Abc-Std-Mil-105e Sampling Standard & It's Impact On Average Outgoing Quality Level

Syed Muhammad Ali IEng MIMechE

Abstract— The objective of this study is to share the perception of the application of ABC-STD-MIL-105 E Sampling Standard for random sampling in automotive vending industries of Pakistan. There are sever international standard are being followed by this sector which are accessed periodically by certification bodies, but their qualitative performance they are delivering to their customers are generally not well known. The perception that MIL-STD better perform than 100% inspection or any other sampling inspection standards are shared with this community along with the hypothesis what it effect commonly on cost of inspection, supplier appraisal, help in decision making for inspectors and ultimately on the higher customer satisfaction. Beside Average Outgoing Quality Level (AOQL) was also the focal point of this study to determine what are their internal rejection rate at the time of final inspection of the finished product leaving vendor premises verses the percentage of rejection they physically received from original equipment manufacturers (OEM) in using diversified sampling inspection plan. Sample size of 96 vendors selected for study out of their population of 166 vendors and data collected on the basis of convenience sampling during the Auto Part Show held in 2014. Main objective are organization meeting the higher customer rate? Is the MIL-Standard is the strong enabler among the other locally applicable standards? Do their customers are highly satisfied with their AOQLs?

Key Words— ABC-MIL-STD-105E , Automotive Vendors, Average Outgoing Quality Level (AOQL), Inspection, Pakistan

1 INTRODUCTION

Automobile industry has the potential to spearhead the country's economic contribution and advancement towards creating jobs, new investment in vendor industry and opportunity for opening a door for new entries as vendors and Original Equipment Manufacturers (OEMs). Estimated vending units are 2800 units, out of which organized & Tier one are 670, Tire two are 900, small and cottage units are 1230 units, they are engaged in developing and producing auto parts for replacement market as well as for OEMs. In these vending industries 289 vendors are registered with Pakistan Association of Auto Parts & Accessories Manufacturers (PAAPAM) under their close collaborative efforts this sector of automotive vendor industries established and up till now this sectors have proven their capability by developing and producing 70% parts and accessories for cars, 80 % for three wheelers, 95 % for Motorcycles and 96 % for Tractors, with yearly growth rate of over 12 %. Pak Suzuki Motor Company (PSMC) is the 1st OEM established in Pakistan in early 1980, with inception of this operation in Pakistan the development of indigenous components started and PSMC transformed technology, skills to uplift local vending industries. After this successful experience other OEMs like Hino, Honda, Yamaha, Toyot, Nisan, Hyundai, Issuzu established in Pakistan. Still their major multinational OEMs are Toyota, Zuzuki, Honda, Hino, Nissan, Hyundai, Issuzu, Volvo, and many others including Koran and Chinese. These vendors are not only producing and supplying parts and accessories to automobile but also engaged in developing and producing parts for OEMs in engineering sectors like GRANDFOS pumps, KSB, Philips, and domestic appliances manufacturers of repute. This sector participated in 07 trade shows in 2012 and 07 trade shows in 2013 held in Germany, France and USA. The current export is US$ 128 Millions. Automotive vendors are playing a vital role in transformation of technology from OEM to vending industries, creating job opportunities, skill development where country's own human resources proven their capability across the world and most of the peoples from automobile sectors of Pakistan are rendering their services to General Motors, Chryslers, and other leading OEMs in the USA, Europe and Japan, UAE, and India as well. Organizing and celebrating their own Auto Show Parts at national level every year at major cities like Karachi and Lahore where auto buyers from across the world participated this show. PAAPAM formed in 1988 with aims and objectives to provide platform for technical & management support. PAAPAM is now more than two years decades and now attained a certain level of maturity. Almost all PAAPAM members are working under Certified Quality Management System ISO-9001-2008, QS9000, (M/s. Omer Jibran at Karachi is the 1st organization getting QS9000), TS-16494 (A Quality Standard for Automotive Industries, M/s.A-One-Technique is the 1st organization to certified under this standard), TQM, TQC, TPM & complying other engineering standards. Standardized sampling plan always yield better 'Average Outgoing Quality Levels (AOQL), ABC-MIL-STD-105E is one of the most well known standard applied throughout the globe particularly in Military organization engaged in inspection of arms and weapons since from the world war, similarly other engineering an allied organization are also using this standards and their quality level is extra ordinary satisfied.

