Toyota Production System in a batch type production plant as a Pilot study

G.J.Naveen, Ramesh.S.Rao, R.Rengarajan, Paniraj Shanbhog

Abstract — **Today's challenge for business operations and management lies in providing customers with products of excellent quality cost and delivery (QCD) performance in the pursuit of customer satisfaction (CS) and staying ahead of competitors through market creation activities. Manufacturing companies; in particular, are required to grasp customer needs and provide products responsibly to the market through global production without falling behind their competitors. Therefore, new strategic management technologies that drive a company to lead the competition have become increasingly essential on a global scale. Major manufacturing companies are facing the strong need to innovate their businesses for global production. Depending on the situation in each country; including product specifications, production volume and market conditions, manufacturing may be fully automated or require manual labor. If so, the success of global production is highly dependent upon the quality of workers; indicating the necessity of work innovations. In case of automobile parts manufacturing, safety is considered specifically important. Taking shortcuts, doing shoddy work or in the extreme case, putting a faulty product on a vehicle in the market amounts for an adverse effect, and can have devastating consequences for a company; in the long run. Many people assume that Japanese management practices; the Toyota Production System, have been whole-heartedly implemented by American automakers for more than two decades [1]. However, the recent financial and operational crisis faced by American automakers indicate that a performance gap still exists between their production processes and those used by their Japanese counterparts. Considering many such issues a prime motto was to study and try to enhance the existing scenario by continuous improvement.**

Index Terms — **Batch type production plant, Continuous improvement, Powder Metallurgy.**

I. INTRODUCTION

The Toyota Production System (TPS) arose out of necessity in response to the circumstances surrounding the company. Many of the foundational concepts are old and unique to Toyota while others have their roots in more traditional sources. The production system philosophy of Toyota embodies a manufacturing culture of continuous improvement based on setting standards aimed at eliminating waste through participation of all employees. The goal of the system is to reduce the timeline from the time an order is received until the time it is delivered to the actual customer. Ideally the system strives to produce the highest possible quality, at the lowest possible cost, with the shortest lead-time possible. The production system developed by Toyota Motor Corporation to provide best quality, lowest cost and shortest lead time through the elimination of waste.TPS is comprised of two pillars, Just-in-Time and Jidoka (autonomation).Sequencing of a mixed model paced assembly line is investigated assuming the component parts usage smoothing as the goal of sequence selection. This sequencing problem, commonly known as Toyota Goal Chasing method [2].Since the early 1990s, the Toyota Production System (TPS) has been widely accepted in the rest of the industrial world [3].JIT applications and benefits apply not only to the shop floor but also to the distribution and the purchasing ends of the business[4].The Toyota production system (TPS),or lean production, has been associated with many benefits for manufacturing firms that implement the system. However, to implement the TPS successfully, it is necessary to integrate the so-called "hard side" of the system (that is, the technical aspects of material handling) with the "soft side" of the program (that is, the aspects associated with human factors). The present study makes a contribution to such a holistic view of the TPS by proposing an integrated model that consists of the technical aspects of the TPS, together with elements associated with total quality management (TQM), human resources management (HRM), and certain identified "people factors"[5].

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II. OBJECTIVE

The Toyota Production System (TPS) is more effective and efficient than traditional mass production system and is represented as a completely new paradigm. The major challenge as regards, the manufacture of final products for several applications lies in controlling the process parameters of several secondary processes involved. The objective decides; ones goal or destination to be achieved. Every study is carried out for the achievement of certain objectives. The present study focuses on

i. To analyze the various components of TPS for Batch type Production Plant.
ii. To study the operations and working of TPS for Batch type Production Plant.
iii. To study and analyze the operating cycle of Batch type Production Plant and its use of TPS in the shop floor activities.

