

# **Optimization of Lean Implementation by the Seven New Operational Areas**

**John Zvidzayi**

Department of Quality and Operations management  
University of Johannesburg South Africa  
[rejohzvidzayi@gmail.com](mailto:rejohzvidzayi@gmail.com)

**Anup Pradhan**

Department of Quality and Operations management  
University of Johannesburg South Africa  
[anupp@uj.ac.za](mailto:anupp@uj.ac.za)

**Charles Mbohwa**

College of Science Engineering and Technology  
University of South Africa, Johannesburg, South Africa  
[mbohwc@unisa.ac.za](mailto:mbohwc@unisa.ac.za)

## **Abstract**

In the implementation of Lean manufacturing (LM) the focus was to eliminate the barriers within the ten generic barrier areas to achieve a remarkable success. The Automotive Supply Chain (ASC) in South Africa (SA) found these ten generic barrier areas insufficient because of the culture mix, level of education of employees, religion, and cultural values. To optimize the implementation of LM the ASC in SA found seven new barrier areas that needs subordination. The seven barrier areas are not yet documented as critical in the academic work. The seven areas are Green Technologies, workers, sustenance, safety, security, profitability, and Marketing, but are discussed elsewhere with no relation to implementing LM. These have increased the success rate in the SA setting. Some of these technologies are broken down to subunits because they involve many attributes. The study will elaborate the generic ten critical areas then discuss the seven as findings in the ASC in SA.

## **Keywords**

Green technologies, sustenance, profitability, motivation and marketing

## **1. Introduction**

The strategic change in manufacturing from mass production to Lean Manufacturing (LM) has many drawbacks when it is implemented to old companies. The machinery and equipment need an upgrade to meet the LM requirements. The workers need to get more skills training on LM to form cross functional teams. The focus all along was on eliminating the barriers that are embedded in the ten generic operational areas where critical success factors lie in (Netland, 2016).

The academics (Kumar & Singh, 2014) and (Tan et al., 2020) established the ten critical areas in implementing LM for the first time. The study seeks to find the impact of the generic and the emerging seven barrier areas used in implementing LM in the ASC in SA. The study obtained the factors and challenges that affected the level of success at each supplier from both the generic and new areas. The new areas maybe specific to the ASC in SA due to the geographical position of the ASC companies.

The diversity of employees brings in different religions namely Christians, Jews, Moslems, and African traditions. They also come with mixed working cultures; some are from a LM culture that uses a 100% quality checking at all machines whilst others are from the traditional Mass production culture that checks a sample of maybe 2- 5 %. The ASC also has a high gender mix where females do light manufacturing and assemble tasks on small components in the manufacturing plant. They are also involved in the sewing of leather seat and gear lever covers.

## **2. Literature**

The literature discusses how the ten generic barriers areas affect the implementation of LM at the ASC as compared to other industries before discussing the new seven areas.

### **2.1 The Knowledge area**

The knowledge area affects the workforce ability to measure and evaluate the performance of each LM technique. Adequate knowledge is required to subordinate any constrain and increase flexibility whilst reducing rejects and re-work (Norani, 2012) and (Netland, 2016).

When the workforce is trained on the underpinning knowledge of Lean techniques, they can eliminate the 8 wastes during implementation (Yahya, 2019). The training imparts, knowledge, skills and experience that creates an enabling environment to minimum waste. Lean knowledge is used to make small improvements of about 1% per shift as opposed to a once off radical change. The knowledge is used in the ASC by first training and imparting skills to the work force before the do any task. It is the norm in ASC industries to train and evaluate each hired employee before he joins the production line.

### **2.2 The Management area**

Proactive managers formulate strategies and methods of implementing, tracking, evaluating, and rewarding the LM (Kumar & Singh, 2014).The academic revealed that the management developed the vision, improvement strategy, plan of action, avail adequate resources, skills and knowledge on LM to get right the first time.

Likewise, the managers in the ASC formulated strategies to keep the project plan in track whilst providing sufficient support, commitment, and resources to each workstation where value is added. Rewards and moral support are used to motivate the employees. Senior managers in consultation with all employees optimise knowledge intake to avoid conflicts.

