TABLE 4: Summary of lean and just-in-time operations management performance.

Lean and JIT operations	Company A	Company B
Product design		
1. Standardised parts	Yes	No
2. Modular design	No	No
3. Quality	Yes	Yes
4. Concurrent engineering	No	Yes
5. PLM	No	No
Process design		
1. Small batches	No – long production runs and continuous flow	Yes
2. Reduced setup time	No – 3 h	Yes – 10 min (reduced from 2 h)
3. Work cells	No	Yes – carbide section No – HSS
4. Fail safes	No	Yes – poka yoke
5. Reduced inventory	No – high raw materials, WIP and finished product	Yes – of raw materials No – consumables not JIT
Manufacturing, planning and control		
1. Visual systems	No	Yes
2. Pull systems	No	Yes
3. Level loading and reduced bottlenecks or WIP	No – result of variable items per shot	No – balanced workloads in carbide but high WIP in HSS
4. Layout for process flow and flexibility	No – assemblers located away, results in unnecessary transport	Yes – reconfigurable
TQM		
1. Continuous improvement	No – inspection and rework not built in quality	Yes
2. Six sigma	No	Yes
3. Housekeeping, 5 S's	No – for example, old machines clutter factory floor	Yes
4. TPM	No – breakdown repair	Yes – preventative maintenance in carbide, less effective in HSS

JIT, just-in-time; PLM, product life cycle management; HSS, high-speed steel; TQM, total quality management; TPM, total productive maintenance; WIP, work-in-process.

TABLE 5: Summary of organisational culture and personnel elements.

Personnel	Company A	Company B
Employee integration and information flow		
1. Formalised problem solving	No	Yes
2. Feedback to employees	No	Good, product performance feedback
3. High level of transparency	No	Yes
Team building		
1. Motivation	Low in factory	High
2. Cross-functional	No	Yes
3. Job rotation	No	Yes
Learning organisation		
1. Continuous improvement	No	Kaizen meetings
2. Change management	No	Yes
3. Training and retraining	Yes	Yes
Employee welfare and satisfaction issues		
1. Disciplinary action	Frequent	Infrequent
2. Health and safety	Good	Good
3. Absenteeism	High	Low
4. Compensation related	Numerous	Seldom
5. Promotion opportunities	Limited	Limited
6. Incentives	No	Yes – for innovative ideas

TABLE 6: Summary of customer relationship management in the two companies.

Customer	Company A	Company B
Quality		
1. Management of returns	Frequent because of delay, dealt with on an <i>ad hoc</i> basis	Occasional – quality-related problems
2. Communication channels	Via salespeople	Advanced technical support provided
Timeliness		
1. Order cycle time	Short	Short
2. Waiting time	Poor – stockouts frequent	Poor – stockouts frequent
3. Speed of delivery	Good if available, 3PL used	Good, 3PL, < 24 h
Flexibility		
1. Emergency order procedures	Responsive if stock available	Responsive if stock available
2. Choice of lot size	No	No
3. Variety	High but being decreased to improve availability	High
4. Customisation	Subject to extended lead times	Make-to-order 4-week delay
Value		
Customer needs assessment	Not formal, but salespeople involved in NPD Long-term customers enjoy preferential treatment	Technical support and after-sales service

NPD, new product development.

Company B's finished inventory levels are high in the carbide factory because of economic batch quantity (EBQ) constraints associated with international customers, but the feasibility of a make-to-order strategy was being assessed. In this section, batch size has been reduced and a reconfigurable layout has added flexibility. Work cells improve efficiency. Finished inventory levels are high in the HSS factory because of overproduction. This section of the plant has a more rigid layout with ageing machinery and longer setup times.

Personnel and organisational culture

Very different organisational cultures were encountered in the two companies. Table 5 shows the elements of personnel and organisational culture that were particularly relevant to lean operations.

TABLE 7: Summary of agile capability of the two companies.

Supply chain aspect	Company A	Company B
Supplier relationships	Little evidence	Little evidence
Operations	Little evidence	Yes
Organisational culture and personnel	Little evidence	Yes
Customer relations	Agile in some areas	Agile in some areas

Overall, Company A's management appeared to experience an antagonistic relationship with its factory employees, although with office staff there was a far more collaborative culture.

