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Full Length Research Paper

Improving quality and productivity at an automotive component manufacturing organisation in Durban - South Africa

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The manufacturing sector is considered to be an important industry in any country and is often plagued with a significant degree of competition. In order to cope with this competition, organisations attempt to improve their manufacturing operations by using different tools and techniques to reduce costs and improve profits. This study investigated the existing lean manufacturing tool of an automotive organisation in Durban. The objective of this study was to identify the strengths and weaknesses of the current lean manufacturing process in improving quality and productivity. An empirical study was conducted, using a survey questionnaire with an assessment score ranking to gather and evaluate employees' responses pertaining to this lean application in their production environment. The quantitative method of research was adopted. The results of the study showed evidence of misalignment and inconsistencies for lean manufacturing in the organisation. Several important findings on the implications of lean activities that affect manufacturing performance were revealed. The study concluded that a significant gap exists between the actual adoption of lean manufacturing on the shop floor to those that are documented.

Key words: Lean manufacturing, automotive industry, operational performance, quality, productivity

INTRODUCTION

Background of the study

Satisfying customer expectations and demands are inevitable. The way a business reacts to achieve these expectations and demands impacts on its competitiveness and profitability. Karatepe and Ekiz (2004: 476) cite in Parasuraman et al. (1991: 32) where increasing global competition, understanding customers' expectations and meeting customer needs are critical if superior service quality is to be delivered. This places organisations all over the world under tremendous pressure to reduce their costs, increase their service levels and supply goods of superior quality. In order to meet these goals and remain more competitive, organisations embark on the use of many different tools, techniques and strategies to make their production processes more efficient. In addition, organisations are always searching for ways to optimise business processes so that they can reduce manufacturing costs. Stemming from this desire, Yandell (2002: 19) contends that organisations are turning to lean manufacturing as a way of rapidly reducing production costs, improving quality and providing superior customer service.

Similarly, Columbus (2008: 2) claims that organisations adopt lean manufacturing to control waste and to create greater value.

Acknowledging Toyota as the world benchmark, lean manufacturing evolved purposefully over time in North America. Lean manufacturing is reaping astonishing rewards in productivity, quality and customer satisfaction each year.

It is the symbol of efficiency and optimal performance since the 1980's, and is mainly due to its association with the Toyota automotive industry (Alony and Jones, 2008: 165; Sassenberg, 2008: 36). With a wide practice in

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many organisations and consequent improvements, it appears from literature that lean manufacturing is a broad collection of principles and practices that has improved organisations' performance.

Problem statement

The extent of the current global financial crisis has led to many job losses in South Africa's automotive industry. In 2008, General Motors South Africa reduced its employees by 1000, as a result of the decline of new vehicle sales and as part of a drive to improve efficiencies and their overall competitiveness (The Citizen, 2009: February 18). Several other motor manufacturers, including Volkswagen South Africa and Mercedes-Benz South Africa, have also; either reduced the number of employees or are looking at the possibility of doing so. On the other hand, the Ford Motor Company of Southern Africa has implemented a four-day production week, which is expected to remain in place until there is a change in economic conditions (http://www.southafrica.info/news/business/24083.htm, 09-02-09).

The organisation represented in this study is based in Durban, South Africa. It has established a global footprint in the international automotive industry and is a leading manufacturer of engine cooling systems and service parts. This organisation's philosophy of "Top Performance in vehicle air conditioning and engine cooling" as reflected in their Management System Manual (2004: 19) has ensured its place as a preferred partner within the global automotive industry. In keeping with the international top performance, the organisation continuously develops ways to achieve world class manufacturing to survive in the present economic conditions (Selected Organisation's Management System Manual, 2004: 19).

Currently, this organisation faces similar challenges like the rest of the global manufacturing community. The organisation had to reduce their sales forecast for 2008 significantly owing to the decrease in orders from their customers as published in their Organisation's magazine (2008: 3). Many of these customers found themselves in an overstocked position due to the fall in market demand and have thus reduced their orders even further. Likewise, the organisation in this study had to reduce their planned sales in 2009 to reflect in accordance with the local and global market demand (Selected Organisation's Magazine, 2008: 3). Profit margins have been eroded as a result of reduced turnover.

Although there has been a decrease in sales volumes during the past year, problems such as process defects, excessive scrap, inaccurate inventory levels, and defective products supplied to customers, continue to surface. Therefore, in an attempt to continually satisfy customer requirements, this organisation adopted selected lean manufacturing practices.

Aim and Objectives

The aim of this research is to develop a framework to improve the current lean manufacturing process in an automotive component organisation while the objective of the study will be to analyse the repercussions of this organisation's lean manufacturing principles on process and quality improvement.

Hypotheses

H_0: There is no difference in responses between positions and departments for each statement in the respective category on lean adoption.

H_1: There is a difference in responses between positions and departments for each statement in the respective category on lean adoption.

LITERATURE REVIEW

Lean manufacturing was derived from the Toyota Production System (TPS) in Japan, and can be traced back to the borrowed concepts and practices of Henry Ford and other predecessors (Emiliani and Stec, 2005: 370). Similarly, Andersson et al. (2006: 283) provide strong empirical support of other quality management concepts such as Total Quality Management, Value Engineering and Six Sigma.

These concepts also had their origin in Japan and revolve around minimising waste and resources while improving customer satisfaction and financial results. More specifically, Total Quality Management centres on customer satisfaction, Value Engineering concentrates on systematically improving the value of products and services and Six Sigma drive towards processes to reduce defects by minimising variation. These authors further postulate that the lean manufacturing concept appears to be the more wide-spread and successful attempts when compared to other quality management concepts.

The term "lean manufacturing" focuses on producing value-added features while identifying and eliminating non-value-added activities in the production environment. The central focus of value, according to Womack and Jones (1996: 19), should be on providing products with specific capabilities, offered at predetermined prices, through a dialogue with predefined customers. To understand how this concept applies to industry, Carreira (2005: 2) distinguishes "value-added" as an activity that makes a product more complete from "non-value-added" as an activity which does not advance the product to a finished state.

In order to focus on all activities that create value, Hines et al. (2006: 873) propose that it is essential to have an alignment between strategic goals and operational activities. Yandell (2002: 19) contends that traditional organisations grow both value-added and non-value-added operations in order to increase production and profits. However, lean organisations should focus on reducing non-value-added activities by transferring efforts to those operations which add value, thus growing both production and profits without added resources.

There is extensive literature describing various viewpoints of lean manufacturing and its application in the different industries (Lee-Mortimer, 2006: 265; Papadopoulou and Ozbayrak, 2005: 797-798; Meier and Forrester, 2002: 104; Cooney, 2002: 1130). Results have shown significant improvement in the operational performance such as cost, quality, on-time delivery and inventory levels (Womack and Jones, 1996: 121). Several researchers have investigated the contents and methods of lean manufacturing, which resulted in the development of numerous models (Liker, 2004: 6; Sanchez and Perez, 2001: 1434; Karlsson and Ahlstrom, 1996: 26). Many of the models developed often have a lot of similarities or common points and are not necessarily new.

The model developed by Karlsson and Ahlstrom illustrated in Figure 1 incorporates the entire value stream lean enterprise network, therefore it was selected for discussion in this study. Based on this model and from the review of literature it can be established that lean manufacturing principles in the production environment are: waste elimination, continuous improvement, multi-functional teams, zero defects, just-in-time (JIT), vertical information systems, decentralised responsibilities, integrated functions and pull systems. These are defined in the following sub-sections.

