



Technical paper

Performance of Lean in large organisations

Sanjay Bhasin*

NOMS College, Stretton-under-Fosse, Warwickshire, CV23 0TH, United Kingdom

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ABSTRACT

The paper focuses upon an in depth investigation to decipher whether larger organisations embracing Lean as a philosophy were indeed more successful. Achievement was measured by the impact an organisation's Lean journey had on its financial and operational efficiency levels.

An adapted balance scorecard was utilised which embraced strategic, operational and indices focused towards the organisation's future performance. The methodology principally analysed primary data meticulously captured from 68 survey questionnaires undertaken in manufacturing organisations in Britain representative of small, medium and large entities. Subsequently extensive case studies were undertaken in seven companies as a comprehensive validating exercise.

The results revealed that the larger organisations viewing Lean as an ideology performed better; this was exposed by applying the balance scorecard to the respective Lean implementations. Evidently concoctions of inputs were deemed essential for this situation to exist. A research limitation would noticeably invoke a natural extension by replicating the investigation in a non-manufacturing environment. The creativity value of the research demonstrates that the results suggest that whilst considerable investment is required for organisations to be deemed to be embracing Lean as an ideology; nonetheless, this does result in the respective organisation benefiting from greater levels of efficiency.

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1. Introduction

Lean is a business model that delivers far superior performance for customers, employees, shareholders and society at large. Whilst this entails delivering to the customer exactly what is required, it also involves freeing up capacity to deliver more value from existing resources with fewer additional costs [1]. Allegedly, less than 10% of UK organisations accomplish successful Lean implementations [2]. The benefits from Lean are not always obvious [3]. In the last two decades a plethora of performance measurement systems dwelling both on qualitative and quantitative perspectives have emerged [4]. This investigation scrutinizes the performance levels of large organisations implementing Lean as opposed to the medium and small organisations. The literature is inconclusive. Equally, it is considered that the findings will be of enormous help to both Lean managers and organisations embarking upon their Lean journeys by distinguishing the possible focus of concentration. The article proceeds to advocate preventative actions British manufacturing organisations should pursue in their efforts to improve their implementation records. In order to make a distinction between company sizes, the prevailing British classifications [5], is used to

clarify this. It states that to be regarded as small or medium it is necessary to fulfil any two of the criteria listed in Table 1.

2. Literature research

Shah and Ward [6] examined three organisational characteristics; namely unionisation, plant size, and plant age. The empirical evidence was constrained to one or two facets of Lean, often JIT or TQM. 22 individual Lean practices were selected and pooled into 4 bundles; namely JIT, TPM, TQM and human resource management. All practices connected to production flow were shared to form the JIT bundle. Whilst it has been advocated that older plants employing older work forces are more resistant to the changes; the evidence suggested that older plants are less likely to implement only five practices relative to newer plants. Literature suggests that large plants are more likely to possess the resources to implement Lean practices [7]. The findings are consistent with other sources [8]. Larger plants are more likely to extensively implement all but five of the Lean practices. Shah and Ward [6] found that four bundles; namely JIT, TQM, TPM and HRM displayed a positive correlation with operational performance. As a group they accounted for 23% of the variations in operational performance even after accounting for the effects of industry and organisational context.

To reliably measure organisational performance, there is a need to adopt a more holistic and comprehensive approach to performance assessment [9]. The Balanced Scorecard established the

* Correspondence address: 15 Kelway, Binley, Coventry CV3 2XP, United Kingdom. Tel.: +44 01788 804147; mobile: +44 07974 778558.

E-mail addresses: sanjay.bhasin@noms.gsi.gov.uk, s.bhasin@btinternet.com

Table 1
Classification of British organisation.

	Small	Medium
Turnover (less than or equal to)	£3.1 millions (net) £3.76 millions (gross)	£12.2 millions (net) £14.5 millions (gross)
Aggregate gross assets (less than or equal to)	£1.9 millions (net) £2.18 millions (gross)	£6.6 millions (net) £7.72 millions (gross)
Number of employees (less than or equal to)	50	250

momentum for this viewpoint [10–13]; other contributors provided the foundation for this work [14,15,1,29,30]. Traditional means of measuring results through accounting methods fails to incorporate the true valuation of an organisation's intangible and intellectual assets [16]. It is also advocated that aspects such as shrinking the lead time are more critical to the long-term future of the organisation [17]. There are many reasons why **business performance measurement systems** have become more topical; the literature indicates that:

- traditional accounting systems allocated overheads on the basis of direct labour; presently, this rarely constitutes more than 5% of the cost of goods sold [18],
- the increased level of global competition faced by organisations encourages them to compete on service, flexibility, customisation and innovation [16,19],
- varying external demands as customers not only expect high levels of service but also expect firms to operate in identifiable ways [20,21].