### **2.3 The Human Resources Area**

The academic work by (Memon & Khalid, 2018) highlighted and supported the notion that knowledge and understanding is critical to empower the work force. This builds the communication, Continuous improvement (CI), customer trust (quality & reliability) and teamwork in the organization culture as supported by senior management. In the ASC in SA, the training, communication, participation, and involvement in decision making changed the organizational culture to one that supports and empower the workers. The ASC in SA had mixed nationalities, with mixed cultures that needed to be treated with care before and during implementation to prevent conflicts and resistance to change. Respect for People, fair treatment of workers, regular training, feedback, and rewards motivates employees. Employee engagement, involvement and participation in decision making is critical in developing the pathway to

implement LM. Unlike the mass production system which is management centric the LM philosophy is worker centric by engaging and involving the worker and customers.

#### **2.4 The Conflict area**

The academic work by (Durakovic et al., 2018), (Qureshi et al., 2022)) and (Maware, 2019) analysed and concluded that the conflict area was a result of multiple factors that need to be understood and used carefully. The factors are communication strategy, inventory management, poor quality improvements, lack of employee participation and lack of top management commitment. Conflict areas save as bottlenecks in the implementing of LM because they retard progress and flow of information (Skoogh et al., 2023).

In the ASC industry in SA identified the conflict areas and their impact to the process of implementing Lean. Preliminary studies in the ASC showed that ethnic diversity, the blame game, lack of empowerment, poor vision and strategy, communication and lack of training were key areas of conflict. A neutral and highly innovative change management strategy is used to build sustainability and respect for humans to reduce doubts, tensions, and job security concerns. A clear, focused, and credible change management process minimises conflicts. Employee were involved in benchmarking and setting clear standard operating procedures (SoPs) that are communicated to the work force.

#### **2.5 The Resources area**

The academic work by (Tan et al., 2020) and (Madhani, 2020) highly regarded the provision of resources such as manpower, capital, materials, machines, and methods by management. Manpower recruitment use a basic minimum education level to increase the ability to train the work force. The LM companies provides education and training to new recruits to upgrade the education level of both employees and their dependents to build a pool of trainable employees (Ramli(B) & 2021).

In the ASC in SA, quality standards and standard operating procedures were set and established for effective manpower, equipment, software, and material resources to be available in value addition. These standards were formulated in consultation with the workforce, suppliers, and customers as a symbol of management commitment to provide resources needed to eliminate the wastes.

#### **2.6 The Finance area**

The academic work by (Madhani, 2021) indicated that availing an adequate budget for resources is key to building smart factories. The financial resource is an enabler and change agent that enables education and training of employees at the site and outside. Adequate financial resources give job satisfaction and retention of employees and customers (Vashishth et al., 2023) and (Vashishth et al., 2023).

The lean Six Sigma (LSS) is applied to provide the control of the manufacturing environment and ensures information flow is smooth and consistent. The application of LSS guides the finance and accounting services that help to develop the tactics which are beneficial to the business (Madhani, 2021).

The green supply chain principle is used in the acquisition and development materials that are used by the ASC. This reduces the disposal costs of scrap and old equipment which is sold as scrap or second parts for fure use after reconditioning (Effendi, Widjanarko, & Sugandini, 2021).

In the ASC, adequate finance budgets for all operations were developed and set for each resource by experienced teams in consultation of the workforce. The training of employees is normally done at TSAM which has modern facilities and equipment. The trained workforce goes back to their ASC companies and apply the skills and recommend the purchase of appropriate equipment and facilities. The funding for training and sustenance onsite is availed to speed the implementing process from the rollout date. The return on investment (ROI) and payback period is never immediate because of small improvements.

#### **2.7 The Experience Operational area**

The study (Panwar et al., 2015) recommended a risk assessment evaluation to be done based on the previous failures to identify and eliminate the risks on the onset. The successful attempts were developed and guidelines for sustainability of LM were set. The unsuccessful attempts were analysed to determine the root cause of failure using

the 5WHY mitigations and other LM techniques. It was found critical to engage, involve and motivate the employees to see and realise the benefits. Brainstorming and respect for people is crucial at this stage since employees would know it as a failure. Training and developing new skills can be used to change the mindset of workers in this case. The acquisition of new skills and technology is used as a tool to motivate the employees whilst investing in error proof technologies such as Jidoka and use Andon lights (Grout & Toussaint, 2010),(Dat Minh, Danh Nguyen, & Kien Cuong, 2018) and (Tekin et al., 2019).