Elimination of waste

According to the various authors (Taj, 2008: 219; Chase et al., 2006: 472; Heizer and Render, 2004: 596; Yandell, 2002: 19), waste can be defined as any activity that does not add value to the finished product. These can be excess inventory, unnecessary operations, scrap, rework or transportation. The core feature of this concept is that by reducing waste activities, more resources are made available to concentrate on those activities that add value to the product or service.

Continuous improvement

In arguing the main concept of continuous improvement, Bhuiyan and Baghel (2005: 761) insist that it should be based on a culture of sustained improvement that targets the elimination of waste in an organisation.

Multifunctional teams

According to Bicheno (2004: 144) and Heizer and Render (2004: 375), a multifunctional team consists of employees working together towards some common purpose whilst teamwork refers to an environment that creates and sustains relationships of trust, support, respect, interdependence and collaboration. Some authors (Olivella et al., 2008: 803; Santos et al., 2006: 68; Karlsson and Ahlstrom, 1996: 34) work on the perception that multifunctional teams are a salient feature and common concept of lean manufacturing and are best described as a group of employees that are organised along a cell-based part of the product flow and are able to perform many different tasks.

Zero defects

The concept of zero defects is a way of thinking and doing production tasks right the first time without manufacturing defects.

It is a philosophy that increases profits by eliminating the cost of failure and increasing revenues through increased customer satisfaction. According to Karlsson and Ahlstrom (1996: 30), an organisation that operates with zero defects indicates that the organisation works lean towards attaining quality. Lean organisations work towards greater process control and strive towards keeping the processes under control instead of controlling the part produced.

Just-in-time

The JIT concept was envisioned by Taichi Ohno at Toyota in the 1950's as a method for facilitating smooth flow (Womack and Jones, 1996: 58). According to Cooney (2002: 1132), JIT is central to the lean manufacturing concept as it drives the use of visual factory controls, continuous improvement activities and the delegation of enhanced responsibilities to the front line employees. Santos et al. (2006: 5) notes that the Japanese refer to the principle of JIT as parts that arrive exactly at the appointed time. Bayraktar et al. (2007: 849), Chase et al. (2006:474), Sanchez and Perez (2001: 1437) and Karlsson and Ahlstrom (1996: 32) are in agreement that in the production environment JIT simply means providing the required part, in the correct quantity, at the exact point in time. It can be seen as a "hand-to-mouth" operation with production and delivery quantities approaching one single unit. This means that only one component will move to the next operation when required at the correct time.

Vertical information systems

Womack and Jones (1996: 26) declare that transparency is the most important spur to perfection in a lean organisation. In addition, the authors stress that when

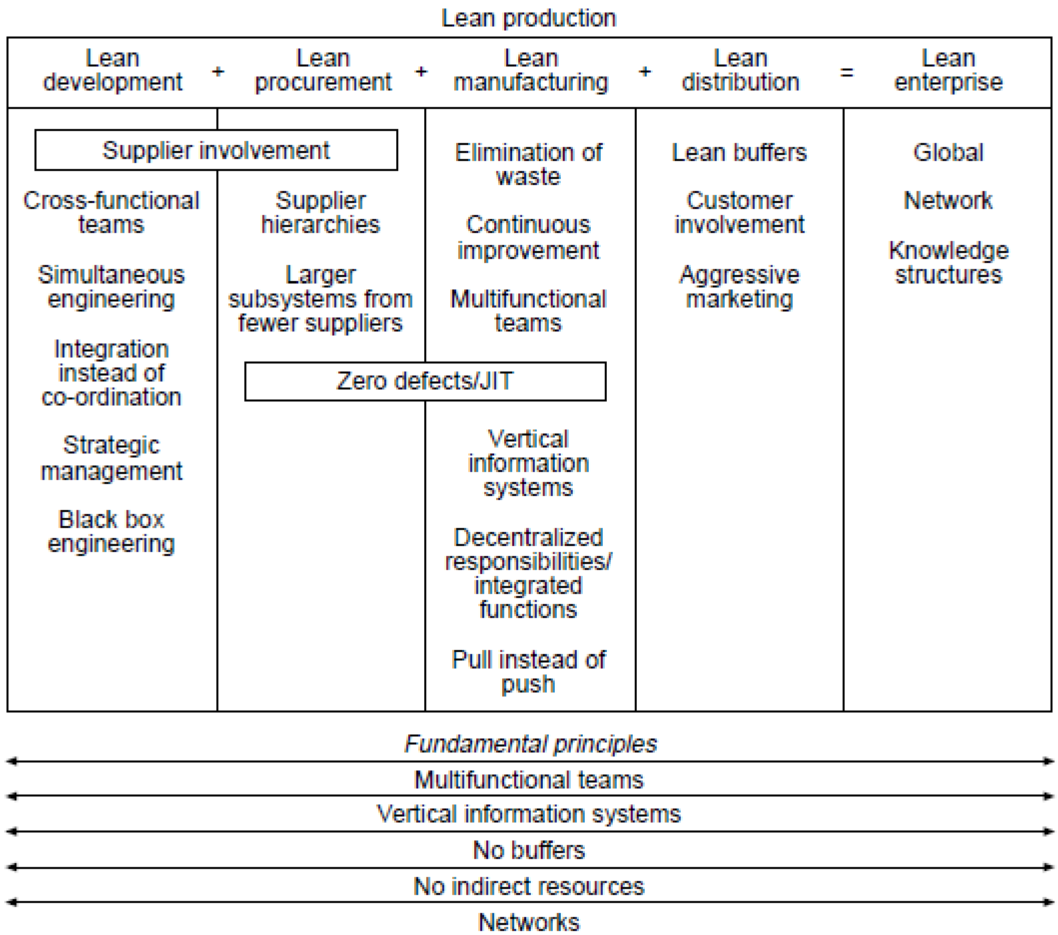

Figure 1. The principles of lean manufacturing (Adapted from Karlsson and Ahlstrom, 1996: 26).

important information is transparent and continuously provided to employees at all levels of the organisation, it allows them to discover better ways to create value. In view of the content of information that should be filtered through to the employees, Lee-Mortimer (2006: 270), Comm and Mathaisel (2005: 137), Sanchez and Perez (2001: 1440) and Karlsson and Ahlstrom (1996: 38-39) believe that it should be in the form of a strategic type as well as operational type which includes internal business processes and external outcomes.

Decentralised responsibilities

In terms of theory, decentralisation is the process of transferring and assigning decision-making authority to lower levels of an organisational hierarchy (Karlsson and Ahlstrom, 1996: 36). The lean thinking concept removes the employee's focus away from hierarchy such as departmental roles and responsibilities. According to Marsh and Blau (2007: 202), managers generally serve as facilitators in lean organisations. In addition, Sanchez and Perez (2001: 1437) and Karlsson and Ahlstrom (1996: 36) articulate that there is also no supervisory level in the hierarchy since responsibilities are decentralised onto employees and teams.

Integrated functions

The lean philosophy makes optimal use of employees' skills, thereby reducing indirect departments. According to Comm (2005: 64), Karlsson and Ahlstrom (1996: 37) and Forza (1996: 48), tasks previously performed by indirect departments are integrated into the functions of multifunctional teams.

