LEAN SYSTEM IMPLEMENTATION STRATEGY AND KNOWLEDGE FRAMEWORK

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Abstract
Current research has exposed the fact that organisations in South Africa grapple with the implementation of lean systems. Lean systems affect the entire organisation and require strategies which link core and supporting processes from end-to-end. In many cases it requires the redesign of the supply chains' supporting activities or processes that provide added value to the business processes of the organisation.

Contemporary research postulates that to be successful, an organisation should have specific objectives when implementing a lean system. The objectives would ensure a smooth, rapid flow of materials and or work through a system. Primarily it compels management to perform a health-check or business capability performance gap analysis before attempting to formulate a lean implementation strategy.

The objective of the paper based on topical research, is the development of a health-check. In developing a knowledge framework and measurement model, various tools were used for statistical analysis. The framework would assist organisations in identifying critical success factors during the implementation of lean. It addresses lean implementation strategy confirming the overall business improvement endeavour through value adding activities. An added advantage is that it would assist an organisation in performing a capability performance health-check before embarking on a lean or value adding project.

Keywords: continuous improvement, measurement, performance, lean objectives, Lean Synchronisation, competitive priorities, business processes capability, supply chain optimisation

Introduction

This paper introduces a lean system implementation strategy and knowledge framework to enable organisations to implement lean processes towards sustainable performance and excellence. This lean system implementation strategy and knowledge framework is based on recent research conducted by the authors. [i] [xxv]

The objective of lean is to ensure a smooth, rapid flow of materials and or work through a system. This in itself depends on how well supporting goals are achievable. It requires that all waste be eliminated and forms the basis of understanding the all-encompassing extent of the philosophy of JIT. In essence, waste is defined as any activity that does not add value to entire organisation business processes, to products and services. It therefore adds cost, but not value to products or services. [ii] The ultimate goal of any organisation is to be lean as it represents the elimination of unproductive resources in order to optimise processes, systems and supply chains. [iv] [viii]

It is important that waste must be eliminated and to understand why organisations and managers must implement corrective measures to reduce, control or eliminate any problems. According to the research, waste contributes to underachievement of business competitive priorities, process capability and performance. [iii] [v] It is also evident from the research that to eliminate waste, organisations must develop a continuous improvement system focusing on the elimination of waste, achieving operating cost reductions and the "will" to improve the effectiveness of business processes. [vii] The research also focused on what impact waste has on organisations. [xxv] The traditional categories of elimination of waste in seven areas, as identified by Taiichi Ohno [Toyota Production Systems (TPS)], are as follows:

i. Overproduction which involves excessive use of manufacturing or operations resources;
ii. Waiting time, known as queuing and refers to periods of inactivity in a downstream process. It occurs because an upstream activity does not deliver on time and includes bottlenecks.
iii. Transportation due to unnecessary motion or movement of materials;
iv. Process waste and is related to any additional unnecessary operations taking place. This occurs due to rework, reprocessing, handling or storage which takes place due to defects, overproduction or excess inventory.
v. Inventory, not directly required in fulfilling demand or capacity. Inventory includes raw materials, work-in-process and finished goods and requires additional handling and space.
vi. Inefficient work methods, motion or unnecessary activities performed by employees and equipment. This is due to inefficient process layout, defects, reprocessing, overproduction or excess inventory. It also includes unnecessary motion time that adds no value to the product or service.

vii. Defects affecting the quality in products or services and require rework and leading to possible loss of sales.

However, the research highlights the importance of supply chain optimisation and continuous improvement when applying lean principles. [xxiv]

Lean Processes and Lean Synchronisation

Lean operations identify customer values by analysing all the activities required in producing the products and services. It is therefore an attempt to optimise the entire process from a customer perspective by removing waste and delays. [vii] [xx]

In order to apply the above principle, the research involved the study of the cause-and-effect relationship between dependent and independent variables. The research embarked on a comprehensive formal descriptive study which examined the effect it has on dependent and independent variables.

According to the research, waste can be described in terms of lean and aims to meet demand instantaneously, with near perfect quality and no resultant waste. Waste therefore contributes to underachievement of process capability, competitive priorities and performance.