In the ASC some companies succeeded in implementing LM first time and others succeeded the second or third time. They used the experience to remove constraints and obstacles in their path. If experience is not handled properly, it can cause resistance to change and divide employees. One group of workers will resist and prefer backsliding to old methods which they have confidence in whilst the other moves forward. It was essential to determine the root cause using the (RCA) strategy and 5WHY analysis and use the SWOT analysis to build strength.

## **2.8 The Organization culture Operational area**

The academic work by (Rakesh & Kumar, 2014) showed that the LM culture exploited the mistakes in manufacturing as the source of continuous improvement rather than giving blame to the worker. It promoted diversity and teamwork at all levels whilst discouraging individualism and management centric tendencies. These academics stressed that the change of attitudes and values improved the implementation process. Workers are not blamed or dismissed for mistakes, but an error was considered as the start for continuous improvements in the Manufacturing sector.

The ASC in SA has a high diversity of culture among its employees who work alongside contractors, and suppliers from different countries that had different beliefs, attitudes, behaviours, and language. LM embraced the empowering culture by instilling customer centric leadership that was innovative and competitive in the market. The organization culture has embraced lean organization policies that motivated the workers and instilled self-discipline. It embraced small continuous improvements and a “no-blame culture,” as a tool to change poor attitudes and but empower the employees to give a sense of belonging and ownership of the ASC company.

## **2.9 The Technology Operational area**

The study by (Kumar, 2014) showed that Lean software technologies is used in analysing and ensuring total quality by use of Jidoka system sensors. It linked relevant stakeholders for timely supply of materials and product distribution using the Kanban and Heijunka levelling Kaizens. Use of robotics and automatic control of machine tools for Total quality control was used extensively in lean manufacturing (Koohestani, Poshdar, & Gonzalez, 2020a)

In the ASC, the appropriate technologies are used from the onset, starting with the cheap and user-friendly technology to make workers buy-in before bringing in sophisticated technology that have a potential to attract resistance for fear of victimisation. Lean Kanban software's links the ASC stakeholders in the plant to control the flow and Takt times. The visual Andon light systems in the manufacturing floor provides Realtime displays of machine status in the manufacturing floor whilst Six Sigma provides 100% quality testing at each station to prevent passing a defect to the next station in the production line.

## **2.10 The customers satisfaction Operational area**

(Koohestani, Poshdar, & Gonzalez, 2020b) found that the power of lobbying was key to win new consumers from the distributor and end user of the auto spare parts sales outlets. The quality of the product and efficiency of supply satisfied the customers to remain in business. The bedrock principles of LM were designed to develop a comprehensive e-commerce business model that maximized the chances of success. The academic work by (Simatupang, 2016) revealed that customer service is a principal strategic goal to win new contracts and retain the old. The marketing, purchasing, shipping, and supply service departments supported LM principles and satisfied the customer (quality and lead times).

The study focused on how customers visualized the improvements and their impact. Small and emerging firms in ASC had a smaller market share and needed to embrace modern and innovative manufacturing technologies to meet customers demand and value needs, thus retain old and attracted new clients by staying ahead of the competition.

## **3. Methodology**

The study used a mix of descriptive quantitative and qualitative methods where observations and interviews were used to collect data in the ASC industries. Planned interviews were arranged prior to the meeting whereas unplanned

interviews were random and done when accessed the plant. After interviews I requested to spend observe and meet the operators and technicians.

#### **4. Data Collection**

Two check lists were compiled, the first was used in interviewing the team leaders and Engineers in the manufacturing floor who had more than 20years experience and the second in observing the plant operations and meeting the junior staff members.

#### **5. Findings**

Planned interviews had similar answers and responses as compared to random interviews on junior staff. Similar responses came from employees who had longest experience. These were recruited without any skill but high school education then trained by the company in the same program.

The ASC also thrived to improve the success of implementing LM by upgrading the seven wastes to eight. They included the utilization of workers' talents in the innovation initiative to win the global market. This was found effective when each worker was placed at the area where the talent was high for innovation purposes.

The innovative ASC in SA saw a gap in the ten generic areas was filled by developing and applying additional seven critical areas in implementing LM. The ASC has upgraded the generic barriers areas from ten to seventeen in the implementation of LM in SA. The study discovered seven more operational areas that are not documented in most literature barrier areas. Fig 1 shows the additional seven barrier areas discovered in this study (Figure 1).