Support functions such as the quality department in traditional production systems are reduced as lean manufacturing systems revolutionalise these functions through the integration of job responsibilities to employees on the shop floor.

Pull instead of push system

A "pull system", according to Womack and Jones (1996:

67), means that no one upstream should produce a part or service until the customer downstream requests for it. In this approach, Zylstra (2006: 186) contends that the "pull" method synchronises the upstream flow to actual demand and initiates replenishments to the consumption point.

In comparison to the traditional "push system", Liker (2004: 105-108) highlights that the purest form of "pull" is one-piece flow and is the ideal state of JIT manufacturing. Since the "pull system" corresponds with actual usage or consumption, lean organisations should constantly work towards achieving JIT replenishment. The "pull" approach completes the linkage by leveraging operating capabilities to meet customer demand and is the final link between customer requirements, internal operations and suppliers.

DESIGN OF RESEARCH AND METHODOLOGY

The research approach was based on an empirical study and an explanatory research design was used to fulfil the purpose of this project as suggested by Alam (2011). Babbie and Mouton (2001: 74-79) describe explanatory research as an investigation that provides causal explanations of phenomena. In addition, this study incorporated the quantitative research approach. Cooper and Schindler (2006: 198) articulated that quantitative research is often used for testing a theory and focuses on describing, explaining and predicting data with the use of statistical and mathematical methods. The initial step was to systematically study and define the history of lean manufacturing accompanied by its tools and techniques. The next phase examined the strengths and weaknesses of the current lean manufacturing principles used in the organisation chosen for this study through a survey method. The survey method was deemed appropriate as employees in the organisation could easily be accessed, as also reported by Alam et al. (2010: 775). The results of this study are applicable to this organisation and may not be generalised to all organisations, however the findings may be useful to organisations which have or are implementing lean manufacturing.

Survey instrument design

Survey-type questionnaires developed by other researchers (Yen, 2003: 1359; Meier and Forrester, 2002: 105; Sanchez and Perez, 2001: 1434; Karlsson and Ahlstrom, 1996: 26) in lean manufacturing were consulted to inform the design instrument of the questionnaire in this study. The content of the questionnaire was based on the nine lean manufacturing principles developed by Karlsson and Ahlstrom (1996:26) in their lean production model. To avoid any misconception or ambiguity by the participants, the researcher provided a short explanation of each principle, followed by the underlying questions that included words which were familiar to the participants. A covering letter of the questionnaire presented the purpose of the survey, including assurance of confidentiality, as recommended by Alam and Hoque (2010: 537). In addition, close-ended questions were adopted and the questionnaire was kept as short as possible since the research included the majority of employees in the production environment that have limited time to participate in the survey. The first part of the questionnaire required general details of the participants. This was to ensure that the results could be categorised in terms of departmental roles and job description in the organisation. The second part of the questionnaire was a list of the nine lean manufacturing principles, where the participants were required to rank the possibility of their adoption in their organisation's production system.

Pilot test and questionnaire modification

The questionnaire was pilot tested with twenty employees in the quality department at the organisation to determine the feasibility of the study. As identified by Alam and Hoque (2010: 537-538) that there were three common comments identified by the participants from the pilot test: namely, the questionnaire was too long, the content of questions was not clearly structured and many participants did not understand some of the terminology used. Furthermore, the participants reported that the questions needed to be designed such that the operators were able to understand the terminology used. In an attempt to amend the comments identified, the results from the Cronbach's alpha reliability analysis indicated that 11 questions were strongly negative and 18 questions were incorrectly answered or could have probably been misinterpreted. In addition, 10 questions were identified as inappropriate and could be eliminated. Following the feedback given by the participants and the results of the reliability analysis, the questionnaire was edited to reduce the number of questions and reformulated with the help of the quality manager and the production manager of the organisation, to enhance the accuracy of the results for the main study.

Sampling

The main study followed the same format as the pilot study; however, the purposeful method of non-probability sampling was used.

Purposive sampling is where researchers rely on their experience, ingenuity or previous research findings to collect information from sample members that are representative of the relevant population (Welman and Kruger, 2001: 63).

In response to establishing the appropriate sample size for this study, Sekaran (2006: 293-294) cites specific cases conducted by Krejcie and Morgan (1970) where they document representative predefined sample sizes for population ranges to ensure a good decision model.

Upon examining this documented sampling table, the appropriate sample size that represents a population of 600 equates to 234 and 650 equates to 242, respectively. In relation to this study, the population group at the selected organisation is 625. Therefore, through interpolation, a sample size of 238 participants was selected for this study.

It was decided to distribute 300 questionnaires to employees within the different departments over a three month period. These employees contributed to the daily operational activities that impact productivity, quality and customers at the organisation in the study. The questions were evaluated on a 5 point Likert scale; ranging from "do not agree at all" with a value of (1) to "agree fully" with a value of (5).

A total of 254 questionnaires were returned answered which indicated a good response rate of 85%. The sample included 24 managers, 27 supervisors, 11 engineers, 45 technicians, 14 administration, 23 auditors and 110 operators.

Method of data analysis

The Statistical Package for Social Sciences (version 18.0) was used to process the data. Each question was analysed individually in terms of validity, content and the frequency of responses. Construct validity and internal validity were used to verify the measuring instrument while the Cronbach's alpha test confirmed

Table 1. Results pertaining to the principle of waste elimination.

Question	Mean	Gap	Communality	p-value for DEPARTMENT	p-value for position	Cronbach's alpha
Products are manufactured only when required	3.1	-1.9	0.635	0.000	0.034	
Inventory in stores is kept to a minimum	2.9	-2.1	0.684	0.004	0.008	
The movement of material within the organisation is kept to a minimum	3.0	-2.0	0.637	0.261	0.547	
Operators or processes do not wait unnecessarily during production	2.6	-2.4	0.579	0.052	0.022	
Operators do not move excessively to complete a task	3.0	-2.0	0.614	0.000	0.168	
There are no unnecessary processing steps in production	3.1	-1.9	0.681	0.006	0.405	
Defects and scrap are constantly monitored	3.2	-1.8	0.640	0.002	0.239	
Employees are motivated to be more creative	3.2	-1.8	0.556	0.000	0.001	
Overall	3	-2.0	0.628			0.844

the reliability. The methods employed for analysing the data collected included descriptive statistics such as frequencies, means and gap values, and inferential statistics such as factor analysis, communalities and hypotheses testing.

The gap value represents the difference between the actual mean score and the hypothesized perfect score of 5. The emphasis on the average score of 3 should be that there were as many who “agreed” and as well “disagreed”. Reasons for this dichotomy would enhance the results.

Factor analysis is a statistical technique with the main goal of data reduction. A typical use of factor analysis, according to Gaur and Gaur (2009: 131-132) and Pallant (2005: 172), is in survey research where a researcher wishes to represent a number of questions with a small number of hypothetical factors. In addition, Gaur and Gaur (2009: 133) and Kinnear and Gray (2009: 568,573) explain that the communality of a given variable can be interpreted as the total proportion of its variation that is accounted by the extracted factors.

An assessment of how well the questionnaire model is doing can be obtained from the communalities. The ideal is to obtain values that are close to one. This would indicate that the model explains most of the variation for those variables. In the case of this study, the model is acceptable as it explains approximately 64% of the variation for the 41 variables.