However, the objective of lean synchronisation is to ensure that the flow of products and services transpire according to customer needs, in exact quantities, when and where needed, at the lowest possible cost throughout the entire supply chain. It requires that items flow rapidly and smoothly through processes, operations and supply networks. Lean synchronisation therefore assists organisations to achieve their goals with limited and various resources that are available and at the same time optimises the supply chain. [xv] [vii] [xvi] [xxv]

It is important that deliberate actions must be taken to eliminate waste. This will ensure that organisations and managers institute corrective measures which should reduce, control or eliminate any problems. Therefore organisations should develop a system of continuous improvement focusing on eliminating waste, reducing cost and improving the effectiveness of business processes. [xxii] [xxii] [xxiv]

In order to become lean (reducing waste/increasing customer value), organisations are generally expected to follow five core lean objectives. These five core principles concern: [xxvii] [xxviii] [xxvii] [xxviii]

i. Specifying value, where value is established in terms of customer needs.
ii. Value stream analysis. Value stream analysis is executed by examining processes and activities that are required to deliver a product/service according to customer requirements in order to identify activities that add value, as well as those that do not, in order to eliminate activities which do not add value. Value stream analysis includes the entire set of actions required to align product and service from (1) concept, (2)

design, (3) engineering, (4) launch, (5) order taking and (6) delivery to the customer.

iii. Creating conditions for value to flow smoothly through the stream. Steady and smooth value-creating activities in the value stream without stops, delays, interruptions and defects.

iv. A customer pull system. Organisations should "only" produce goods or services as required by the customer.

v. Pursuing perfection. A continuous striving for improvements and better capability. Organisation members should continuously work towards reducing costs and improving quality.

As a result of the above lean organisations set their sights explicitly on perfection: continually declining costs, zero defects, zero inventories and endless product and service variety. Therefore the endless quest for perfection leads to continuous improvement which requires the following phases of implementation: [xvii] [xix] [xx] [xxvi]

Phase 1: Using operations to compete in and manage effective projects;
Phase 2: Designing and managing processes by developing a process strategy, analysing processes, managing quality, planning capacity, managing process constraints and designing a lean system;
Phase 3: Designing and managing supply chains by designing effective supply chains, integrating supply chains, locating facilities, managing inventories, forecasting demand, planning and scheduling and planning sufficient resources;
Phase 4: Redesigning business processes.

Business Process Redesign

Redesigning business processes requires dedicated and specific actions to be undertaken. It is a systematic approach for analysing processes in order to identify opportunities for improvement.

It starts with process analysis and requires steps identifying opportunities for process improvements and ends with implementing a revised process before going back to the first step, thus creating a cycle of continuous improvement.

There are many approaches to systematically analysing and redesigning processes. The research identified the following as the most useful: (1) process reengineering, (2) implementing the Six Sigma improvement model, (3) implementing quality management and value stream mapping and finally (4) designing lean systems. [ix] [xi] [xii] [xiii] [xiv]

However, whatever approach is taken, supply chain capabilities in terms of lean should always be considered when optimising processes and resources.

Supply Chain Capabilities

Supply chain management is one of the core competencies required in any organisation. Supply managers and organisations should focus their decision-making process on proactively improving and optimising their supply processes. It is important that supply chain objectives should be clearly stated according to lean principles and competitive priorities. [xx]

All processes in the supply chain should contribute towards a mix of quality, speed, dependability, flexibility and cost. Therefore, the supply chain should be continuously monitored to identify any signs of waste. This calls for a close relationship and partnership between customer and supplier. [ix] [x]

The research conducted clearly shows that the supplier relationship contributes towards the success of the processes' capability and performance. In addition, the results obtained show that when considering to implement lean, consideration should be given to what impact process variation (due to waste) has on balancing demand according to design capacity, available capacity and actual capacity.