III. METHODOLOGY

Toyota Production System was initially developed for accounting specific issues that were facing the Toyota manufacturing company. However, the concepts and ideas of TPS are also applicable in other industries and organizations

all over the world. The main focus of this particular production system is value. Through value definition and comprehension, TPS has assisted many companies maximize value. The Toyota Production System works so as to get rid of variation. The concept of TPS delivers great value to consumers and this may boost consumer retention. A Questionnaire approach is made to thoroughly understand the batch type production plant using a TPS concept. The department chosen for the present study is Batch type Production Plant which manufactures metal forming, metal cutting and energy products via the powder metallurgy route. Powder metallurgy is a process of making components from metallic powders. Initially, it was used to replace castings for metals which were difficult to melt because of high melting point. The development of technique made it possible to produce a product economically and today it occupies an important place in the field of metal process. The number of material products made by powder metallurgy is increasing and includes tungsten filaments in lamps, contact points, self lubricating bearings, cemented carbides for cutting tools etc. The manufacturing of parts by powder metallurgy process involve the following steps

(a) Blending and mixing of powders
(b) Compacting
(c) Sintering
(d) Finishing operations

The traditional powder metallurgy process consists of blending the metal powders and other constituents followed by compaction to produce the desired size and shape. Sintering to bond the metallic particles; thereby increasing strength and hardness of the compacted material. Secondary operations are performed to increase density, improve accuracy and accomplish additional shaping of the sintered part. Powders can also be rolled continuously and sintered to produce strips and other flat products or can be forged to get high strength finished components. The limitation of die compaction and sintering in traditional powder metallurgy process can be overcome by the recently developed isostatic compaction and hot isostatic compaction methods.

QUESTIONNAIRE FOR THE ANALYSIS & EVALUATION OF EFFECTIVE TOYOTA PRODUCTION SYSTEM IMPLEMENTATION IN BATCH TYPE PRODUCTION PLANT

Interacting with the Department Head and visiting the shop floor activities in the organization; data related to TPS and TQM Tools from Batch type Production Plant was obtained. Data is required in the form of a feedback to a questionnaire attached herewith. Responding to the questionnaire is by level of agreement with respect to a statement made with respect to work environment in a scale of 1 to 5 i.e.,

If you STRONGLY AGREE to statement give a score of 5
If you AGREE to a statement give a score of 4
If you have NO OPINION or NOT SURE give a score of 3
If you DISAGREE with the statement then give a score of 2
If you STRONGLY DISAGREE with the statement then give a score of 1

III. (i) LEADERSHIP

1.	Our Senior executives are actively and personally involved in developing the quality goals and standards for the organization and communicating these goals
2.	In our organization all levels of management demonstrate through their words and actions that quality is the first priority within the organization
3.	Our top management is willing to assist departments and individual employees to improve
4.	We operate in a manner consistent with high sense of ethics, concern for public health and concern for environment
5.	We have a system to evaluate the effectiveness of leadership
6.	Our Senior Managers actively encourage change; implement a culture of improvement, learning and innovation towards 'excellence'.
7.	Our employees have the opportunity to share in and are encouraged to help the organization implement changes.
8.	There is a high degree of unity of purpose in our organization and we have eliminated barriers between individuals and/or departments.
9.	Our managers visibly demonstrate commitment to a culture of Total Quality.
10.	Our top management support improvement and involvement by providing appropriate resources and assistance.
11.	Our top managers are involved with customers, suppliers and other external organizations.
12.	Our top management recognizes and appreciates people's efforts and achievements.
13.	Our top management encourages long-term strategic thinking
14.	Our top management generates consensus on future direction
15.	Our organization encourages participation of all stakeholders
16.	In our organization top management is committed to quality and accepts responsibility for quality
17.	Our organization has a clear definition for a quality strategy
18.	Exact guidelines on quality are existing in our organization

Table III (a) Leadership Assessment

III. (ii) RESOURCE MANAGEMENT

1.	Human resource ability considered in improvement activities
2.	Employees are given information and training they need to do the job effectively
3.	Employees are given tools they need to do the job effectively
4.	Sufficient financial resources provided to support improvement activities
5.	Company manages its material resources effectively
6.	We constantly determine future requirements of the customer
7.	Our policy and strategy are based on information which is relevant and comprehensive.
8.	Our policy and strategy are communicated and implemented.
9.	Our policy and strategy are regularly updated and improved.