By 2000 intangible assets became the major source for competitive advantage. Tangible assets accounted for a book value of less than 20% of companies' market values [22]. The problem remains how to quantify intangible assets; frequently intangible assets such as knowledge affect financial outcomes through chains of cause and effect linkages involving several stages [22,38]. Often they need to be bundled with other intangible and tangible assets to demonstrate any creation of value [18]; an example would be a newly devised growth strategy which requires customer knowledge, training for sales employees, new databases, new information systems, a new organisational structure and an incentive compensation program [23]. Concentrating on just one or, all but one, of the above could cause the new strategy to fail [24].

Vinodh and Balaji [16] suggest that by managing and improving processes associated with the customer, employee, supplier and the organisational perspectives would ultimately improve the financial standpoint. Non-financial measures such as quality, customer satisfaction and innovation have become increasingly important [8]. Some advocate that the traditional emphasis on profit is short-term and any measurement of success should be congruent with company strategy [25]. Financial measures, undoubtedly, focus on the past and survival in the longer term depends on customer service [26,27,39]; this can be measured by factors such as quality, cycle time, employee skills and productivity.

Sustained Lean success does not materialise from targeting opportunities in a haphazard manner using few of the Lean tools [7,21,36,39]. To build a sustainable Lean foundation that consistently yields dramatic company-wide improvements on a global basis necessitates a roadmap [20]. It is maintained that there are three "inhibitors" (p. 28), why performance can be impaired. The first is variability, i.e., fluctuations in demand; secondly waste and thirdly, inflexibility whereby the company cannot react to changes in demand, or alter its working practices. In this case, a "technical solution" (p. 29), is needed, i.e., value stream mapping. Moreover, a management system is needed to ensure that the solutions are

adhered to. However, coupled with this is an effective change management policy; without any of these three elements the philosophy breaks down [19,21,34,38]. It is also suggested that many mediocre companies focus on performance measures relating to internal processes without a strong correlation or linkage to the customer needs in the respective targeted markets [9,28,31,35]. Whilst benchmarking and best practices can yield positive results, if not careful, the company can be lead in the wrong direction by focusing on the same processes and practices of the industry, without paying sufficient emphasis on the customer [16,33,34,36,39].

3. Research methodology

The methodology played a major role in substantiating the findings. In order to secure validity and reliability, two separate data capture instruments were used. Principally the data was captured through meticulous **survey questionnaires** undertaken in sixty-eight manufacturing organisations; this was subsequently complemented by extensive **case studies** undertaken in seven organisations which assisted to validate the findings. The survey questionnaire was split into the following categories with several or more questions in each category to determine the:

- underlying reasons for the Lean adoption,
- the barriers encountered,
- how Lean was tracked internally,
- the aspirations from Lean,
- application of the Lean tools,
- the cultural factors influencing Lean, and
- concluded with a **scorecard to measure the impact of Lean as outlined below.**

Equally the stratification was chosen to represent the discrete characteristics. The companies were grouped in terms of:

- geographical location,
- size (in view of turnover, people employed and aggregate gross assets),
- differing level of Lean adoption,
- age of the organisation,
- time since Lean had been instigated,
- degree of process intricacy,
- extent of product complexity,
- levels of success and
- from a selection of varying manufacturing sectors.

Since the survey is predominately **cross sectional** in nature, it was imperative that it generated a high level of confidence. Consequently, the survey questionnaire formed an ideal method to extract this information. In order to combat the potential shortcomings of surveys efforts were made to:

- ensure that interview bias was not present,
- certify that the data was not affected by interactions of interviewer/respondent,
- stress to respondents that their information was to remain anonymous,
- consider the over reliance on standardisation; it could have resulted in developing questions general enough to be minimally appropriate for all respondents,
- possibly missing what was most appropriate to many respondents,
- deter inflexibility in that they require the initial study design (the tool and administration of the tool) to remain unchanged throughout the data collection,

- bear in mind that it may be difficult for participants to recall information or to tell the truth about a controversial question.

3.1. Credibility of the research findings

A key issue for any investigative enquiry is its credibility; the extent to which the data obtained is both relevant and valuable. Anderson [14] summarises that whilst the concepts of validity and reliability are difficult to understand; both can be better comprehended by a set of questions. Questions relating to reliability, which this research considered, were:

- whether the methods used would generate the same results on other similar occasions?
- would similar observations be reached by different observers?
- is it easy to understand how raw data has been collated and analysed?