In terms of lean capacity, utilisation and performance measurements should be recognised. It is therefore essential when measuring lean that measurements should include the following: [xvi] [xxi] [xxii] [xxiii]

i. Resource planning and control system interface with customers;
ii. Resource planning and control system interface with suppliers;
iii. Integration of resource planning and control information;
iv. Application of lean synchronisation throughout the supply network;
v. Understanding of lean synchronisation within the organisation;
vi. Calculation of "waste" caused by any variability and quality within the operations processes;
vii. Integration of inventory information into all inventory decisions;
viii. Exploration and application of all JIT principles;
ix. Itemisation and assessment of all inventories;
x. Exploration of methods of reducing waste and inventories.

In conclusion, the success of lean and improvement strategies lie in the ability of business processes to perform at a desired level of performance and excellence. This can only be achieved if:

i. performance standards and compliance principles have been determined. This should include all business processes during all appropriate stages of lean implementation and business process capability measurements.
ii. performance standards as well as the responsibility and accountability of all stakeholders regarding set standards on all businesses processes (from end-to-end) have been properly communicated and understood.
iii. the organisation can identify suitable measurement techniques that are aligned to enterprise-wide goals and are integrated within the organisations.
iv. the measurement of business process performance involved all stakeholders and employees.

v. measurement techniques are understood and results are communicated to all stakeholders, employees and supply chain managers.
vi. an organisational quality culture is installed and aligned towards continuous improvement by means of measurements and standards.
vii. capacity utilisation and performance measurement results are recognised in achieving lean synchronisation according to the business capability strategy.

Research Process

The objective of this research is to develop an analytical instrument for measuring processes capability and performance. Therefore, a framework was designed as a measuring instrument that will enable organisations to assess the status of business process capability and be able to identify limitations impacting on capability. This will assist the organisation to make informed analyses and judgments on whether the organisation or business unit is successfully applying lean, lean synchronisation and continuous improvement in an attempt to achieve capability, performance and excellence. [vi]

In order to apply the above, the researcher designed the research that involves the identification and determination of causes and interrelationships of dependent and independent variables impacting on lean, lean synchronisation and processes optimisation. [xviii]

The result of the research had to be found in the application of an analytical instrument measuring lean and capability performance. Therefore, a measuring instrument that assesses whether organisations or business units are successfully applying lean in an attempt to achieve capability and performance has to assess according to the following criteria. [ix] [x] [xxv]

i. Continuous improvement, conformance and quality management;
ii. Elimination of waste in terms of distinct types of waste as experienced in a lean management system;
iii. Leadership, employee involvement in terms of supply chain objectives based on competitive priorities;
iv. Visual management systems that attempt to improve organisational performance through connecting and aligning organisational vision, core values, goals and culture with other management systems, work processes, workplace elements and stakeholders.

Lean Factor Items

Research results revealed that lean and lean systems affect the entire organisation. It clearly highlighted that lean implementation is not just about the application of a set of tools, but it is about the application of systematic methods and principles

of lean. Successes of lean implementation depend on how lean practices are implemented within the larger context of lean rules.

Organisations should therefore continuously seek methodologies to measure and assess their capability status. To achieve this the organisation, people, employees and stakeholders should participate in self-assessment, as it should allow organisations to identify strengths and weaknesses as improvement opportunities and to enable the measurement and monitoring of progress in a systematic analytical way. [xxvi]

The intent throughout the study was to determine the existing interrelationship between factors impacting on developing a framework which analyses factors impacting on lean.

The statistical analysis process and integration of multiple methods, techniques, results and findings consisted of the following:

i. The development of factor items to facilitate the development of the measuring tool.
ii. Performing the necessary statistical testing of factor items clustered as part of the critical factors enabling organisations to increase and improve process optimisation inclusive of the application of lean.

The assessment and measurement focuses on 14 broad spectrum critical factor items. See Table 1: Factor Item Description. Critically analysing all data by means of Pearson's correlation and Cronbach's Alpha values enabled the researchers to determine if there is any interrelationship, relevancy, validity or reliability of note between the factor items. The following factor items were included in the study:

Table 1: Factor Item Description

	Factor Description
1	Supply chain objectives are clear so that each process and product design throughout the chain contributes towards a mix of quality, speed, dependability, flexibility and cost that the end customer requires.
2	Risk assessment of supply chain lean application is conducted.
3	Operations capacity measurement balances process variation focusing on demand and capacity.
4	Capacity utilisation and performance measurement results are recognised in achieving lean synchronisation strategy.
5	Resource planning and control system interface with customers.
6	Resource planning and control system interface with suppliers.
7	Resource planning and control information is integrated.
8	Lean and lean synchronisation is applied throughout the supply network.
9	Lean and lean synchronisation is understood and applied within the organisation.
10	"Waste" caused by variability and quality is calculated within the operational processes.
11	Inventory information systems integrate all inventory decisions.
12	JIT principles are explored and applied throughout the

	organisation.
13	Performing "things" cost effectively by means of lean application.
14	Elimination of waste – under or over utilisation of resources.

Research Results

Pearson's and Cronbach's Alpha Result Output

Results obtained from statistics of 14 factor items show a clear global picture. All fourteen factor items using SPSS were subjected to Cronbach's Alpha validity, reliability and correlation analysis. The results obtained indicated that all factor items are accepted to be relevant, valid and reliable. The statistical results using SPSS Output (Table 2) show that all factor items have a high Cronbach's Alpha reliability coefficient indicating a good internal consistency between the factor items measured. It is therefore accepted that all 14 factor items measured according to the underlying (or latent) construct are relevant, valid and reliable. [xxv] [xxvi]

Table 2: Inter-correlation and Cronbach's Alpha Result Output

	INTER–CORRELATION														Total Inter-Correlation	Cronbach's Alpha
Factor	1	2	3	4	5	6	7	8	9	10	11	12	13	14		N=14
1	1.000	.799	.805	.804	.759	.849	.848	.681	.641	.777	.824	.754	0.615	0.734	.866	.982
2	.799	1.000	.812	.784	.785	.805	.752	.703	.690	.754	.817	.748	0.608	0.705	.847	.982
3	.805	.812	1.000	.856	.803	.824	.770	.786	.755	.774	.821	.827	0.545	0.704	.895	.982
4	.804	.784	.856	1.000	.856	.835	.768	.795	.779	.849	.868	.816	0.668	0.692	.902	.982
`5	.759	.785	.803	.856	1.000	.871	.798	.747	.702	.798	.850	.811	0.669	0.694	.881	.982
6	.849	.805	.824	.835	.871	1.000	.866	.717	.725	.797	.834	.744	0.665	0.734	.875	.982
7	.848	.752	.770	.768	.798	.866	1.000	.754	.676	.831	.829	.720	0.77	0.82	.860	.982
8	.681	.703	.786	.795	.747	.717	.754	1.000	.885	.845	.805	.811	0.669	0.72	.845	.982
9	.641	.690	.755	.779	.702	.725	.676	.885	1.000	.827	.756	.831	0.768	0.784	.816	.983
10	.777	.754	.774	.849	.798	.797	.831	.845	.827	1.000	.861	.845	0.83	0.809	.908	.981
11	.824	.817	.821	.868	.850	.834	.829	.805	.756	.861	1.000	.846	0.784	0.829	.928	.981
12	.754	.748	.827	.816	.811	.744	.720	.811	.831	.845	.846	1.000	0.831	0.879	.915	.981
13	0.609	0.567	0.528	0.639	0.638	0.665	0.77	0.669	0.768	0.83	0.784	0.831	1	0.928	0.851	0.971
14	0.615	0.608	0.545	0.668	0.669	0.734	0.82	0.72	0.784	0.809	0.829	0.879	0.928	1	0.831	0.972

Cronbach's Alpha Results

The Cronbach's Alpha values for all fourteen (14) factor items are greater than $\alpha \geq 0.80$ and are accepted as relevant, valid and reliable.

Pearson's Correlation

SPSS Output results measuring reliability and internal consistency indicate that all factor items are to be considered consistently internally correlated. The results obtained on all factor items indicate an inter-correlation relationship and no factor item Pearson's coefficient at less than < 0.50. Overall, the Pearson correlation results obtained indicate a relatively high correlation amongst all items suggesting that they are measuring the same construct within.

However, a concern has been identified as it seems that organisations do not apply lean process optimisation strategies to do "things" more effectively or eliminate waste in terms of under or over utilisation of resources. This does impact on supply chain objectives and competitive priorities contributing towards a mix of quality, speed, dependability, flexibility and cost.