Table III (b) Resource Management Accountability

III. (iii). MEASUREMENT AND FEEDBACK

1.	Customer satisfaction levels are measured and monitored
2.	Information on quality and customers are collected and analyzed
3.	Information on operational and financial performances are collected and analyzed
4.	Employees views are listened to acted upon
5.	Employee performance are measured and recognized
6.	Employees visit customer's premises as appropriate; to help promote understanding
7.	We are responsive to customer enquiries and complaints
8.	Employees are alerted to report possible customer dissatisfaction with products / services
9.	Those who interface with the customer receive special training (listening, complaint resolution, negotiation and the like.)
10.	Customer needs and expectations are effectively disseminated and understood throughout the workforce.
11.	We involve customers in our product design processes.
12.	We always maintain a close relationship with our customers and provide them an easy channel for communicating with us.
13.	We have an effective process for resolving customers' complaints.
14.	For us customer satisfaction is a measure of quality
15.	Our organization encourage customers to provide feedback

Table III (c) Measurement and Feedback

III. (iv) CONTINUOUS IMPROVEMENT

1.	There is a quality improvement coordinating body (e.g. quality steering committee)
2.	Improvement teams are active in the department
3.	Quality improvement tools and techniques are widely used
4.	The company practices continuous improvement of all its products, services and processes.

Table III (d) CONTINUOS IMPROVEMENT (CHANGE)

III. (v).SUPPLIER QUALITY MANAGEMENT

1.	Suppliers are selected on the basis of quality aspects
2.	Company ensures that suppliers can maintain high technical standards and meeting quality specifications
3.	Company regularly conducts supplier quality audits
4.	Company works closely with suppliers towards long term partnership and improvement
5.	Suppliers provide relevant quality records and data

Table III (e) Supplier quality management aspect

III. (vi).SYSTEM PROCESS MANAGEMENT

(These statements refer to all processes performed by the organization including administrative, logical, engineering, and production)

1.	In our organization Process Capabilities and Performance standards for processes have been established.
2.	We have an effective system for prioritizing the processes for improvement and improving those processes identified as needing improvement
3.	All processes performed by this organization have been identified and the ownership of each process can be established.
4.	There is an effective means of disseminating lessons learned information from project to project and throughout the organization.
5.	We have an effective method for evaluating the process improvement system itself.
6.	The concept of the 'internal customer' (i.e. the next process down the line) is well understood in our organization.
7.	We design processes in our plant to be "fool-proof" (preventive-oriented e.g. poka yoke).
8.	We have clear, standardized and documented process instructions which are well understood by our employees.
9.	We make extensive use of statistical techniques (e.g. SPC & QC tools)) to improve the processes and to reduce variation.
10.	We give a strong emphasis on quality in design (e.g. QFD)
11.	We strive for achieving zero defects or zero customer dissatisfaction and adopt methods to achieve this (e.g. Six Sigma)
12.	We have documented the production/service processes and maintain records as evidence to the documented procedures. (e.g. ISO 9001 QMS)
13.	Our work areas are orderly, clean and we practice workplace improvement practices like (e.g. 5s).
14.	Our organization benchmarks itself against competitors
15.	Our organization gives a lot of emphasis on preventive maintenance and we have a planned maintenance management in place (e.g. TPM).
16.	In our organization processes are changed as a continuous improvement program and the benefits evaluated (e.g. Kaizen).
17.	In our organization the performance of our products/services are assessed by at each and every stage of manufacturing/service delivery
18.	We ensure the reliability and durability of our products by subjecting our products to life testing methods.

Table III (f) System Process Management Performance

III. (vii). EDUCATION & TRAINING

1.	Top management always updates their knowledge
2.	Employees are trained for job related skills
3.	Employees are trained on Total Quality concepts , TQM tools & techniques
4.	Continuous learning is provided through education and training

Table III (g) Education and Training Initiation

III. (viii). WORK ENVIRONMENT AND CULTURE

1.	A pleasant environment exists in all working areas.
2.	Positive values such as trust, honesty, hardworking are fostered by management
3.	Team work and involvement are normal practice in the company
4	The company adopts "employee satisfaction" initiatives (such as suggestion schemes, profit sharing etc)