2 RESEARCH DESIGN

This study is designed in context to small scale quantitative research, as comprehensive primary and secondary data in conducting, maximum data collected vide structured questionnaires and information through questionnaires verified to ascertain the credibility of information. The data collected from C.E.Os, Managers, Engineers and employee working in the department of quality assurance, parts development, and production planning & material control because they are the employees whose services are directly impacting on quality of goods and services in cross disciplinary areas. The data gathered vide questionnaires tested through statistical tool such as 'One-Sample T-Test using SPSS. Other information which are relevant to the vendor's verses customer rejection rate were represented graphically. Other data and information collected through various other source such as telephonic interview with executives who are not the part of contribution in filling the questionnaires in order to get their experts opinion during this interview information and data duly collected were also shared for verification and authenticity. In few cases some practices in few organization such as Hawks Engineering, Teletronics, Silver Falcon, as well as other vendors in small and medium scale industries were also referred as a basis of analysis objectively to determine the use of MIL-105E and its

impact on their performance. I also referred my past experience in Dewan Farooque Motors where I introduced and implemented MIL-105E sampling standards and evaluated several vendors as a key member of vendor development committee and where I improved manufacturing system in term reducing their rejection rate by improving their process control.

2.1 Research Methodology

Since the study was quantitative in nature and majority of the questionnaire were bases on the perception so an One-Sample T-Test conducted to determine the degree of respondent's agreement on my perception to confirm that MIL-STD-105E impact on the cost, providing rules to shift to more sever acceptance criteria, criteria for switching over other qualitative supplier, and in building increased customer confidence in getting more market shares, as well as the combination of these four basic important attribute leads to least rejection rate. Questionnaires were distributed to 96 respondent of 100 organizations out of which 96 responses were received, 04 organization refused to participate due to their internal management policies. Questionnaire was consist of 20 questions out of which 16 questions were quantitatively analyzed through SPSS. The rest of 04 question were qualitative questions which were represented graphically.

2.2 Sample and Sampling Technique

The Directory of "Pakistan Association of Parts and Accessories Manufacturers" was referred as the 'Sample Frame' for this study. Where vendors out of 289 were belongs to Punjab. Convenience Sampling followed and 96 questionnaires filled during the event of Pakistan Auto Show Parts 2014 held at Lahore. Data collected by hired engineers from OEMs.

The respondents of these questionnaires are classified as under.

1. C.E.Os.
2. Managers.
3. Engineers
4. Technical Staff working in cross disciplinary areas in inter-firm relationship.
5. Few questionnaires were filled by the executives who either retired from OEMs or served in vendor industries for a long period of time but currently working in OEMs.

2.3 Selection of Sample Size

2.3.1 Convenience Sampling Plan

Initially this was planned to circulate the questionnaires via emails and postal mail services, but unfortunately the Pakistan Auto Parts Show was going to held at Lahore. As this was most convenience to collect information during this event of Auto Show Part, that held in the Lahore in February 2014, where almost all vendors and OEMs of automotive sectors from all areas of Pakistan were available and this was the golden opportunity to meet with experts in vendors, hence data and information collected in this event. A working groups of few engineers and executives assisted in collection of data and these information were also shared with the senior experts in automobile industries of Pakistan during the same event. Sample size (N) = 100 vendors

3 LITERATURE REVIEW

American Society for Quality, 2013, During period of second world war 1941, quality become an essential demand of business especially in manufacturers of arms and ammunition in the United State with the core concept of safety because an unsafe arms and ammunition was not accepted to military forces. Manufacturers faced an problem in 100 % inspection as this incurred a huge labor cost and on other side 100 % inspection required time constrain and more inspectors for inspecting and testing a large population size of the lot tendered for inspection. To resolve these issues in quality without comprising on safety issues a sampling inspection introduced and implemented that economically suitable as requiring minimum manpower who choose randomly the samples as per given criteria and took decision on acceptance or rejection of lot on the basis of acceptance and rejection criteria provided by the given sampling tables based on the statistical research. Before the world war in mid of 1920, Bell Laboratories worked on statistical quality control, that after world war published with relevant tables for selection of sample size against the given lot size with decision making acceptance and rejection values, Leavenworth S. Richard & L. Grant Rugene (1987) later on during the years 1960 to 1962 experts from America, Britain and Canada formed a working group known as ABC they engaged in formulizing on agreed common standard for acceptance sampling by attributes to be used by three countries. The international designation of MIL-STD-105 is based on the "Average Outgoing Quality Level (AOQL) ABC-STD-MIL-105D of which later version released in 1962 as ABC-STD-MIL-105E. This system is now widely adopted by government and private industrial sector and yielding effective and efficient result in all type of products. ABC-STD-105-E is based on three main tables identified as table *L to N* attached as **Annex-C** to **Annex-E** these tables provided sample size and acceptance and rejection numbers in light of which inspector judgment is based. This system provide three main level known as the normal, tightened and reduced level, for selection of sample size inspector must refer to the AOQL and sample size code letter against the population or lot sizes, table also provide ranges of population or lot size for example 1 to 15, 300 to 500 and so on. Another table known as table *K* attached provide the relationship between population or lot or batch size and the code letter that determine the sample size. The "general inspection levels" on the right-hand side of the table are the being used in most common cases when less discrimination if required.