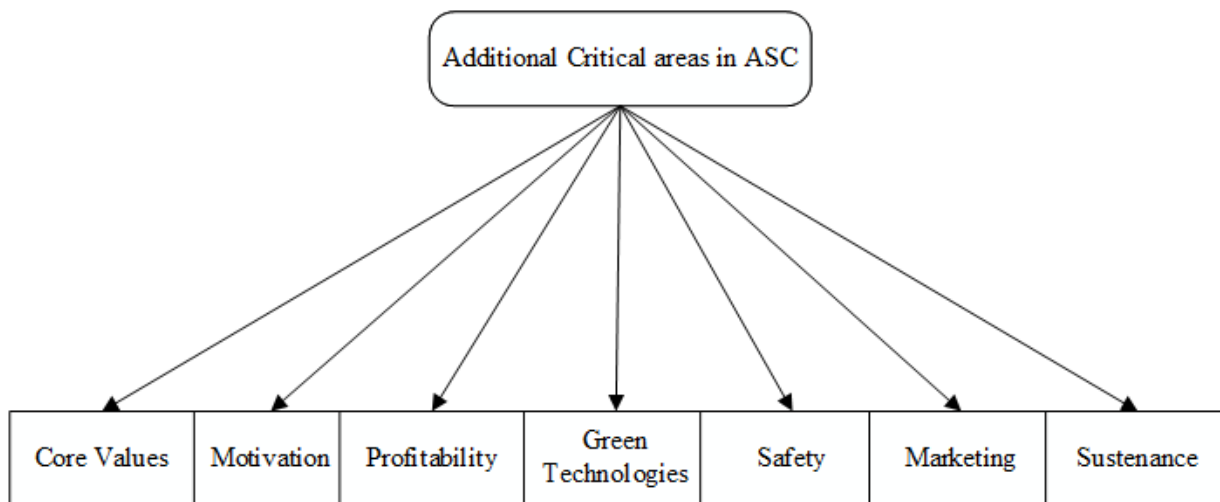


Figure 1. Critical areas are implementing ML in the automotive supply chain in South Africa (Zvidzayi J et al. 2024)

##### **5.1 Green Technology Area**

The objective of green Supply Chain Management (GSCM) is to reduce waste and maintain the quality of the environment and re-manufacturing using materials from products that have reached their end of life. The ASC visibly showed the application of the Green Technologies area where bins with informative signs are placed indicating which material is disposed in which bin. The materials selection for auto parts by the suppliers is done in full collaboration with TSAM and selected customers. The best materials to be used are those which are ecofriendly during and after use. All materials used are approved and developed in collaboration TSAM, the supplier, consumer, and the ASC companies. The disposal of consumables and service auto-parts is done by Toyota Dealers who service the cars. The problem comes when individual car owners do the service themselves and fail to comply with the waste disposal requirements methods.

The end user garages, and car breakers dispose auto parts properly. Used oils are collected at Toyota dealers and recycled by Fuel Firing System (FFS) which has set oil recycling and refinery plants in Durban, Secunda and other cities in SA. The Solid particles are removed before adding viscosity improvers to the cleaned used oils. Additives that improve thermal stability and shear strength (viscosity) at elevated temperatures are added.

The plastic Actinolite Butadiene Styrene (ABS) from electronic housings is collected crushed and used as a filler in the plastic industry. Polytetrafluoroethylene (PTFE) which is used for plain bearings, gears, slide plates, seals, gaskets, and bushings is recovered and recycled since it is a thermoplastic. The metal casing for filters is reclaimed and recycled to make metal products.

Rubber products from SUMITOMO are collected and used to make artefacts such as plastic meshes, tiles, carpets, and a variety of toys. Green companies apply cleaner production methods of converting process waste into raw materials for downstream industries. The technology has an 8R effect by its ability to Reduce waste, Re-use old parts, Rework oversize products, Re-furbish the damaged body, reclaim materials after use, Recycle materials after use, Re-manufacture products from used material parts, Re -logistic of old parts to dealers like Barnet.

The study showed that nearly 50% of green materials have contributed to the success of LM. Green byproducts are recovered and reused. For instance, electrical energy that forms heat can be used in preheating geyser water. Water that flows to the drainage systems can be used for flushing toilets prior to the removal of solid material particles to avoid blocking the system. In some cases, the same water can be used to irrigate the lawn in the golf course.