Table III (h) Work Environment and Culture adaptations

III. (ix). BUSINESS RESULTS

1.	Employee satisfaction improved
2.	Company has developed a culture that emphasizes Quality
3.	Reduced delivery times
4.	Financial results have been improving
5.	Rework Reduced
6.	Supplier quality improved
7.	Productivity Increased
8.	Improve organizational culture
9.	Administrative processes
10.	Customer satisfaction has shown improvement
11.	Market share increased
12.	The number of employees participating in TQM program has increased
13.	Reduces process variability, create process stability and predictability & control
14.	Improve workflow, reduce NVA and Waste
15.	Improve competitiveness, effectiveness and flexibility of a whole organization

Table III (i) Business Result Analysis

IV. RESULTS AND DISCUSSION

A questionnaire is the main means of collecting quantitative primary data. It also enables quantitative data to be collected in a standardized way so that the data are internally consistent and coherent for analysis. *Likert Scale* named after its developer *Rensis Likert*; is one of the most widely used itemized scales. The end-points of a Likert scale are typically "strongly disagree" and "strongly agree." The respondents are asked to indicate their degree of agreement by checking one of five response categories. In the present analysis for all the categories - STRONGLY AGREE statement is given a score of 5; AGREE statement is given a score of 4; NO OPINION or NOT SURE is give a score of 3; DISAGREE with the statement is given a score of 2 and STRONGLY DISAGREE with the statement is given a score of 1.There are 75 people working in Batch type Production Plant altogether. Figure IV (i) shows variation of the prime factor in a batch type production plant i.e., the leadership quality and its assessment. With 34% of work force strongly agreeing the vibrant leadership skills and their effectiveness and 52% of people agreeing with the present leadership initiatives and qualities is a beneficial situation for any batch type production plant as compared to disagreeing which accounts for a mere 1%.Positive leadership may be due to top manager's involvement with customers, suppliers and other external organizations; including appreciating people's effort towards achieving targets.