Company B was successfully introducing lean human resources practices such as *kaizen* meetings. Responsibilities were devolved to lower levels and incentives encourage employees to be innovative.

Customer relations

The aspects of customer relationship management relevant to lean operations are summarised in Table 6. Company B was found to have a better developed customer relationship management system than Company A in terms of after-sales service and customer feedback. It experienced fewer returns, but a concern was that these were mainly for quality reasons. There was little evidence of customisation in either company, and the willingness to make-to-order appeared to be compromised as a result of extended production lead times.

Communication through sales people was good for Company A, but the returns they experienced were mostly because of delays in filling orders and rejection by customers as a result.

Potential for agility

The markets for products produced by companies A and B exhibit volatility, with fluctuations in both variety of product demanded by the customers and volumes needed. The catalogues of both companies offer considerable variety, but demand for the different items is not consistent. Both companies experience stockouts and long lead times to supply out-of-stock products. In spite of good communication with customers, they are unable to respond rapidly and flexibly to demand. Many of their products are highly differentiated and may experience short life cycles.

This suggests the need for continual future product design changes and process requirement changes. Both companies need to increase their agility to service their markets better.

The agile capabilities of Companies A and B were compared, and an assessment of their performance with regard to the four key aspects of the supply chain is summarised in Table 7. Neither company had an effective supplier relationship, with systems such as fluid collaborations, vendor managed inventory (VMI), outsourcing or effective communication to

facilitate speed, flexibility and response in supply. Company A is not well equipped to produce greater variety, with long setup times, an inflexible layout and a low investment in technology. Furthermore, their organisational culture does not encourage agility because the workforce is not empowered to be self-managed or motivated. Company B, however, has already developed a flexible, proactive workforce. Their carbide section is technologically advanced and setup times are short. Both companies are performing well in some aspects of their customer relationships and poorly in others. The 3PL companies allow them to deliver with a short lead time, but only on products that are already in finished goods inventory. Lead times are excessive for products on their catalogue which they do not have in stock. Forecasting is weak, and communication with customers to anticipate demand is poor. Nonetheless, relationships appear to be good as a result of good after-sales service and motivated sales teams.

Discussion

The framework developed for this study provided a comprehensive approach for assessing lean capabilities. The different themes that were identified were easily understood by respondents and highlighted areas of strength and areas of weakness within each company.

Company B has a significantly leaner operation than Company A. It has reduced inventory, setup time and increased flexibility. Another key difference between the two companies is in their organisational culture. Company B has embraced the lean principles of team work, devolution of responsibility and open information flows. Company A experiences an antagonistic relationship between shop floor and management. This obstacle suggests that it will be difficult to succeed with lean. Investments in improved technologies, and information systems in particular, may assist in improving human resources efficiency.

Neither company has achieved lean supply management. The literature suggests that this is a particular challenge for SMEs, which do not carry the financial weight to influence suppliers. Company B has had some success in establishing a JIT supply with local partners and has developed some strategic alliances, but imported raw materials pose a major challenge.

Although both companies are facing uncertain market environments, both are still profitable and offer products that usually meet customer requirements. There are weaknesses in their ability to meet changes in demand and to supply the variety of products needed.

In terms of agility readiness, the introduction of lean has given Company B an advantage. Some of the IT and automation capabilities are in place, and the workforce is flexible and motivated to improve performance. It seems most unlikely that Company A could achieve agility