## **5.2 Marketing**

Today' marketing department use green technologies in their adverts to lure the customers by telling the consumer how user friendly the products are and how materials are collected for disposal after-use. The marketing area is effective in meeting customer requirements in terms of customer and JIT.

The study found that 30 % of marketing activities have positively contributed to the success of LM by keeping the ASC industries in business by stressing on a 100 % quality test and timely delivery to all customers. For instance, the company Sumitomo which produces car tyres provides its customer with quality tyres for the assemble line in time. The main customer TSAM collaborate with suppliers to get it right first time and reduce meetings and allow smooth flow of information.

Intellectual property is guided and protected by the marketing department and any public information is checked against piracy and plagiarism. The Green technology aspect is used so often as evidence that the company meets the customer value and protect the environment.

The sixth and seventh Ss namely safety and security are embedded in the marketing strategy to convince the customers that the product is user friendly and backed by on the road maintenance back up of up to 120 000km. The upgraded 8<sup>th</sup> waste "Non utilization of talent" is used advertising when they highlight that all parts of the car are made by skilled and talented personnel, and they will get you wrong. At the ASC employees are placed at areas where their passion is to allow them to fully utilize the talent in CI. The materials used are certified and of high strength that you cannot go wrong with Toyota cars.

## **5.3 Profitability**

The ASC showed that 85 % of the profitability area contributes to the success of LM by increasing social benefits rewards and security to workers when the Productivity is above unity. The extra profit above maximum is used to reward teams and develop schools, sports, and social facilities for the community. A once off additional bonus to all employees or the team that is outstanding. Issuing and displaying on notice boards the certificates and medals motivates the employees.

## **5.4 Motivation**

The study showed that 65 % of motivation contributes to the success of LM. The human resources (HR) are subdivided into management and workers to provide specific motivation. All managers are trained in HR knowledge and skills to handle matters that affect productivity and provide job satisfaction. Job Security, worker, environmental and machinery safety are motivating factors that add the success of LM and make employees buy in.

## **5.5 Safety**

Safety is subdivided into information, equipment, workers and environment of which each is treated separately to give a full understanding and cover most aspects in the findings.

First is Information Safety and security being a custody of the management department, the safety champion ensures that confidential documents are passworded to prevent access by all workers and the threat of pirating by competitors if the company uses one drive. In Engineering the new designs and developments are also protected so that other competitors have no access to that drive.

Second is the Environment and Safety and Health Act (OSHAC) Acts which are enforced by the Safety Health & Environmental officer (SHE) to ensure the safety of workers, machines, and protection of the environment. The OSHAC act binds all workers using informative signs (normally blue colours), danger warning signs (Red) that are visible in all technical departments to comply with the safety regulations. The ASC have standard charts, diagrams and signs that guide the workers and Automated Guided Vehicles (AGV)s unlike the non-lean companies.

To promote the safety of equipment and employees the leading SHE officer records and assesses minor and serious accidents and rewards the team of workers who maintain zero tolerance to accidents. This motivates the workers and gives them awareness to safe practice at work.

Third is the Worker's security that is embedded in the upgraded 7S to retain staff and provide job satisfaction by training and provision of social benefits that improve the lives of the workers. The social benefits include pensions, medical insurance, subsidies such as dependence school fees contribution, housing, and transport allowances and so on. These benefits provide security at work in case a mishap happens. To the family and dependents, the ASC provides medical support and education contributions by the employer.

The prohibited tasks or movements are shown by red marked warning signs. In all ASC industries which uses AGVs you find hand signs on the floor that compels the pedestrian to point all directions before getting into the intersection to protect the workers and equipment. Reflections which are done at the end of each shift keep the workers abreast of the safety rules. Any visitor or contractor attends an induction course and writes a test to get a permit to walk or do any work in the plant. The provision of employee security motivates them to be innovative in areas where they are talented.