The questions relevant to validity were:

- the difference, if any, that the context of the investigation would have made to the data generated?
- to what extent has the enquiry process itself influenced the possible responses?
- how easy was it to separate cause and effect in the data?
- the certainty that other factors (intervening variables) had not affected the data and
- to what extent would the research results be generalisable?

3.2. Reliability and validity

The case studies permitted the appraisal from a more holistic perspective. An added appeal was that the evidence could be analysed from a positivistic or a phenomenological perspective. Consequently, results can be synthesised in a manner that permits a proposal of a theoretical conjecture or even be used as evidence to support or contradict an established theory. Nonetheless, by inquiring about multiple sources of evidence; in the case of both managers and operatives, the validity and reliability of the research was greatly improved. By using multiple case studies it was considered that the evidence would be more compelling and the results additionally robust. Eight informants were used in each case study; the split was as follows:

- two managers interviewed in a semi-structured manner using interview schedules,
- two shop floor operatives interviewed in a semi structured manner again utilising interview schedules,
- two different managers were requested to complete a questionnaire,
- two different shop floor operatives were also asked to complete a questionnaire.

Attempts were made to measure the reliability of the responses to questions in both questionnaires and interviews [37]. “*Test re-test method*” (p. 186) suggests asking the same people, the same questions on two separate occasions. The responses on the two occasions were then correlated and the correlation coefficient of the two sets of data calculated. This provided an index of reliability. However, the problem was convincing individuals to partake in this exercise. Consequently this was only undertaken on a few respondents in the cases concerning the survey questionnaire, the interview schedules and the questionnaires. Moreover, the “*split-halves method*” whereby the responses were split by compiling a separate pile for responses to the first half of the questionnaires and to the latter half. Equally, the two piles were then correlated and

Table 2
Performance template.

Category	Actual measurement
Finance	Earnings per share Current ratio – [current assets – current liabilities] Rate of return on capital employed Profit after interest and tax
Customer	Market share by product group Customer retention rate Responsiveness (customer defined) Service quality Customer satisfaction index On – time delivery (customer defined)
Process	Material costs Time to market for new products Capital efficiency Quality ratings Quality costs Manufacturing costs Quality of new product development and project management processes NPD lead time Finished goods inventory Labour productivity Defects of critical products/components Stock turnover WIP materials inventory Raw material inventory Space productivity Cycle time
People	Retention of top employees Health and safety per employee: I. labour turnover II. absenteeism III. accidents Quality of professional/technical development Quality of leadership development Employee perception surveys
Future	New market development New technology development Anticipating future changes Depth and quality of strategic planning % sales from new products (<5 years)

the correlation coefficient of both sets of the data construed. This was undertaken for several survey questionnaires, interview schedules and questionnaires. Nonetheless, it was evident that whilst the questions reflected a satisfactorily high reliability rating, there is little indication of their respective validity. In order to combat this, every effort was made to ensure that the questions closely corresponded to the purpose of the study. Often this could be gauged by surmising the level of interest the respondents displayed in answering the questions.

3.3. Scorecard utilised

Table 2 depicts a scorecard which formed part of the survey questionnaire and was used in the research to determine the impact of Lean on the respective organisations. It was crucial to broaden the determination beyond the financial analysis alone. A performance model [30] was adapted to gauge the impact of Lean on organisations. Consequently, the performance measures in assessing whether an organisation was successful as a result of adopting Lean espoused the DMP framework [30] embracing the five dimensions together with the other guidelines offered [4,10–13,15,29,32,33]. The Maltz et al. [30] model was adopted since its multi-dimensional context looks at the possible future direction of an organisation; its flexibility permits the appropriate set of measures to be tailored towards the firm's size, technology, strategy, and characteristics of the relevant industry and environment in which the firm operates.

Table 3
Case study responses related to the spread of Lean.