The Pearson’s Chi-square test was performed to determine whether there was a statistically significant relationship between the variables (rows vs. columns). As suggested by Kinnear and Gray (2009: 409) and Pallant (2005: 290), a p-value is generated from a test statistic with a significant result indicated by "$p < 0.05$". The null hypothesis states that there is no association between the variables. The alternate hypothesis indicates that there is an association. The results in the main study indicate that there are differences between each statement and the respective category. All significant Chi square values are highlighted and are discussed in the results section.

RESULTS AND DISCUSSION

Elimination of waste

It is observed that the focal gaps in Table 1 were identified for question 4, 7 and 8. For question 4, it is understandable that customer centre would show a high level of “uncertainty” as they are not directly involved in the production process. The majority of “agreement” within the purchasing department could mean that since expediters are responsible to ensure components are readily available for operations, they do not believe that operators wait unnecessarily in production. In the position category, only supervisors show a marginal positive difference in “agreement”. This may be due to supervisors wanting to indicate that processes are running smoothly under their watch. The results for question 4

Table 2. Results pertaining to the principle of continuous improvement.

Question	Mean	Gap	Communality	p-value for department	p-value for position	Cronbach's alpha
All employees are asked to assist in solving problems	2.9	-2.1	0.638	0.005	0.001	
Training is provided for all employees on continuous improvement	2.9	-2.1	0.603	0.144	0.003	
Employees are motivated to come up with suggestions	3.5	-1.5	0.729	0.056	0.000	
Kaizen workshops are held to assist in improving operations	3.1	-1.9	0.613	0.191	0.002	
The Plan Do Check Act (PDCA) cycle is used to address problems	3.0	-2.0	0.564	0.009	0.000	
There is order and cleanliness in the organisation	3.4	-1.6	0.678	0.094	0.000	
Overall	3.1	-1.9	0.637			0.845

highlight significant improvement opportunities for unnecessary waiting time which is aligned with Bicheno (2004: 16) who surmises that waiting for parts in production affects lead time.

With majority of the participants "agreeing" with question 7, it can be deduced that these findings are beneficial to the organisation. There is substantial evidence by various authors such as Bendell (2006: 258), Rawabdeh (2005: 806), Carreira (2005: 62) and Liker (2004: 29) to confirm that monitoring of defects and scrap reduces financial losses and customer dissatisfaction. By position, the engineers and operators indicate the highest "disagreement" for this statement. The engineers' responses could possibly be related to their personal views when conducting trials and for which there are no reconciliation of the samples. On the other hand, the operators could possibly be relating their responses to defects that are identified at the source and reworked immediately, for which there is no record. By department, engineering showed the highest content of "disagreement" for question 8. These differences could perhaps be attributed to the different departmental management styles and the manner in which these managers motivate their teams. By position, operators were the majority of the employees who "disagreed" with the statement.

The high negativity in responses from operators is consistent with the findings of Sim and Rogers (2009: 37-46) who found in their study that shop floor employees (referred to as operators) do not believe that the organisation views them as the most important asset, requiring constant motivation. Similarly, the opinions of Worley and Doolen (2006: 231) and Dahlgaard and Dahlgaard-Park (2006: 275) indicate major discouragement in the lean effort when employees' views are not respected.

Continuous improvement

As can be seen in Table 2, questions 3, 4 and 6 indicate stronger patterns of "agreement" and have the largest gaps in this category compared to the others. In response to question 2.3, participants within departments "agree" with this statement. There is evidence to suggest that the existing suggestion scheme programme within the organisation is effective. These findings align with the views of Chase et al. (2006: 327) and Karlsson and Ahlstrom (1996: 29) who agree that the suggestion scheme programme is commonly used as a method of motivating employees to develop continuous improvement suggestions. The overall results of this study are similar to the findings of Lee and Peccei (2008: 22) of two Korean organisations which identified that rewards generally motivates employees as opposed to the job itself. By position as well, all categories of employees "agree" with the statement. As a natural consequence of suggestions that are not implemented, it could validate some responses of "disagreement". The findings highlighted for "disagreement" are in contradict-tion with the views of Bhuiyan and Baghel (2005: 766) who contend that employees are generally given

Table 3. Results pertaining to the principle of zero defects.

Question	Mean	Gap	Communality	p-value for department	p-value for position	Cronbach's alpha
Operators are responsible to identify defects	3.3	-1.7	0.690	0.165	0.000	
Operators are encouraged to stop the line should a defect occur	3.0	-2.0	0.602	0.162	0.000	
Operators are responsible to correct defects	2.9	-2.1	0.582	0.010	0.000	
Poka-Yoke devices are used to prevent defects	3.2	-1.8	0.653	0.011	0.000	
Overall	3.1	-1.9	0.632			0.832

explanations for suggestions that are rejected.

For question 4, Table 2 the overall responses of "uncertainty" within departments appears to be in contradiction with the views of Khan et al. (2007: 349-350) who indicate that Kaizen is used to identify better ways of working and is not restricted to any department in particular. By the position category, the major trend of "disagreement" lies within the operators. In retrospect therefore, it would appear that the different positions are not restricted to the operators only and are not included in Kaizen activities. Perhaps this was the reason for the responses of "disagreement" and "uncertainty". These responses are in contradiction with the views of Forza (1996:52) and Bhuiyan and Baghel (2005: 766) who indicate that Kaizen activities involve the collective effort of employees at every level of the organisation.

The positive responses for question 6 Table 2 revealed that the "5S" tool is correctly used in the organisation to maintain a clean and organised work environment. These results are consistent with the views of Motwani (2003: 345) who contends that a clean and organised working environment lays the foundation for all other improvements.

Zero defects

It is evident in Table 3 that questions 1 and 4 scores are high in terms of "agreement". The responses for question 1 indicate a high level of "disagreement" within the production department. In attempting to understand the negative responses from production, it can be concluded that since the actual operations take place within the production department, these employees should have the best knowledge as to whether the operators have the ability to identify defects or not. It can therefore be surmised that the overall consensus in "agreement" concurs with the findings of Lee and Peccei (2008: 5), who declare that the entire organisation should be responsible for the quality of products. By position, the analysis reveals that operators do not believe they are responsible for identifying defects. This belief is contradictory to the views of the authors (Lee and Peccei, 2008: 11; Chase et al., 2006: 474; Liker, 2004: 129; ReVelle, 2002: 183; Sanchez and Perez, 2001: 1436; Karlsson and Ahlstrom, 1996:30) who contend they should.

The contributing factors of "disagreement" for question 4, Table 3 could possibly be related to those departments that have immediate interaction with defects when they surface and for which there is no Poka-Yoke devices available to prevent them. By position, the operators share the highest content of "disagreement". Although there are positive responses from other positions, there is also a fair amount of "disagreement" between the technicians and auditors. Taken together, these positions are directly involved in production, which confirms that not enough Poka-Yoke devices exist within the organisation to prevent defects

Just-in-time

It can be concluded from Table 4 that questions 1 and 2 indicate an approximate 2:1 ratio of "disagreement" to "agreement". For question 1, the results within departments indicate a trend of "disagreement" for components being delivered to each workstation on time. By position, it is evident that with the exception of the administration category, all other positions do not believe that components are delivered to each workstation on time. The results obtained could possibly mean that processes constantly wait for parts during production. The responses to question 2, Table 4 are similar to those

Table 4. Results pertaining to the principle of just-in-time.