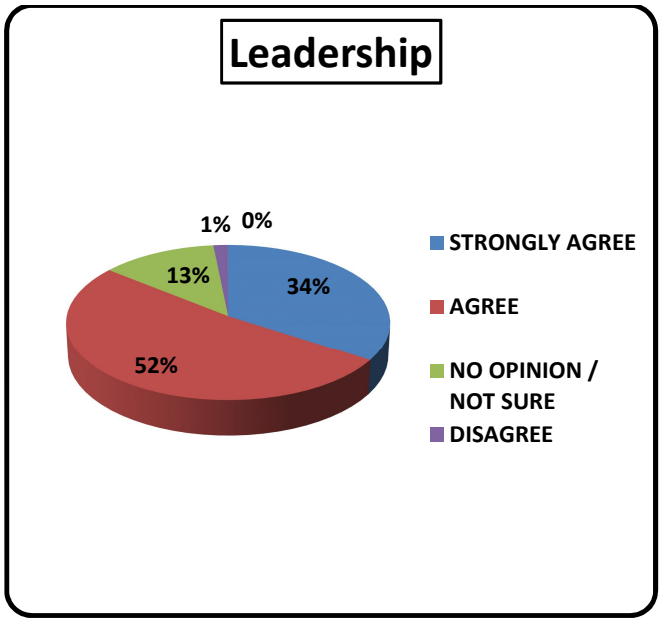

Fig. IV (i) Leadership

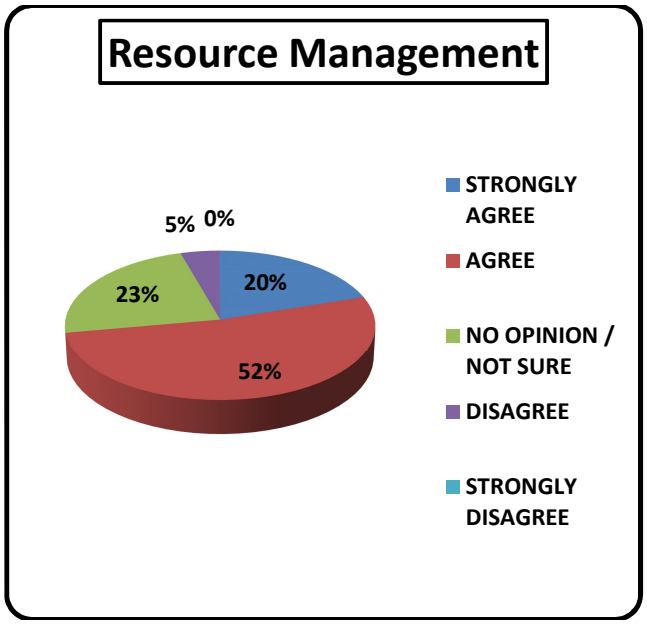

Fig. IV (ii) Resource Management

Figure IV (ii) shows the graph of work force agreeing with 52% and 20% of strongly agreeing people with the available resource management in the production plant.23% of the work force are not sure of the resource management and 5% of them are disagreeing with the present resource management. Handling the available resources (man, machine, material and money) is a challenging job and should be thoroughly assessed. Allocation of job according to the expertise (eg. In the shop floor for Operator, Technical Programmer, Designer and Assembler) will be strategically advantageous. With the comprehensive company policies; one can achieve the tasks assigned confidently and promote the results to the customers effectively.

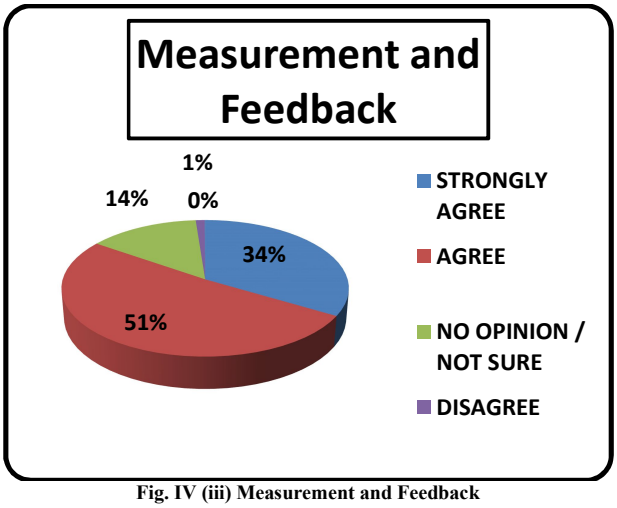

Fig. IV (iii) Measurement and Feedback

Figure IV (iii) shows the pie diagram of using the measurement and feedback system followed by people working in Batch type Production Plant.34% of people strongly agree with the present feedback initiative and 51% of the people agree with the feedback system. Majority of people are satisfied with the present measurement and feedback system which accounts for around 85%.This may be attributed for having an effective process for resolving customers' complaints.

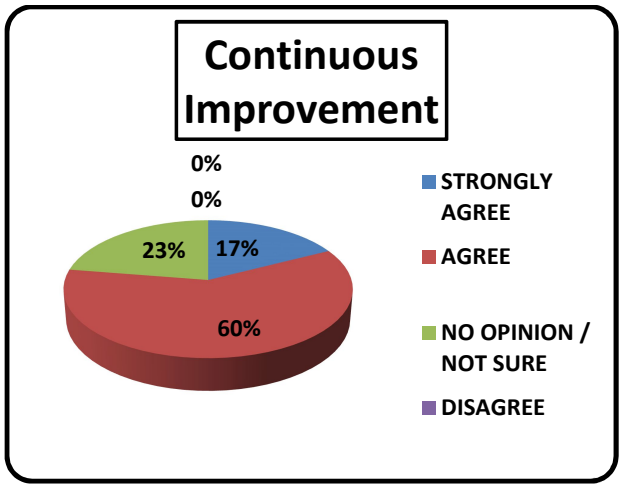

Fig. IV (iv) **Continuous Improvement**

Figure IV (iv) shows the pie diagram of using the continuous improvement ('KAIZEN') tool followed by people working in Batch type Production Plant. It can be observed that; larger groups working under the active teams are widely agreeing and improving the standards under the quality improvement coordinating body (steering committee) and practicing the above said concept thoroughly. Figure IV (v) shows the graph of supplier quality management aspects in Batch type Production Plant.20% of the people strongly agrees as suppliers are selected on the basis of quality.48% of the people agree the system as company works closely with suppliers towards long term partnership and improvement. Supplier quality audits are regularly conducted to maintain efficiency.