Fourth is Environmental safety where the SHE department guards against process emissions that cause environmental pollution. Accidents damage expensive machines and hurt or kill workers leading to loss of talent because of disabilities incurred. The company will also lose money in fines and the brand will be smeared with mishaps that adversely affect the market. In processes where they are toxic gas emissions, toxic gas adsorbents or catalyst are used to scrub the toxins to the safe level before the gas is discharged to the atmosphere. Similarly, dust suppressants and collectors are designed to minimise dust formation or direct dust into a water pool. The dust, off cuts and scrap are collected and used in the downstream industries as raw materials. All cars are fitted with catalyst in car exhaust minimises atmospheric pollution by carbon.

## **5.6 Sustenance**

About 65% of sustenance contributes to implementing LM using the five soft skills. The first is respect for people (RFP) which provides mutual trust among management, workers, and customers. Without RFP the workers will not be open to share their ideas because they will be afraid of management. Good managers have a positive attribute of listening to workers and acknowledging their efforts. From time to time senior and line managers discuss with workers during reflections to map the way forward. This involvement and engagement impart a sense of belonging to the workers.

The workers need to have mutual trust with their managers for CI. Where there is no mutual trust, the tasks are not done properly in the sense that some workers are afraid of the unknown and possible victimization if they make mistakes. Honesty and integrity among workers are instilled through mutual trust of workers by their managers. This attribute is built over time by engagement and involvement of employees in decision making and giving feedback to workers in time. If workers have been provided with their training needs, they demonstrate the skills and knowledge during brainstorming and decision making for CI. The maintenance of Manufacturing operations helps sustain its competitiveness and profitability overtime.

### **5.7 Core Values**

The core values aim to build mutual trust, RFP, quality, collaboration, and innovation to meet the customer needs by initiating change to LM. Building trust and transparency in the control and handling of all inventories has added success to LM. The quick response in the change of product in the value stream has improved efficiency and reliability in ASC. 90% of the Core Value area has made LM successful in the ASC. Education and awareness on the Core values of the organization is available on charts and company television (TV) in the company library and canteens. The Core Values and outstanding lean technique are screened on company TV during lunch time to remind, update the employees on pertinent issues, provide feedback on success factors and announce the award-winning teams.

### **5.8 Proposed improvements**

The implementation of LM can be done by benchmarking industries that uses similar machines and materials. This help in collaboration and providing appropriate training to the workforce. The building up green scrap technologies is easily done when benchmarking an industry that has similar functions.

### **5.9 Significance of the new areas**

The new barrier areas improve the implementation success rate by facilitating Cleaner Production plant operations to sustain the business and its core values. Use of green materials allows the materials to be reused at the end of their life.

Obsolete materials are raw materials for downstream industries which buy them to generate income. All plastic products from thermosets are ground and used as fillers and strengtheners. Some are used as fuel for energy recovery supplements in furnaces such as brick kilns. Thermoplastics are recycled and used to make cheaper structural products and toys.

Green manufacturing processes cleanse the emissions of any toxic substances to prevent pollution. Use of activated carbon catalysts in auto exhaust systems reduces atmospheric pollution otherwise in cities where you have many cars the atmospheric gases would be choking. The security of employees allows CI and productivity at the expense of the generic 8 waste. The safety of workers, equipment and machinery enforces the Standard operating Procedures in manufacturing to meet the customer needs.

Car breakers have created employment opportunities for people who strip old parts from accident damaged parts for reuse. The old parts are reconditioned and companies like Barnet and Mandos have established mutual trust with the manufacturers and service garages who get parts from these car breakers. The companies meet the core values of the customers. The 2nd hand Toyota parts spares outlet is available at Barnet, Toyo parts, and Car breakers such as Mando's and others resale used parts to repair companies and individuals.

The damaged body parts are sold to plastic and metal recycling companies where they are processed to form raw materials at the smelters to sustain the demand for raw materials. Metal scrap dealers buy scrap metal and supply the smelters for further processing. Plastic companies recycle thermoplastics whilst the thermosets are used as fillers or fuels for low temperature furnaces. Rubber materials are used by REDISA to form carpets, tiles stadium lawn to mention but a few. Metal waste is sold to scrap metal sales company for recycling. Employment opportunities and experiential training is offered by most companies that recycle and recondition parts.

## **6. Conclusions**

The ASC industry has adopted the upgraded 7S techniques and another upgrade may come since they practice CI. The new generic areas are used to retain employees, provide safety at work, and generate income to increase profitability. The new areas spearhead the setting up of downstream industries that consume scrap for recycling, stock, and sale old parts at car breakers which are a lifeline to many people.