Question	Mean	Gap	Communality	p-value for department	p-value for position	Cronbach's alpha
Components are delivered to each workstation on time	2.7	-2.3	0.691	0.011	0.004	
Components are delivered to each workstation in the correct quantities	2.7	-2.3	0.747	0.130	0.047	
Correct components are delivered to each workstation	2.9	-2.1	0.709	0.018	0.001	
Overall	2.8	-2.2	0.716			0.821

Table 5. Results pertaining to the principle of multifunctional teams.

Question	Mean	Gap	Communality	p-value for department	p-value for position	Cronbach's alpha
Multifunctional teams exist within the organisation	2.9	-2.1	0.598	0.128	0.000	
Operators within each department know how to perform all operations	2.8	-2.2	0.543	0.008	0.009	
The organisation does not rely on designated employees to perform specific tasks	2.7	-2.3	0.458	0.819	0.078	
Tasks are rotated between operators within a department	3.0	-2.0	0.566	0.097	0.001	
Teamwork promotes trust, support, respect and collaboration	4.1	-0.9	0.795	0.480	0.680	
Overall	3.1	-1.9	0.592			0.593

highlighted in question 1 of Table 4. The highest contention of “disagreement” was within the production department. As such, it is not uncommon that since the production department works with these components they should have actual knowledge of the delivery of the correct quantities of components. There is a general trend of “disagreement” by the position category as well. These results also support the notion that there is a causal relationship between quantity and timeliness of components being delivered to workstations. The ranking of these factors is consistent with the principles of JIT and are aligned with the authors (Bayraktar et al., 2007: 849; Chase et al., 2006: 474; Sanchez and Perez, 2001: 1437; Karlsson and Ahlstrom, 1996: 32) proclaiming that it involves providing the required part, in the correct quantity, at the exact point in time during production.

Multifunctional teams

It can be inferred from Table 5 that questions 2 and 3 show a relatively strong “disagreement”, whilst question 5 indicates strong “agreement”. The responses for question 2 highlight that operators are designated to perform only their specific job functions and are not able to multitask. Within the context of the lean manufacturing concept, these results are in contradiction with the authors (Olivella et al., 2008: 803; Santos et al., 2006: 68; Karlsson and Ahlstrom, 1996: 34) positing that this principle allows employees to perform many different tasks. From the range of positions, the supervisors mainly “agree” with this statement. This may be due to the supervisors’ wanting to indicate that their immediate subordinates are expected to perform all operations in

Table 6. Results pertaining to the principle of decentralised responsibilities.

Question	Mean	Gap	Communality	p-value for department	p-value for position	Cronbach's alpha
Operators are given more responsibilities in production	2.8	-2.2	0.650	0.003	0.001	
The hierarchical level in the organisation is kept to a minimum	2.9	-2.1	0.531	0.000	0.000	
Operators are encouraged to make decisions concerning production and quality	2.7	-2.3	0.666	0.018	0.000	
Operators have real influence and power when they participate in decision making instead of serving as consultants	2.7	-2.3	0.631	0.067	0.000	
Overall	2.8	-2.2	0.619			0.745

their particular section.

For question 3, Table 5 the responses of “disagreement” indicate that there is no workforce flexibility in the organisation. To a certain extent, the functions within the production department should not be vulnerable to designated employees as this could lead the organisation to production downtime and losses. This is supported by the findings of Wallace (2004: 803) who reported that multi-skilling employees was used as a strategy in response to the high levels of absenteeism experienced in Swedish organisations.

All responses for question 5 Table 5 “agree” that team work is effective within an organisation. This result is consistent with the findings from the literature (Bicheno, 2004: 144; Heizer and Render, 2004: 375) that teamwork promotes trust, support, respect and collaboration within the organisation.

Decentralised responsibilities

As depicted in Table 6, there seems to be overall “disagreement” in this category. Even though independence and contributions by employees are encouraged, the marginal majority of employees do not believe that this takes place. This leads to the question of who should be given responsibility. From the literature, there is consensus among the authors (Olivella et al., 2008: 804; Chase et al., 2006: 474; Forza, 1996: 44) that employees should be assigned responsibilities for production, quality, maintenance and planning. The significant amount of evidence highlighted in literature proceeds to suggest that empowering employees encourages work performance and willingness to take added responsibility.

According to the results presented in Table 6, it can be inferred that question 1 indicates that the organisation does not have sufficient trust in the employees to allocate more responsibilities to them. Question 2 reveals that the organisation currently has a large range of positions in the hierarchical structure. Question 3 highlights that operators are not encouraged to participate in quality and productivity activities.

Question 4 suggests that employees are not respected for their opinions. There is no further analysis performed to investigate responses within departments and positions as there is overall disagreement for all questions.

One insight into decentralising responsibilities onto employees ensures that talent is spread throughout the organisation and not restricted to specific positions.

Integrated functions

The most significant gaps evident in Table 7 exists for question 1 and 3 since it shows stronger “disagreement”. In response to question 1, the results indicate that operators are restricted and are not given opportunities to multitask. From this viewpoint, there is contradiction with the findings of the lean manufacturing experts (Comm, 2005: 64; Karlsson and Ahlstrom, 1996: 37; Forza, 1996: 48) who stress that operators performing a broader range of tasks reduce indirect departments such as quality. Managers and supervisors, on the other hand, “agree” with this statement. In comparing the results, it makes sense for managers and supervisors to agree with the statement as they delegate and allocate tasks to the operators and expect results. There is high consensus in “disagreement” for question 3, Table 7. The findings are consistent with Schroeder (2007: 404) and Forza (1996: 49) who believe that employees’ loyalty and commitment is significantly influenced by appraisal schemes. Of particular interest, managers indicate a high level of uncertainty although they are responsible for deciding employees’ rewards. The tendency of employees not

Table 7. Results pertaining to the principle of integrated functions

Question	Mean	Gap	Communality	p-value for department	p-value for position	Cronbach's alpha
Operators are given a broader range of tasks	2.8	-2.2	0.591	0.000	0.001	
Sufficient training is provided to multi-skill employees	3.1	-1.9	0.576	0.712	0.013	
Employees are rewarded for learning new skills	2.6	-2.4	0.569	0.005	0.136	
Overall	2.8	-2.2	0.579			0.607

Table 8. Results pertaining to the principle of vertical information systems.

Question	Mean	Gap	Communality	p-value for department	p-value for position	Cronbach's alpha
The organisation is transparent in all aspects of the business	2.8	-2.2	0.663	0.016	0.008	
Strategic information such as the organisations market plans, and financial performance is communicated to all employees	3.0	-2.0	0.721	0.090	0.013	
Operational information such as productivity, timeliness and quality is communicated to all employees	3.2	-1.8	0.678	0.585	0.000	
Information is continually displayed in dedicated spaces throughout the organisation	3.3	-1.7	0.660	0.143	0.000	
Overall	3.1	-1.9	0.680			0.831

being rewarded for learning new skills is in contradiction with Schroeder (2007: 404) who believes that increased job responsibility and enlargement should be compensated for accordingly.