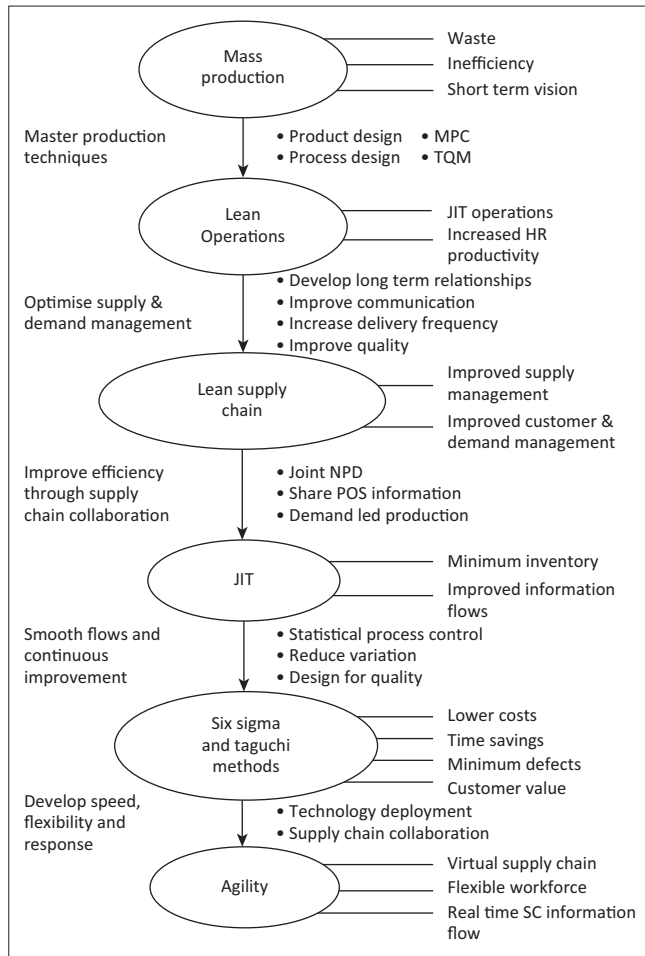
without first improving these same aspects of their operation. The findings support the contention that lean serves as an important precursor to agile. Furthermore, there is no indication that lean is compromising agility or resulting in rigid practices that reduce responsiveness. It may be that an incomplete implementation of lean is important: A fully realised lean system may in practice restrict a firm's agility, but preliminary steps taken on the lean journey may enable the development of the agile capabilities of the supply chain. Small organisations, by their very nature, may already be more adaptable and responsive. If they can achieve responsiveness to customer needs by efficient and flexible operations, they may not need to contradict the principles of lean by holding excessive inventory. The key to improving both the lean and agile capabilities may lie in taking full advantage of modern communications technology to develop more effective and versatile collaborations with customers, suppliers and competitors. Small- and medium-sized enterprises could support a virtual supply chain that has the agility to meet and exceed customer expectations.

Although the findings are not necessarily generalisable to the wider population of SMEs, because the sample was limited to two companies, several avenues for further investigation were suggested by this study. The framework that was developed provides a useful tool to structure assessments of lean and agile capabilities in SMEs. From the findings of this exploratory study, a 'Lean to Agile Journey' is proposed. This journey will take companies from a traditional, mass production strategy to agility through a sequenced implementation of lean principles and practices. This staged approach is illustrated in Figure 2.

Waste reduction, through the use of lean operating practices, should be accompanied by any organisational culture changes that are needed to develop a self-managed and empowered work force.

Once the company in focus is lean, it should turn its attention to suppliers and customers and initiate the process of supply chain integration. Improving relationships and information flow is critical in achieving a lean supply chain. Just-in-time is only possible once these relationships are well developed. Six Sigma and Taguchi methods can elevate the focal company's operations to an even higher level, with reduced costs and improved quality.

Finally, the lean company is in a position to reassess its agility and to make the necessary adjustments to achieve speed, flexibility and response. This requires the development of a virtual supply chain which can be reconfigured to meet volatile demand. A network of SMEs which collaborates to produce a wide variety of products and achieves the critical mass to overcome international supply constraints may prove more agile than larger competitors.



TQM, total quality management; JIT, just-in-time; NPD, new product development; MPC, manufacturing planning and control; SC, supply chain.

FIGURE 2: The lean journey for small- and medium-sized enterprises.

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Competing interests

The authors declare that they have no competing interests with regard to the writing of this article.

Authors' contributions

N.G. conducted empirical research leading to the awarding of a Master of Commerce degree in supply chain management. Data collected towards fulfilling this degree were used in the preparation of this article. R.H.S. supervised the research conducted by N.G., and using some of the data from this research, determined and wrote the content of this article.

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