The environment is cleaned of the scrap and old parts by scavengers who collect the automotive debris and sell usable parts to secondhand shops and recycling plants. These benefits are coming from the upgraded generic areas that uses green materials and processes. Academics and industry can use it as a generic framework to educate, train and empower the users in industry with modifications to suit their specific needs. Academics will use the knowledge to educate and train the students who will use the knowledge when they graduate and join the field of work. During their



studies they can use the knowledge to implement LM in the workshops and laboratories. Figure 2. shows a framework with both generic and upgraded barrier areas that are to adopter LM. Similarly, the companies that have already failed using the generic barrier areas can analyze the new framework and use it for the second attempt.

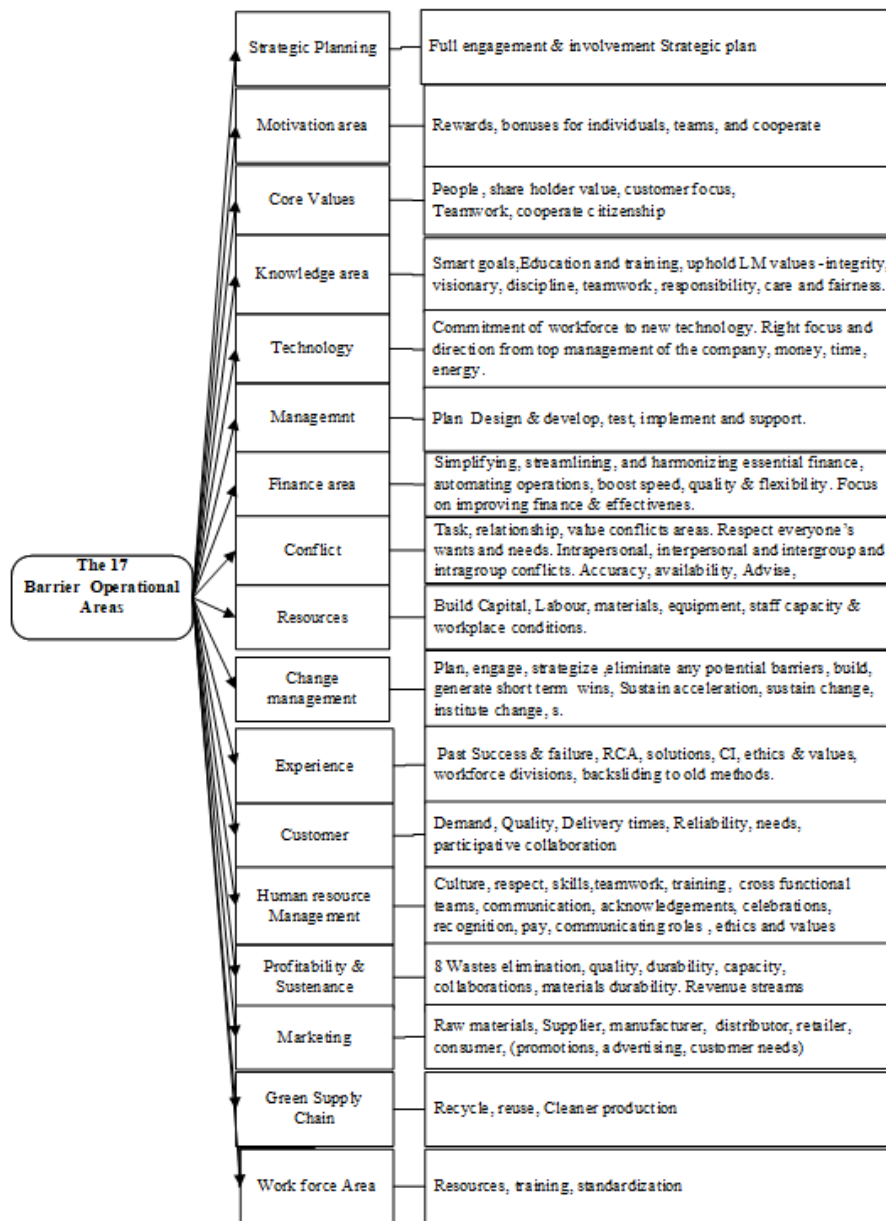


Figure 2. The framework of the 17 Barrier operational areas

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