Vertical information systems

The majority of the participants do not believe that the organisation is transparent in all aspects of the business. Altogether, there is consensus in agreement for questions 2, 3 and 4 as depicted in Table 8. It can be inferred that necessary information relative to organisation performance, market plans and operational information is made available through various channels such as notice boards. For question 2, Table 8, the primary effect of providing strategic information to all employees creates an atmosphere of trust within the organisation, as suggested by Motwani (2003: 342). In relation to question 3, the effect of providing operational information is validated by the findings of Forza (1996: 47) who asserts that continuously providing operational information, allows employees to immediately acknowledge the problems identified. Lastly for question 4, Table 8 the overall positive findings are in consensus with the views of Bicheno (2004: 61) who documents that visual management allows employees to be responsive for day to day operations. The results for question 1, Table 8 indicate that since there are some aspects of the business available only to certain departments, this could be the result of the contradicting views in responses. The findings contradict the views of Womack and Jones (1996: 26) who believe that transparency allows employees to discover better ways to create value. As far as positions are concerned, it could mean that different

Table 9. Results pertaining to the principle of pull instead of push system.

Question	Mean	Gap	Communality	p-value for department	p-value for position	Cronbach's alpha
All employees have profound knowledge on how a pull system works	2.2	-2.8	0.627	0.003	0.036	
Production is made to actual customer demand rather than to forecasts	3.0	-2.0	0.696	0.437	0.004	
Each workstation pulls the output from the preceding process	2.9	-2.1	0.668	0.008	0.000	
A Kanban card system is used to signal when material is required	2.4	-2.6	0.697	0.001	0.004	
Overall	2.6	-2.4	0.672			0.773

job categories have exposure to various aspects of the business. The implication here is that only the managers and administration employees "agree" that the organisation is transparent in all aspects of the business.

Pull instead of push system

Some amount of training needs to be done with respect to Table 9, questions 1 and 4, as most employees do not know what a "pull system" is or the functioning of the Kanban card system. Majority of participants within departments "disagree" with question 1. The consensus in "disagreement" indicates that all employees need to be trained on the application of a "pull system".

These findings are important and supported by Dahlgaard and Dahlgaard-Park (2006: 274) who strongly contend that employees should have profound knowledge on the "pull system" in order for it to work. All positions, with the exception of the administration function, do not believe that employees have profound knowledge on how a "pull system" works. It makes sense for the administration functions to indicate "uncertainty" as they are not directly involved in operational activities.

For question 4 Table 9, the extent of "disagreement" is similar to those of "pull" instead of "push" and mirror each other closely. This makes sense, since a Kanban system is the classical signalling device for "pull" production as highlighted by the authors (Schroeder, 2007: 399; Bhasin and Burcher, 2006: 57; Papadopoulou and Ozbayrak, 2005:786; Bicheno, 2004:107). Since the organisation has common processes there is consensus with the views of Schroeder (2007:394) who concludes that Kanban systems are mainly used for repetitive manufacturing. A combination of the responses by position and department validate the strong overall negative response to the "pull" instead of "push" concept.

ACHIEVEMENT OF RESEARCH AIM AND OBJECTIVES

The aim of this study was based on the researcher's intention to create a framework that could evaluate the interrelationship of lean manufacturing in the existing production system as viewed by the employees. Under these circumstances, the study provided empirical evidence of a significant relationship between lean success factors and manufacturing performance. The factors that contributed to quality and productivity were identified through extensive literature review and the responses from the study that measured the application of lean techniques.

The results provided support to the objectives of the study. Firstly, the findings show the existing strengths and weaknesses of the current lean manufacturing process. Secondly, there is a significant, positive relationship between the findings highlighted in comparison to excessive scrap, process defects, inaccurate inventory levels and defective products supplied to customers. Thirdly, all the areas identified for improvement opportunities prevail that additional work is necessary to enhance the current lean manufacturing process in the organisation. On the basis of the relationship established, the empirical part of the study highlighted the following improvement opportunities for each of the nine lean manufacturing principles as represented in Table 10 and will represent the framework to improve the current lean manufacturing process within the organisation under study.

Conclusion

The organisation in which this research was undertaken has a well documented production system and is a good

Table 10. Improvement areas for lean principles (devised by researcher).

Lean principle	Improvement area
Elimination of waste	Operators or processes waiting unnecessarily in production Taking immediate corrective action when defects and scrap appear Encouraging employees to be more creative
Continuous improvement	Including more employees from the shop floor in Kaizen activities Maintaining order and cleanliness in the organisation
Zero defects	Instilling that all employees are responsible for the quality of products Increasing the use of Poka-Yoke devices
Just-in-time	Ensuring the correct quantity of components are delivered to workstations on time
Multifunctional teams	Eliminating reliance of designated employees for certain processes
Decentralised responsibilities	Allocating responsibilities to employees on the shop floor
Integrated functions	Training employees to multi-task Providing recognition or rewards for employees learning new skills
Vertical information systems	Transparency in all aspects of the business
Pull instead of push system	Training on “pull systems” Training on Kanban

practitioner of lean manufacturing, yet significant improvement opportunities were highlighted from the study for certain techniques.

It should be noted that even if an organisation claims to manufacture lean it may be possible to improve performance significantly. Hence, it can be deduced that organisations only practice certain tools and techniques but do not understand what makes them work together as a system. It can also be inferred that despite the wide knowledge and resources available, organisations fail to complete the transition from theory to practice. Both the above conclusions are consistent with Liker (2004: 12) from the review of literature. It can therefore be surmised that organisations which claim to successfully manufacture lean are very few. This study demonstrated that the research hypothesis is correct that there are certain lean manufacturing principles that are not adequately applied. The hypothesis is supported by the results of insufficient lean adoption, which reveal the extent and nature of the differences between the idealised prescription in the organisation and the reality on the shop floor. The most significant conclusion is what the organisation is currently doing and not what it should be doing.

This research is intended to improve productivity and quality through lean manufacturing. It is hoped that the research carried out demonstrates to the organisation in which this study was undertaken and other organisations that documented procedures should have structured follow up mechanisms to ensure sustainability. The research has also presented a checklist for monitoring and measuring the current lean process on the shop floor. In conclusion, it should be emphasised that the study contributes to literature by increasing the understanding of lean processes and performance from a South African perspective.

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ANNEXURE A

Part 1. Personal profile

A. Indicate your department
Production
Quality
Logistics
Maintenance
Purchasing
Customer Centre
Engineering

B. Indicate your position
Manager
Supervisor
Engineer
Technician
Inspector / Auditor
Operator
Administration

Part 2. Lean manufacturing principles.