2.5.1 Selecting a Sampling Plan for Normal Inspection:

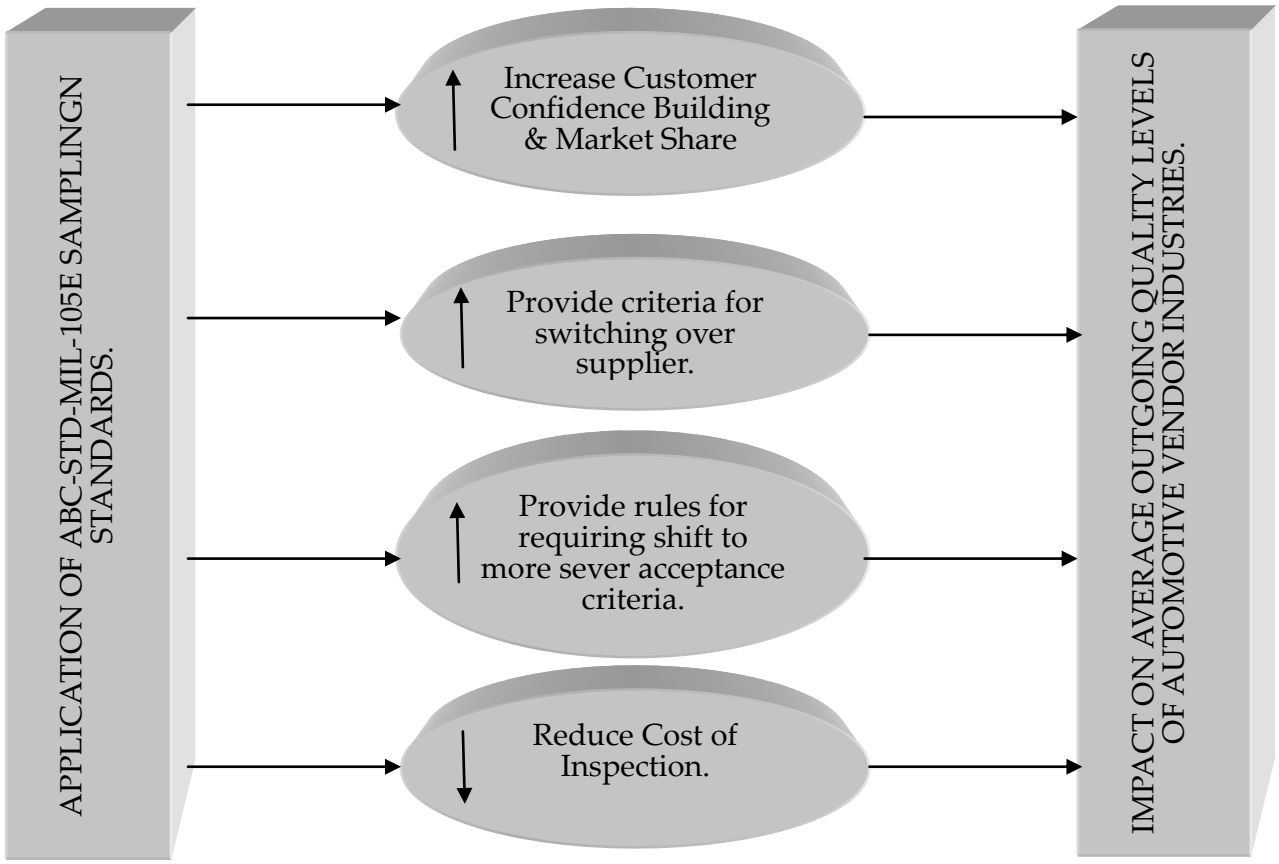
If an inspector assumes that an AQL (Acceptable Quality Level) of 1.5% has been specified for a certain class of defects, in this case normal inspection with a population or lot size of 11,50 and with selection of level II, the Table *K* tells the code letter for your selected sample size if J. For normal inspection and single sampling table L provides criteria tells us that sample size code letter J with acceptance quality level of 1.5 required sample size is 80 and also provide the criteria of acceptance or rejection numbers for example in this case on completion of final inspection of entire units within sample size if three defectives found only the lot will be accepted on other hand if 4 defectives found the entire lot will be rejected. Dr. Shingo Shigeo, Ohno Taiichi (1989), created the Just-in-Time system (JITS), Ohno Taiichi who was the executive managing director of Toyota and who realized a connectivity in Toyota