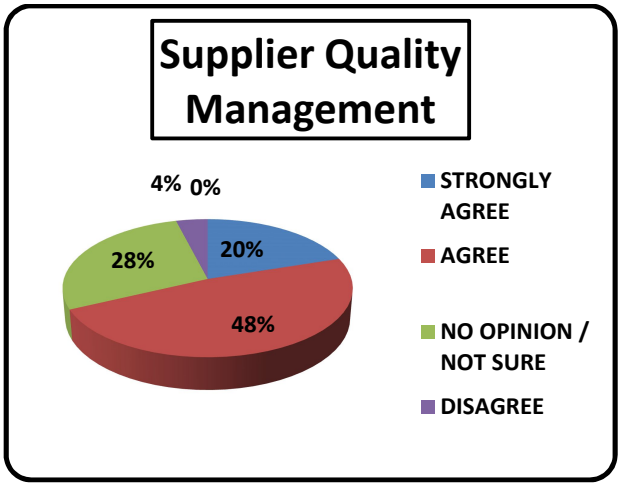

Fig. IV (v) Supplier Quality Management

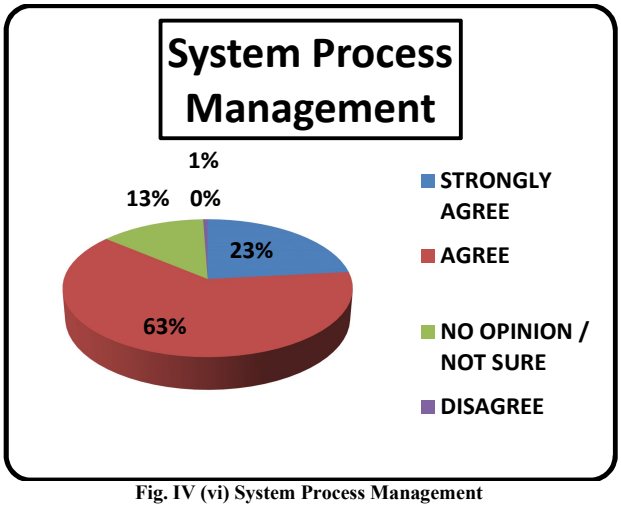

Fig. IV (vi) System Process Management

Figure IV (vi) shows the pie diagram of using the system process management followed by people working in Batch type Production Plant. It is observed that 23% of people strongly agreeing and 63% agreeing with the present system. It can be attributed for the organization establishment of process capabilities and performance standards. Strong emphasis on quality in design is adequately taken care. Around 86% people are adapted to working conditions as the organization benchmarks itself against competitors and the concept of "internal customer" is made fool-proof (Pokayoke).A planned maintenance management system is very active and continuously improving the standards. Figure IV (vii) shows the pie diagram of the Training programs and the knowledge enhancing skills in Batch type Production Plant. From the graph; it can be clearly visualized that 70% of the people agree with the knowledge capacity among the people working in the department and 15% strongly agree with the kind of training given to job related skills. Continuously improving the technical skills and abilities via training on Total quality concepts, TQM tools and techniques is ensured proficiently. Encouragement is given and supported to the people working in the department to substantially be updated with the trending technology from various training sessions and lectures.

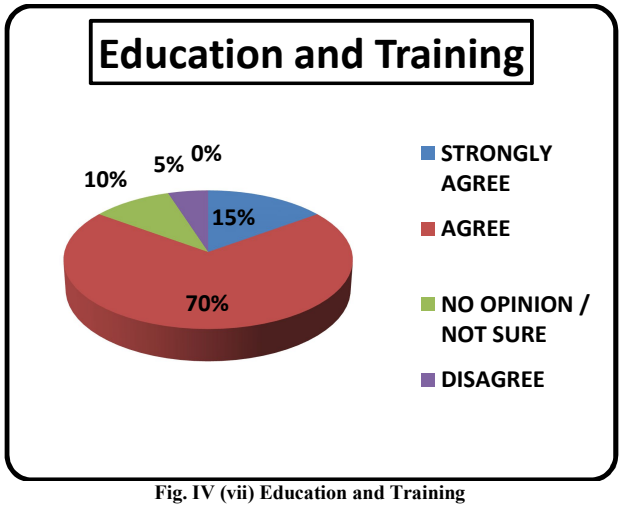

Fig. IV (vii) Education and Training

Figure IV (viii) shows variation in working conditions of the Batch type Production Plant and the different type of adaptations.67% people agree with the present working environment of the department as it is pleasant and 22% of the people strongly agree with the culture as the people are selfless with positive values such as trust, honesty, hardworking and teamwork involving difficult tasks.