		Strongly disagree	Disagree	Not sure	Agree	Strongly agree
Q.1	**<u>Elimination of Waste</u> - Any activity in production that does not add value to the finished product, such as excess inventory, unnecessary movements of employees, scrap, rework or transportation.**					
1	Products are manufactured only when required					
2	Inventory in stores is kept to a minimum					
3	The movement of material within the organisation is kept to a minimum					
4	Operators or processes do not wait unnecessarily during production					
5	Operators do not move excessively to complete a task					
6	There are no unnecessary processing steps in production					
7	Defects and scrap are constantly monitored					
8	Employees are motivated to be more creative					
Q.2	**<u>Continuous Improvement</u> – Continuous improvement is an ongoing effort by all employees to improve products, services or processes.**					
1	All employees are asked to assist in solving problems					
2	Training is provided for all employees on continuous improvement					
3	Employees are motivated to come up with suggestions					
4	Kaizen workshops are held to assist in improving operations					
5	The Plan Do Check Act (PDCA) cycle is used to address problems					
6	There is order and cleanliness in the organisation					

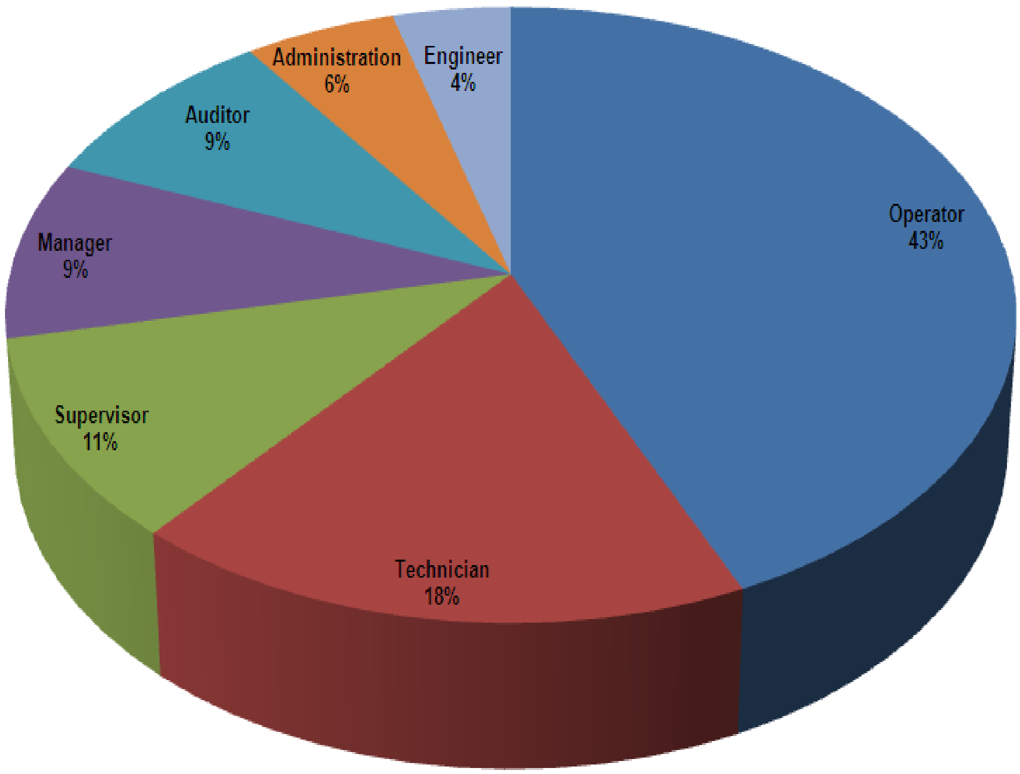
Q.3	**<u>Zero Defects</u> - Zero defects is a way of thinking and doing production tasks right the first time without manufacturing defects.**
1	Operators are responsible to identify defects
2	Operators are encouraged to stop the line should a defect occur
3	Operators are responsible to correct defects
4	Poka-Yoke devices are used to prevent defects
Q.4	**<u>Just-in-time</u> – It is a concept that controls inventory and material flow throughout the entire organisation. The philosophy involves providing the required part, in the correct quantity at the exact point in time.**
1	Components are delivered to each workstation on time
2	Components are delivered to each workstation in the correct quantities
3	Correct components are delivered to each workstation
Q.5	**<u>Multifunctional teams</u> – A group of employees that are organised in a particular work area and are able to perform many different tasks.**
1	Multifunctional teams exist within the organisation
2	Operators within each department know how to perform all operations
3	The organisation does not rely on designated employees to perform specific tasks
4	Tasks are rotated between operators within a department
5	Teamwork promotes trust, support, respect and collaboration
Q.6	**<u>Decentralised responsibilities</u> - The process of transferring and assigning decision-making authority to lower level employees in an organisation hierarchy.**
1	Operators are given more responsibilities in production
2	The hierarchical level in the organisation is kept to a minimum
3	Operators are encouraged to make decisions concerning production and quality
4	Operators have real influence and power when they participate in decision making instead of serving as consultants
Q.7	**<u>Integrated functions</u> – A philosophy that enables employees to perform many different tasks.**
1	Operators are given a broader range of tasks
2	Sufficient training is provided to multi-skill employees
3	Employees are rewarded for learning new skills
Q.8	**<u>Vertical information systems</u> - The transfer of information to all employees within the organisation.**
1	The organisation is transparent in all aspects of the business
2	Strategic information such as the organisations market plans, and financial performance is communicated to all employees
3	Operational information such as productivity, timeliness and quality is communicated to all employees
4	Information is continually displayed in dedicated spaces throughout the organisation

Q.9	**<u>Pull Instead of Push System</u> – A philosophy that emphasises production planning to manufacture to order instead of manufacturing to stock. No one upstream should produce a part until the customer downstream requests for it.**
1	All employees have profound knowledge on how a pull system works
2	Production is made to actual customer demand rather than to forecasts
3	Each workstation pulls the output from the preceding process
4	A Kanban card system is used to signal when material is required

Thank you very much for participating and completing this questionnaire.

ANNEXURE B

Profile of participants



Department * Position Cross tabulation

			Position							Total (%)
			Operator (%)	**Technician (%)**	**Manager (%)**	**Supervisor (%)**	**Engineer (%)**	**Auditor (%)**	**Admin (%)**	
Department	Production (%)	Within department	68.4	9.2	7.2	15.1				100.0
		Within position	94.5	31.1	45.8	85.2				59.8
		Total	40.9	5.5	4.3	9.1				59.8
	Quality (%)	Within department		22.9	2.9		8.6	65.7		100.0
		Within position		17.8	4.2		27.3	100.0		13.8
		Total		3.1	0.4		1.2	9.1		13.8
	Logistics (%)	Within department	28.6		23.8	9.5			38.1	100.
		Within position	5.5		20.8	7.4			57.1	8.3%
		Total	2.4		2.0	0.8			3.1	8.3
	Maintenance (%)	Within department		54.5	27.3	9.1	9.1			100.0
		Within position		13.3	12.5	3.7	9.1			4.3
		Total		2.4	1.2	0.4	0.4			4.3
	Purchasing (%)	Within department			16.7	16.7			66.7	100.0
		Within position			4.2	3.7			28.6	2.4
		Total			0.4	0.4			1.6	2.4
	Customer Centre (%)	Within department		28.6	28.6		14.3		28.6	100.0
		Within position		4.4	8.3		9.1		14.3	2.8
		Total		0.8	0.8		0.4		0.8	2.8
	Engineering (%)	Within department		68.2	4.5		27.3			100.0
		Within position		33.3	4.2		54.5			8.7
		Total		5.9	0.4		2.4			8.7
Total (%)		Within department	43.3	17.7	9.4	10.6	4.3	9.1	5.5	100.0
		Within position	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Total	43.3	17.7	9.4	10.6	4.3	9.1	5.5	100.0