Production System (TPS) Single minutes exchange of die (SMED). This theory proved and Toyota employee can achieve die changeover in three minutes. JITS provides additional information, highlights system's important areas with weaknesses exists, control over-production, support for Single minute exchange of die (SMED) that enable to respond customer demand within shortened cycle time. SMED lead to improve die and tooling setup in two ways; the internal, which is being performed when machine is idle and the external when machine is in operation, hence SMED separate internal from external operation, convert desire internal operation to external, standardize the function, not the part profile outwardly seems to be acceptable, facilitates application of clamps and fixtures and focus on one touch methods to fasten the dies on machine Shingo;s significant features of Toyota Production System are, to reduce even eliminate inventory, reduce labor cost and elimination of organizational fats. In TPS the Process and the Operation are being the main focal point, in process material transformed into product through a series of operation such as inspection at all level, storage of inventory, whereas operation are the action of workforce and machines performed on the material to shape semi-finished and or finished products. In other words process is the flow of material or product that also termed as product flow and operation is the critical examination of workforce and machine's activity that also termed as work flow. Two important questions are being addressed while improving the process, first the product redesigning in order to maintain and or improve quality with reduction in manufacturing cost, and second the improvement in manufacturing system of a product. Inspection is the key element in improving process, it is the activity of comparison with respect to defined or described standards of quality. In improving the process and operation of inspection traditionally we sort out non-conformities from the conformities that is called the judgment inspection, we can improve the judgment inspection but improvement but it does not so much effect on defect rate but the inspection errors. Simple acting as for discovering of defects has no worth until and unless it communicate to process owners for their necessary preventive measures – this is called informative inspection. The objectivity of inspection is to reduce the defect rate rather than to discover them – the judgment inspection. For reduction in defect rate informative inspection are being required A good process should be built-in-design, meant the Quality should be built in all stages of manufacturing processes, feedback from judgment inspection has no means if provided after the completion of process. There are two main type of the Informative Inspection, the Self Inspection in which the production worker inspect the quality of his concern process stage, the main drawback of this self inspection is that process stage worker may compromise judgments and accept the rejected one which ought to be rejected intentionally or unintentionally both. The other main type is the Successive Inspection that is based on internal supplier-customer relationship concept in which worker prior starting part of his operation first inspect the quality of semi-finished operation they received from the previous operation. Self inspection attain process quality objective as it provide quick and immediate feedback on other hand it reduce average 86 percent reduction in defects. Enhanced self inspection This provides the fastest feedback. Self inspection can be enhanced with the use of devices that automatically detect defects or inadvertent mistakes. Such systems give the individual worker immediate feedback, achieve 100% inspection, and prevent defects. Physical detection devices are called poka-yoke or "mistake-proofing" devices. Source inspection are carried out at source to control the condition that prevents the defects. Vertical source inspection provide identification and traceability of problem in back throughout the process in order to control the causes of defects that affect the on the process quality. Horizontal source inspections identify the condition during the operation and control those condition that affect on the process quality and ultimately the product quality. Poka-yoke Inspection Methods Poka-yoke achieves 100% inspection by using engineering devices such as electronic sensors to stop and warn the process operator to take corrective and preventive measures to correct the process parameters in order to correct the problem, similarly mechanical ejectors that eject glass bottle in single line screening inspection to control the frequency of defects and beside alerts the worker at screen inspection to a problem In case of continual frequency of defects. In poka-yoke inspection 100% inspection is more convenient as jig or fixture are being used to inspect the fitment of product / part that seats at jig or fixture appropriately and 100% inspection in this way is possible to assist quality inspector to accept or reject the product. For example if a part does not seat appropriately at inspection jig it means the one or more dimension of the part does not qualify to the specification and inspector thus reject. Khan A Tariq, 2004 stated in his book Japanese Management, A practical approach with Indus experience that poka-yoke is a fail-safe or fool proof devices that not only give inform employee and help them to prevent from making mistake but also serve as safety device to protect worker from accident it also ensure worker in choosing correct way of assembling the part on vehicle. Abdullah Rashid, Lall Maharjan Keshav and Tatsuo Kimbara (2008) stated that, the Original Equipment Manufacturers (OEMs) focus on the manner in which supplier deliver parts and sub-assembly that defect-free, cost effective and timely delivery of supplies to meet their local as well as global competitiveness. If the part or sub-assemblies produced and supplied by their vendors is lake in any of these respect, the OEM review their decision for looking alternatives source of supply or to work with existing vendor to improve their manufacturing system objectively improve their performance for getting qualitative supplies of parts and sub-assemblies as the switching over to alternative supplier incur high cost. It means firms rely on outside supplier for quality, reliability, timely delivery, cost effective with continuous improvement with innovative approaches. Firms therefore continuously involve in building inter-firm relation with their vendors ensuring and enabling them capable in order to compete in such global competitive environment. When PROTON established its manufacturing business in 1985 there were only 17 vendors supplying 52 parts with low-tech traditional local parts. Now there are 182 vendors supplying more than 4,000 parts to PROTON. The main philosophy of outsourcing parts by PROTON was the challenge of maintaining long-term technological and economic viability. The decision was based on perception of vendor's capability of quality, quantity, delivery, price, after-sales-service, and spare parts availability in replacement market. Where as the CKD parts such as engines, transmission and fasteners are still being imported from Japan, and under indigenous development of parts PROTON localized its 690 more parts in 2006. At PROTON suppliers are