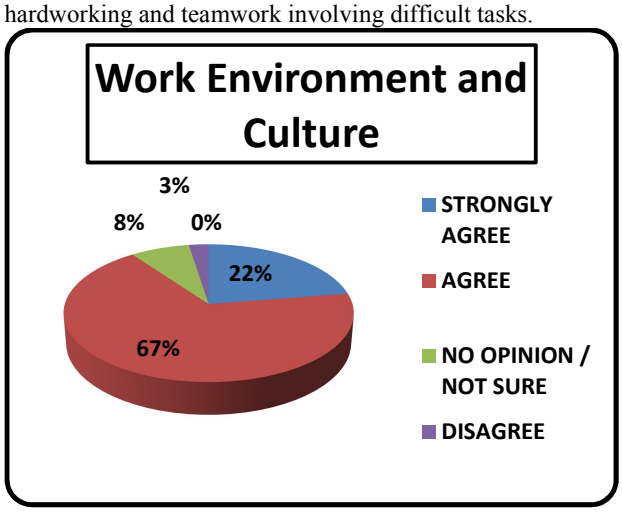

Fig. IV (viii) Work Environment and Culture

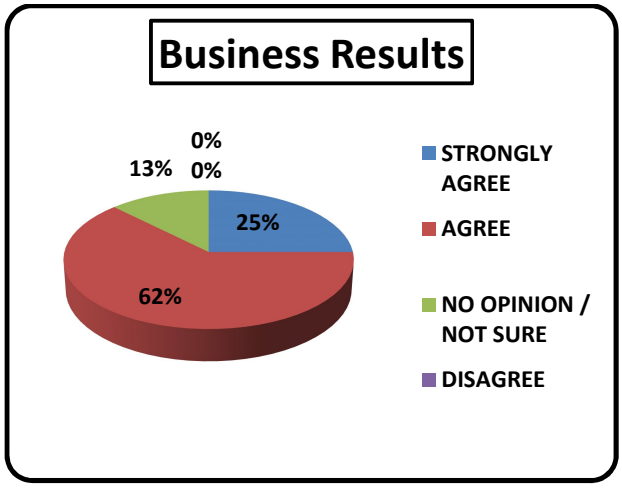

Fig. IV (ix) Business Results

Figure IV (ix) shows the pie diagram of the business results and thorough analysis of the same. 62% of people agree with the business results in the present scenario and 25% people strongly agree as the improved competitiveness is handled wisely with effective flexibility. Various changes and their implications have paved the way for a healthy business and market capture. With Business improvements; employee satisfaction and the organizational culture is standardized.

CONCLUSION

Challenges are the foundation for any success and serve as energy to go beyond difficult situations and sail through easily with constant effective effort and strong optimistic approach. If a plant wants to transform their workplace into higher productivity and profitability, it must modify drastically according to the lean principles. These changes won't be simple and won't happen within short span of time but with persistence; one can make it happen. The culture that many organizations are working to implement does not come naturally and it takes constant team effort and individual commitment to create and maintain it successfully. Implementation of the Toyota Production System into a dynamic lean manufacturing philosophy, supported by systems and tools, requires consistent effort and education. In order to continue to compete in the global market and provide for the needs of customers, employees and investors, it is essential that all employees become well known to the principles of the Toyota Production System. The success of the system requires everyone's participation. Managing ongoing change and improvement is essential .The message is clear for all the major heavy engineering industries specifically (Auto, Machine tool, Construction equipment and so on) in the enormous complexity of today's business, societal expectations and government regulations, they should start checking all kinds of quality and safety related potential issues in their own range of standards to avoid any catastrophic damage in mere future. The major improvement paves way for a drastic change in the global scenario and creates awareness of sheer commitment. Continuously improving the combined aspects in a production plant help in providing better results.

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