Managers opinion regards the spread of Lean within the organisation		
	Interview	Questionnaire
Lean occurs across the whole value chain	0.0%	0.0%
Lean is in our company only	0.0%	0.0%
Lean is in manufacturing and supply only	0.0%	0.0%
Only a few isolated tools are used	0.0%	0.0%
Lean is in manufacturing or supply sections	42.9%	28.6%
Lean is in some units of manufacturing or supply	57.1%	71.4%

The effect of Lean on the customers, internal processes and people was sought through the various indices listed in the second column of Table 2. In total 36 indices were used to make an informed judgement on the actual impact of Lean on the organisation. The performance factor (sum of the five categories averages) was considered to provide an accurate indication of each organisation's performance. The sixty-eight surveys completed comprised this scorecard in the survey; respondents were requested to quote a percentage improvement or deterioration against each index as a direct consequence of adopting Lean by each respective organisation. The following performance categories were used in line with the DMP framework:

- financial, focused on an organisations liquidity and profit margins,
- customer led indices appraised the organisation from the customers' perspective,
- the process suite of indices were selected to deduce an organisation's manufacturing effectiveness,
- people parameters specifically investigated how the organisation treated its staff,
- the future group of indices were viewed particularly innovative when compared with previous performance models. Indices such as "new market development" were regarded to ascertain an organisations capability to sustain and improve.

4. Results

A prevailing factor that emerged from the analysis suggested that larger companies were more successful as a consequence of adopting Lean. As a result of the scorecard devised, it was feasible to identify the impact of Lean on the performance of the respective organisations. The best fifteen performing organisations comprised of the top 22% of all the 68 companies; large companies accounted for 47% of this figure. Whilst an initial judgement could easily be forwarded that the larger companies are more successful; however, since a greater number of larger companies were surveyed, further analysis was undertaken.

4.1. Factors contributing to the performance of larger companies

Exhaustive analysis of small, medium and large organisations guided towards certain causal factors affecting the performance of the respective organisations. Undeniably, an important consideration was the application of Lean across not just the internal organisation, but also the entire value chain. As previously outlined, the literature states the need to embrace Lean across the whole value chain in order to reap the full benefits. The seven case studies investigated the extent of Lean within each organisation. Both interview schedules and questionnaires posed this question to different managers and the results are summarised in Table 3. Equally the 68 organisations that engaged with the survey questionnaire were posed the same question with the results reflected in Table 4. The results from the organisations participating in the

Table 4
Survey responses regards the spread of Lean.

Surveys' response regards the spread of Lean within the organisation	
Across the manufacturing or the supply function only	20%
Across manufacturing and supply functions only	20%
Across the whole value chain including an attempt to involve suppliers	30%
Across some, but not all, units of manufacturing or supply	30%
Embrace a few isolated tools i.e., kanban or 5's in parts of some departments	30%
Across the whole internal organisation	40%

surveys were more buoyant than the case studies; undoubtedly there was room for some embellishment of the results which was not feasible within the case studies. Moreover, there was an element of bias since it was either managers or the Lean champions who introduced Lean to the organisation that acted as respondents to the survey questionnaire.

In comparison the results of the survey questionnaire are summarised in Table 4.

Since the information above, was generic to the whole investigation, an important discovery was made in reference to the state of Lean within the small, medium and large organisations. Table 5 confirms that despite larger organisations occupying a higher proportion of the sample, two out of five applied Lean across the whole value chain. This contrasts with small and medium organisations whereby only one in five organisations applied Lean across the whole value chain. This issue is reinforced by the responses given regards the expectations from Lean; when asked about the possibility of improving the supply chain as an on-going aspiration, the responses received were:

- 74% of the large organisations,
- 53% of the medium sized organisations, and only
- 47% of the small organisations stated it as an aspiration.

Furthermore, an important component extracted from the sixty-eight organisations was to determine the span of Lean in reference to departments and employees. Despite smaller organisations, as depicted in Table 6 revealing that a higher percentage of employees and departments operated under Lean, it should be documented that after considering the size of some of the larger organisations, that the results are still remarkable.

Inevitably, it was anticipated that small organisations would perform better since the number of employees and departments would always favour them; though extraordinarily the larger organisations outperformed medium sized organisations.

4.2. Cultural factors impacting upon the larger organisations

The prevailing literature states that underlying virtually every Lean failure is the fundamental issue of corporate culture and change management. Consequently, it was critical to investigate the impact of culture and assess whether it contributed towards the superiority of larger organisations. When confronted with the question on the survey questionnaire of whether "The organisation promotes a culture which maintains the challenges of existing processes by proactive systems such as Standard Operating Procedures" (Question E8) a response of 1–10 was sought with "10" suggesting total agreement; the following results were achieved:

- 77% of large organisations scored a 7–10,
- 57% of medium sized organisations scored a 7–10, and only
- 42% of small organisations scored a 7–10.

Table 5
Extent of Lean adoption.