Lean and Process Optimisation

To ensure that an organisation's lean and process optimisation strategy is in place it must be aligned to supply chain and operational process capabilities. This requires continuous process improvement in terms of lean strategies. This includes a clear definition in terms of implementation supporting strategies boosting process optimisation objectives. These process optimisation strategies include:

i. Ensuring the quality of doing things right and providing error free goods and services;
ii. Eliminating the waste of resources;
iii. Ensuring that the lean process synchronisation strategy is part of the organisation optimisation and capability strategy;
iv. Ensuring customer satisfaction and competitiveness.

It is critical to the success of a lean initiative that process capacity utilisation and performance measurement results must be achievable in order to gain competitive advantages.

Furthermore the analysis of research results indicates a concern when organisations embark on implementing lean principles. It has been found that numerous organisations do not have a strategy in place and therefore cannot fully reap the benefits of lean and lean synchronisation. Some of the comments in Table 3 summarise serious concerns regarding lean application.

Table 3: Lean Application Concerns

Factor Item	Comment – Serious concerns are raised regarding lean application and lean synchronisation.
1	Supply chain objectives are not clear so that each process and product design throughout the chain contributes towards a mix of quality, speed, dependability, flexibility and cost that the end customer requires.
2	Risk assessment of supply chain vulnerability is not conducted.
3	Operations capacity measurement does not balance the process variation focusing on demand and capacity.
4	Capacity utilisation and performance measurement results are not recognised in achieving lean synchronisation strategy.
5	Resource planning and control systems do not interface with customers.
6	Limited resource planning and control system interface with suppliers.
7	Limited resource planning and control information is integrated.
8	Lean synchronisation is not applied throughout the supply network.
9	Lean synchronisation is not understood within the organisation.
10	"Waste" caused by variability and quality is not calculated within the operational processes.
11	Inventory information systems do not integrate all inventory decisions.
12	JIT principles are not explored and applied.
13	Bottlenecks are not identified and their effect on the smooth flow of items through operations and processes is not evaluated.
14	Inventories are not itemised and assessed. Methods of reducing waste and inventories are not explored.

Lean Performance

Results obtained indicate that a limited application of lean has been achieved. The results obtained indicated serious concerns regarding the process capabilities of suppliers. It is important that supply chain objectives must be clear, enabling every business process and product design contributing towards a mix of quality, speed, dependability, flexibility and cost. Little risk assessment of supply chain vulnerability is measured in terms of balancing operations capacity processes variation with demand and capacity.

Lean Framework

To implement a lean framework, organisations should consider embracing the following interphases:

i. Lean synchronisation should be applied throughout the supply network and be understood within the organisation.
ii. Waste caused by process variability and quality should be calculated for all operational processes.
iii. JIT principles should be explored and applied.
iv. Inventory information systems should integrate all inventory decisions.
v. Methods of reducing all types of waste in the supply chain should be explored.
vi. A continuous improvement strategy for the entire organisation should be formulated focusing on eliminating "waste".
vii. Resource planning and control systems should interface with customers.

viii. Resource planning and control systems should interface with suppliers.
ix. Integration of resource planning and control information systems should be done.
x. Resource and capacity utilisation and performance measurement systems should be introduced.
xi. Smooth flow of items through operations and processes should be evaluated and improved.
xii. Application of Lean Sigma should be considered.

Summary

An organisation must have an optimisation vision and strategy in place as part of their strategic plan to increase process capabilities as process optimisation strategy defines process performance objectives that result in customer satisfaction and competitiveness.

Carrying out work, meeting standards and the provision of error free goods and services, fulfilling internal and external customer needs are imperative. It is important that a clearly defined "lean" strategy must be in place to ensure that the measurement and analysis of the cost of quality is applied. In doing so waste will be identified and eliminated and will ensure improvement in speed, dependability, flexibility and cost.

A final observation from the results obtained is that although lean and lean synchronisation do have a relatively high priority, it is not applied effectively within organisations leaving a concern as to how serious organisations are with respect to applying lean principles.

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