ANNEXURE C

Factor analysis

Rotated Component Matrix

		Component								
		1	2	3	4	5	6	7	8	9
Q.1										
1	Products are manufactured only when required	0.140	0.146	0.271	0.193	0.132	0.673	0.095	-0.015	-0.069
2	Inventory in stores is kept to a minimum	0.169	0.097	0.224	-0.001	0.168	0.723	-0.054	0.203	-0.032
3	The movement of material within the organisation is kept to a minimum	0.415	0.465	0.170	-0.047	0.115	0.333	0.095	0.222	-0.186
4	Operators or processes do not wait unnecessarily during production	0.152	0.657	0.138	-0.074	0.084	0.170	0.236	0.084	-0.032
5	Operators do not move excessively to complete a task	0.571	0.280	0.110	-0.115	0.169	0.312	0.048	0.207	-0.116
6	There are no unnecessary processing steps in production	0.737	0.268	0.074	0.092	0.149	0.079	0.013	0.130	0.085
7	Defects and scrap are constantly monitored	0.633	0.228	0.104	0.262	0.168	0.175	0.157	0.088	0.131
8	Employees are motivated to be more creative	0.478	0.202	0.190	0.293	0.179	0.159	0.318	0.075	-0.032
Q.2										
1	All employees are asked to assist in solving problems	0.225	0.286	0.276	0.188	-0.019	0.444	0.419	-0.026	0.141
2	Training is provided for all employees on continuous improvement	0.300	0.174	0.051	0.260	0.166	0.178	0.561	0.160	0.114
3	Employees are motivated to come up with suggestions	0.556	0.037	0.166	0.318	0.339	0.311	0.271	-0.022	-0.057
4	Kaizen workshops are held to assist in improving operations	0.666	0.141	0.037	0.174	0.212	0.111	0.233	0.066	0.048
5	The Plan Do Check Act (PDCA) cycle is used to address problems	0.499	0.231	0.262	0.295	0.194	0.043	0.070	0.213	0.122
6	There is order and cleanliness in the organisation	0.464	0.269	0.418	0.428	0.156	-0.027	0.044	0.052	0.051
Q.3										
1	Operators are responsible to identify defects	0.520	-0.055	0.122	0.353	0.122	0.380	0.282	0.173	-0.092
2	Operators are encouraged to stop the line should a defect occur	0.432	0.159	0.069	0.307	0.055	0.337	0.314	0.277	-0.018
3	Operators are responsible to correct defects	0.290	0.161	0.003	0.514	0.127	0.324	0.185	0.202	-0.108
4	Poka-Yoke devices are used to prevent defects	0.420	0.145	0.177	0.547	0.272	0.081	0.131	0.139	-0.085
Q.4										
1	Components are delivered to each workstation on time	0.175	0.754	0.055	0.129	0.052	0.090	0.213	0.097	0.086
2	Components are delivered to each workstation in the correct quantities	0.247	0.777	0.097	0.207	0.136	0.050	0.037	0.074	0.046
3	Correct components are delivered to each workstation	0.231	0.652	0.266	0.365	0.128	0.032	-0.049	0.085	-0.012
Q.5										
1	Multifunctional teams exist within the organisation	0.217	0.038	-0.042	0.407	0.228	0.494	0.151	0.046	0.247

2	Operators within each department know how to perform all operations	0.127	0.308	0.081	0.500	0.242	-0.020	0.192	0.234	-0.156
3	The organisation does not rely on designated employees to perform specific tasks	0.337	0.219	0.372	0.080	0.055	0.065	0.142	0.348	-0.063
4	Tasks are rotated between operators within a department	0.495	0.209	0.273	0.131	-0.045	0.074	0.294	0.302	0.001
5	Teamwork promotes trust, support, respect and collaboration	0.078	0.034	-0.012	-0.068	-0.028	-0.028	0.016	-0.036	0.883
Q.6										
1	Operators are given more responsibilities in production	0.151	0.078	0.292	0.649	0.005	0.203	0.087	0.253	0.036
2	The hierarchical level in the organisation is kept to a minimum	0.428	0.108	0.210	0.138	0.193	0.135	0.159	0.425	0.107
3	Operators are encouraged to make decisions concerning production and quality	0.325	0.057	0.205	0.242	0.057	0.042	0.147	0.655	-0.003
4	Operators have real influence and power when they participate in decision making instead of serving as consultants	0.086	0.222	0.111	0.275	0.258	0.187	0.014	0.613	-0.098
Q.7										
1	Operators are given a broader range of tasks	0.059	0.084	0.609	0.184	0.147	0.314	-0.035	0.232	0.014
2	Sufficient training is provided to multi-skill employees	0.283	0.116	0.351	0.236	0.359	0.065	0.383	0.148	0.037
3	Employees are rewarded for learning new skills	0.208	0.195	0.006	0.039	0.333	0.031	0.528	0.306	0.049
Q.8										
1	The organisation is transparent in all aspects of the business	0.112	0.158	0.291	0.062	0.621	0.195	0.184	0.236	0.153
2	Strategic information such as the organisations market plans, and financial performance is communicated to all employees	0.250	0.087	0.163	0.060	0.760	0.071	0.117	0.098	-0.120
3	Operational information such as productivity, timeliness and quality is communicated to all employees	0.346	0.075	0.215	0.279	0.581	0.291	0.081	0.025	0.001
4	Information is continually displayed in dedicated spaces throughout the organisation	0.290	0.250	0.242	0.331	0.532	0.233	0.049	0.046	-0.057
Q.9										
1	All employees have profound knowledge on how a pull system works	-0.076	0.349	0.515	0.099	0.357	0.029	0.256	0.174	-0.009
2	Production is made to actual customer demand rather than to forecasts	0.198	0.025	0.681	0.109	0.316	0.227	0.055	0.136	0.083
3	Each workstation pulls the output from the preceding process	0.221	0.222	0.674	0.072	0.138	0.212	0.180	0.029	-0.118
4	A Kanban card system is used to signal when material is required	0.250	0.264	0.403	0.105	0.111	-0.062	0.568	-0.073	-0.218

Questionnaire

Voluntary questionnaire for selected organisation's employees: Improving quality and productivity at an automotive component manufacturing organisation in Durban

FOR OFFICE USE ONLY: Respondent Code: ___________

Dear Sir / Madam,
I am conducting research to critically review the effectiveness of Lean Manufacturing in the context of the organisation's production system. As the production system forms an integral part of the business, I believe that this survey will enable the organisation to establish why excessive scrap, process defects, inaccurate inventory levels and defective products supplied to customers continue to surface.

Note to the respondent

i) I need your help to understand how effective the application of Lean Manufacturing is carried out in the organisation's production system.
ii) Although I would like you to help me, you do not have to take part in this survey.
iii) If you do not want to take part, just hand in the blank questionnaire at the end of the survey session.
iv) What you say in this questionnaire will remain private and confidential. No one will be able to trace your opinions back to you as a person.
v) Please note that there is no correct or incorrect answer and try to answer all questions even if the alternatives do not necessarily suit your opinion.

How to complete the questionnaire

i) Please answer the questions as truthfully as you can. The questions are grouped into nine categories, and at the start of each category a brief explanation is provided to help you understand the relating questions that follow.
ii) I am only seeking for information that you and your fellow employees should feel comfortable telling me about. The information that I need is based on each individual's personal view on the application of lean manufacturing in the current production system.
iii) You can mark each appropriate response with a tick or a cross.
iv) Please answer the questionnaire with a pen and not a pencil.