Extent to which Lean is administered within the organisation	Small organisations	Medium organisations	Large organisations
Lean applied to whole value chain including suppliers	20%	25%	40%
Lean is administered within the whole internal organisation	80%	25%	43%

Table 6
Lean adoption by company size.

Departments and employees operating under the Lean umbrella	Small organisations	Medium sized organisations	Large organisations
Proportion of an organisation's departments operating under the Lean umbrella	77.9%	49.7%	56.5%
Proportion of an organisations employees operating under Lean	78%	48.4%	58.5%

Likewise, when respondents were asked whether “*The organisation offers customer assistance to suppliers and maintains Supplier Development Teams*” (Question E9) the following results were recorded:

- 23% of larger organisations scored a 9 or 10,
- only 6% of medium sized organisations scored a 9 or 10, and
- 0% of the small organisations managed to score a 9 or 10.

4.3. Lean tools in application

The literature is unwavering in its view that for Lean to succeed, **six or more appropriate and timely Lean tools need to be simultaneously applied within the organisation**. The entire sixty-eight organisations were investigated to discover the length of time the various Lean tools had been implemented within their organisations and the results are summarised in Table 7.

Information was also gathered from the seven case-study organisations regards the deployment of tools; managers views were sought both in the questionnaires (Table 8) and the interview schedules (Table 9) as is summarised below.

Pleasantly, there was considerable agreement; in fact whilst the ranking slightly differed, there was total concurrence regards the **top five tools engaged** within the seven organisations:

- TPM,
- attacking value and the seven wastes,
- process mapping,
- 5's and general visual management and
- kaizen/continuous improvement.

Table 7
Time Lean tools had been in operation.

Survey responses regards the length of time tools have been embraced within the organisations	Years
Step change/Kaikaku	1.5
Single piece flow operations	2.1
Single Minute Exchange of Dies [SMED]	2.4
Supplier base reduction	2.7
Supplier development – activating links with suppliers	3.2
Total preventative maintenance	3.4
Kanban systems	3.6
Attacking value and the seven wastes	3.7
Cellular manufacturing	3.8
Process mapping	3.9
5's and general visual management	4.0
Continuous improvement/kaizen	5.4

Table 8
Tools embraced through questionnaires.

Questionnaire responses from managers regards tools embraced within their organisations	%
Step change/Kaikaku	10.0
Supplier development–activating links with suppliers	11.4
Single Minute Exchange of Dies (SMED)	15.0
Supplier base reduction	30.7
Single piece flow operations	37.1
Cellular manufacturing	40.7
Kanban systems	50.7
Attacking value and the seven wastes	52.1
Total productive maintenance	53.6
Process mapping	64.3
5's and general visual management	68.6
Kiazen/continuous improvement	72.9

Nonetheless, of considerable concern were the results on the following:

- **supplier development and**
- **supplier base reductions**

which appeared very low on the list.

To consolidate this evidence, responses from the survey questionnaires undertaken in the sixty-eight organisations also revealed the following information regards the tools deployed within the organisations; this is depicted in Table 10.

Whilst the case studies were in agreement regards the top five tools engaged within the seven organisations and pleasantly only one ranking order diverged, the top five tools were also identical to those indicated in the survey questionnaires:

Table 9
Tools embraced through interviews.

Interview schedule responses from managers regards the Lean tools embraced within their organisation	%
Step change/Kaikaku	21.4
Single Minute Exchange of Dies (SMED)	25.7
Supplier development – activating links with suppliers	26.4
Cellular manufacturing	35.7
Single piece flow operations	39.3
Kanban systems	43.6
Supplier base reduction	47.9
Total productive maintenance	57.9
Attacking value and the seven wastes	58.6
Process mapping	59.3
5's and general visual management	65.7
Kiazen/continuous improvement	69.3

Table 10
Survey – tools embraced.

Survey responses regards the Lean tools embraced within their organisation	
Step change/Kaikaku	33%
Single Minute Exchange of Dies [SMED]	41%
Supplier development – activating links with suppliers	42%
Supplier base reduction	43%
Single piece flow operations	48%
Cellular manufacturing	61%
Kanban systems	64%
Total productive maintenance	65%
Process mapping	65%
Attacking value and the seven wastes	75%
5's and general visual management	81%
Continuous improvement/kaizen	83%

Table 11
Time on the Lean journey.

Managers opinion of the time span their organisation has embraced Lean			
Interview schedule		Questionnaire	
1–2 years	7.1%	7 months–1 year	0.0%
0–6 months	14.3%	1–2 years	14.3%
7+ years	14.3%	7+ years	14.3%
5–6 years	28.6%	5–6 years	28.6%
3–4 years	35.7%	3–4 years	42.9%

- TPM,
- attacking value and the seven wastes,
- process mapping,
- 5's and general visual management and
- kaizen/continuous improvement.

The case studies attempted to attain further credibility of the results; there was a consensus view with **over 70%** of the respondents agreeing that their respective organisation had been on the Lean journey for between **three to six years as** depicted in **Table 11**; equally only 14.3% considered their organisation to have been on the Lean journey in excess of seven years. The seven case-studies also investigated the time span the organisations had been on the Lean journey; again differing managers were posed this question.

In an effort to further split the analysis, **Tables 12A–12C** depict the prevailing situation in small, medium and large organisations surveyed respectively. It is apparent that whilst the breadth of tool application may not be higher, but the length of time the tools have been implemented is certainly longer in larger organisations (**Table 12C**).

To validate this point, the listed top six tools in small, medium and large organisations were taken to achieve an average application. It was discovered that larger organisations performed much better; the average length that the top six quoted Lean tools had been in operation was:

Table 12A
Tools **in smaller organisations**.

Lean tools	Years
Single piece flow operations	1
Supplier base reduction	1.2
Single Minute Exchange of Dies [SMED]	1.3
Step change/Kaikaku	2.1
Supplier development – activating links with suppliers	2.2
Cellular manufacturing	2.5
Kanban systems	2.7
5's and general visual management	3.3
Total productive maintenance	3.3
Attacking value and the seven wastes	3.4
Continuous improvement/kaizen	3.5
Process mapping	3.8

Table 12B
Tools in medium organisations.

Step change/Kaikaku	0.8
Supplier base reduction	0.9
Single Minute Exchange of Dies [SMED]	1.3
Single piece flow operations	1.6
Kanban systems	1.9
Supplier development – activating links with suppliers	2.1
Cellular manufacturing	2.2
Total preventative maintenance	2.4
Process mapping	2.5
5's and general visual management	3.1
Attacking value and the seven wastes	3.3
Continuous improvement/kaizen	5.1

Table 12C
Tools in large organisations.

Step change/Kaikaku	1.6
Single piece flow operations	2.7
Single Minute Exchange of Dies [SMED]	3.2
Supplier base reduction	3.8
Total preventative maintenance	3.9
Attacking value and the seven wastes	4.0
Supplier development – activating links with suppliers	4.0
Process mapping	4.5
5's and general visual management	4.5
Kanban systems	4.6
Cellular manufacturing	4.8
Continuous improvement/kaizen	6.0

- 4.7 years for large organisations,
- 3.3 years for the small sized organisations, and
- 3.1 years for the medium sized organisations.

Likewise, a similar exercise was undertaken within the Survey questionnaires to deduce any differences between the organisations of different sizes surveyed regards the tools in application. A considerable degree of conformity existed. All three sizes of organisations had identical top seven tools. Whilst the rank varied slightly, the top seven tools were the same as depicted in **Tables 13A–13C**.

The top seven tools were as follows:

- attacking value and the seven wastes
- kaizen,
- general visual management,
- total productive maintenance,
- kanban systems, Process mapping and
- cellular manufacturing.

4.4. Tracking of the Lean results

Equally significant, was the nature in which the Lean results were traced in the respective organisations. The sixty eight

Table 13A
Survey responses to Lean tools adopted in large companies.

Tools large organisations adopted	
Step change/Kaikaku	36%
Single Minute Exchange of Dies [SMED]	50%
Supplier development – activating links with suppliers	53%
Single piece flow operations	55%
Supplier base reduction	55%
Kanban systems	63%
Cellular manufacturing	67%
Total productive maintenance	67%
Process mapping	72%
Attacking value and the seven wastes	74%
5's and general visual management	83%
Continuous improvement/kaizen	84%

Table 13B

Survey responses to Lean tools adopted in medium companies.

Tools medium sized organisations adopted	
Supplier base reduction	29%
Step change/Kaikaku	30%
Supplier development – activating links with suppliers	30%
Single Minute Exchange of Dies [SMED]	34%
Single piece flow operations	46%
Cellular manufacturing	51%
Process mapping	51%
Total productive maintenance	52%
Kanban systems	60%
Attacking value and the seven wastes	69%
5's and general visual management	75%
Continuous improvement/kaizen	79%

Table 13C

Survey responses to Lean tools adopted in small organisations.

Tools small sized organisations adopted	
Single Minute Exchange of Dies [SMED]	22%
Supplier development – activating links with suppliers	22%
Supplier base reduction	23%
Step change/Kaikaku	25%
Single piece flow operations	28%
Cellular manufacturing	57%
Process mapping	61%
Kanban systems	69%
Total productive maintenance	74%
5's and general visual management	83%
Continuous improvement/kaizen	84%
Attacking value and the seven wastes	85%

Table 14A

Tracking of the Lean results.

Survey responses regards how Lean is tracked within the organisation	
Reviewed at board meetings only	10%
Ad-hoc process reviews	30%
Half yearly process reviews	40%
Weekly process reviews	50%
Quarterly process reviews	60%
Monthly process reviews	70%

Table 14B

Small organisations tracking of the Lean results.

Survey responses regards how Lean is tracked in small organisations	
Half yearly process reviews	30%
Ad-hoc process reviews	30%
Weekly process reviews	50%
Monthly process reviews	50%
Quarterly process reviews	70%

organisations surveyed revealed interesting information regards how the companies tracked the results of Lean; Table 14A is a summary for all surveyed organisations; Tables 14B–14D further breaks this down for small, medium and large organisations respectively.

Again various proponents have stressed the importance of instigating a process of systematically tracking the results, hence

Table 14C

Medium sized organisations tracking of the Lean results.

Survey responses regards how Lean is tracked in medium organisations	
Other (please specify below)	13%
Half yearly process reviews	19%
Quarterly process reviews	31%
Weekly process reviews	38%
Ad-hoc process reviews	44%
Monthly process reviews	63%

Table 14D

Large organisations tracking of the Lean results.

Survey responses regards how Lean is tracked in large organisations	
Reviewed at board meetings only	18%
Ad-hoc process reviews	33%
Half yearly process reviews	50%
Weekly process reviews	60%
Quarterly process reviews	65%
Monthly process reviews	83%

ensuring remedial and timely action can be taken when required. When the respondents in the respective organisations were asked how often the Lean results are tracked, the following information became apparent regards the weekly and monthly tracking:

- large organisations: 60% weekly and 83% monthly too,
- medium sized organisations: 38% weekly and 63% monthly, and
- the smaller organisations, 50% weekly and 50% monthly.

5. Limitations of the research

Any potential issues surrounding validity, reliability and generalisability were never relinquished. A superior extent of validity and reliability was secured than would have been the case with a single methodological approach as surveys were supplemented by seven case studies. Equally a cautionary observation is required in reference to the performance measures utilized. The survey respondents were informed that their responses should take into account the naturally projected growth rates and that the research was concentrating solely on the impact of Lean in their organisation.

6. Contribution of the research and general conclusions

The preceding analysis illustrated that **successfully implementing Lean is both difficult and time consuming**. When applied appropriately it aids competitiveness by improving overall performance as reinforced by the top performing organisations in which the survey questionnaire was undertaken and validated by the case studies. The findings revealed a noteworthy consensus that larger organisations performed better. **Every organisation's Lean journey is unique and to simply recommend replicating another organisations Lean change process would be imprudent since the cultures, organisational pressures and supporting infra-structures vary between companies**. Evidently, traditional performance measures do not work in a Lean environment. The performance factor (the sum of the five category averages from the adapted scorecard used in this research) was considered to provide a clear-cut indication of each organisation's performance. The performance factor took into account the overall 36 indices looking at the respective organisations:

- financial standing,
- customer related indices,
- process based performance,
- people and
- indices looking at the organisation's future prospects.

Whilst investment is required for Lean, the research demonstrated that parallel levels of performance improvements could also be realised. Important insights from the research for any progressive managers and organisations contemplating Lean can be established. There are certainly significant and pertinent lessons that should be learnt from the research if the purpose is to improve the potential rates of implementation within manufacturing organisations in the UK; namely:

- the wider application of Lean; an important deduction was the importance of applying Lean across not just the internal organisation,
- but the entire value chain. **Larger organisations seem to operate Lean to a greater extent across the value chain.**
- the importance of **supplier involvement** was also conveyed; this was reinforced by highlighting it as an aspiration to involve suppliers at an early stage of their implementation journey,
- the investigation exposed that **every organisation is unique** and is likely to have distinctive problems and constraints,
- develop and **implement Lean performance indices.** The Lean benefits are not always obvious since the connection between financial and non-financial measures is fragile. In simplest terms,
- manage and **improve processes associated with the customer,**
- employee, supplier and the organisational perspectives; accordingly,
- the financial standpoint will improve. The traditional metrics have not worked; this was witnessed within the case studies; namely the **traditional accounting measures are not suited for strategic decisions; they are historical and difficult to correlate; they provide little information on the root problems; intangible assets are awarded modest attention and that they largely ignore value creation.**
- a recognition that all Lean journeys start under different conditions,
- so there does **not exist a unique recipe.** Organisations need to recognise that there is no simple formula or directives to follow which guarantees success,
- **develop a pilot** and make it a success; proceed this by celebrating and publicizing the success; extend the pilots until Lean is implemented. Predominantly within both the sixty eight companies surveyed and the seven case studies, a trend emerged whereby within the implementations progressing well, a pilot driven approach was evident,
- the prevailing literature states that underlying virtually every Lean failure is the **fundamental issue of corporate culture** and change management. The supporting cultural considerations need to be in place to support the appropriate environment ensuring Lean is successful,
- encourage the **involvement of all parties** to secure authorship, ownership and buy-in. **Lean cannot be viewed in the narrow sense of a set of tools, techniques and practices,** but rather needs to be observed as a holistic approach that transcends the boundaries of the shop-floor,
- the transition to Lean requires considerable effort; experience, shows that sustained Lean success does not come from targeting opportunities in a haphazard manner using few of the Lean tools. **To build a sustainable Lean foundation that consistently yields dramatic company-wide improvements on a global basis necessitates a roadmap.** Likewise, there is a need to embed the changes in formal policies, procedures, processes, work standards, job descriptions and skill classifications,
- the research illustrated that implementing Lean can be extremely elaborate. Often absent from Lean implementations are the organisational development aspects that act as a mechanism to hold things together. This includes **a change management process aligned to the culture, a performance reward structure; pay systems, a performance measurement system and workforce organisation.**
- the literature is resolute in suggesting that for Lean to succeed in an organisation that **six or more appropriate and timely Lean tools need to be simultaneously applied** within the organisation. This was reinforced by the successful large organisations whereby both the quantity and length of time the Lean tools were found to be in operation for a longer period.

An important deduction from the research was that larger organisations proved to be more successful as a consequence of implementing Lean. The overall analysis tended to focus towards several factors contributing towards this situation. An important aspect being that Lean was adopted more extensively in larger organisations; an investigation of the **application of Lean across an organisation's value chain** found that **20% of smaller organisations, 25% of medium sized and 40% of the larger organisations** stated that they administered Lean across the whole value chain. In inquiring whether the continuous improvement of the supply chain was an on-going **aspiration; 47% of small, 53% of medium and 74% of the larger organisations** stated that they continue to aspire towards this objective despite larger organisations already performing better than their counterparts.

Likewise, a greater number of the cultural features were found to be more conducive in the larger organisations. Similarly the literature states that a combination of the appropriate tools and culture is required for Lean to succeed. It was found that there was a wider application of the Lean tools in the larger organisations; an exhaustive analysis of the top six tools was carried out to determine the average length of application. It was discovered that the average length the top six quoted Lean tools had been in operation was 3.1 years for medium sized organisations, 3.3 for the small and 4.7 for the large sized organisation. It was also discovered that a **more robust tracking system existed within the larger organisations.** A scrutiny of the 68 organisations surveyed regarding the tracking of Lean results both weekly and monthly found the following results; 50% of the smaller organisations tracked both weekly and monthly; 38% weekly and 63% monthly for the medium whereas it was 60% and 83% respectively for the larger organisations. Experience, shows that sustained Lean success does not come from targeting opportunities in a haphazard manner using few of the Lean tools. To build a sustainable Lean foundation that consistently yields dramatic company-wide improvements on a global basis **necessitates a roadmap.**

7. Future research

A noticeable natural extension would be to replicate the investigation undertaken but in a non-manufacturing environment. The principal emphasis throughout this enquiry centred on the appropriate tools, processes, cultures and performance management of Lean within the UK manufacturing companies. The application of Lean within the health service, for instance, has witnessed a major intensification since 2004 and the literature still depicts a sketchy implementation record. It would be particularly useful to determine:

- any similarity of the barriers which are encountered,
- the level of significance of both change and cultural issues,
- whether the Lean journey mirrors the stages depicted within this investigation,
- the key issues in attempting to implement appropriate performance measurement systems,
- whether the time span towards high levels of sustainability are comparable to the manufacturing sector and
- the relevance of the complexity of processes within an organisation in attempting to secure a Lean system.

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