being selected in two stages: First the feasibility study stage, the supplier's assessment in which man, machine, method and material are assessed in term of SWOT analysis by examining their strength, weaknesses, opportunity and threat, the second stage is the evaluation of targeted cost and prices on which they will supply the parts. Quality, cost, delivery (QCD) was selected as the top priority. Once the vendors are being qualified and enlisted as company's approved vendors their periodic performance are being monitored, PROTON classify their vendors in two category, first constitutes established suppliers who proved to be reliable and as a qualitative source since long and other category of the newly inducted vendors who required closed technical and managerial assistance. Vendors are rated in term of quality, technical & financial capability service and cost. In inter-firm relationship vendors are provided by OEMs in regards to financial assistance, technical assistance in term of automation and upgrading of tooling and equipments under technical agreements. In inter-firm relationship building the PTOTON frequently interact with their vendors in regards to the Design Quality Conforming Meeting (DQCM) in which they auditing vendor's process audit; ensuring and evaluating off-tool-sample and pilot lots; Production Quality Confirmation Meeting (PQCM) in which technical staff from OEMs visit and inspect vendor's premises for examining operational activities in their production; Quality approval on required standards and practices; All the potential vendors are provided with part drawing, process specification, inspection and test standards, get cost estimate and quoted price. Then the OEM place order to verify the quality and engineering specification as per required standards. Generally OEMs strictly focus about the timelines to judge the vendor's capability to supply parts timely, failure in timely supply causes the chance that PROTON will not necessarily mean to accept them as vendor because a good quality and timely supplied parts enable OEM to incorporate into the final product (the car). After approval of preset parts OEM if think cost is not meeting their objectivity of end product cost they negotiate, after satisfying all requirement PROTON inform vendor about approval. Second step is running the initial regular volume supplies to evaluate the production validity in order to inspect the consistency in vendor's production process ensuring good quality of the parts and performance of vendors – this process is known as the plant and production audit and this is generally the responsibility of Quality Control Division (QCD) in conjunction with parts development department to endure quality of outsourced parts, punctuality and regularity in delivery with reasonable agreed cost. (the responsibility of cost lies on parts purchasing department. The responsibility of QCD is to evaluate and ensure vendor's capability in producing good quality parts as per their pre-defined standards. QCD monitor the factors of production processes, plant, machineries and equipments of the vendors. In inter-firm relationship OEMs wishes the vendors to have QC standard in production, incoming and outgoing inspection, where as incoming inspection refers to sampling procedure to test the quality of raw material at arrival in order to meet the quality of end product. OEM also ensue that vendors have a formal QC section, testing equipment, qualified technical team, production tooling such as dies and mould. Doner Richard F. Gregory W. Noble and John, Ravenhil (2006) vide their research stated that, for success in auto part industries in the countries of China, Indonesia, Japan and Korea during the period of Asian Financial crises in 1990 suggested the need to promote economic of scale, skill development, quality upgrading, inter-firm relationship building and innovative approaches. In Japan, the leaders in auto industries and government together played a vital role in diffusion of quality control techniques and adaption of technological changes. Elisabeth J. Umble (2000) stated that Deming main focal point was to built a close relationship between the workforce and its management for effective and efficient input of employee for betterment of process, system, method and improvement as a cross functional working group. Result oriented process would not possible until and unless based on quality-based improvement with utilization of advance manufacturing tools and practices such as "Just-in-Time Manufacturing. Ahire L. Sanjay L. & Shaughnessy, (1996) concluded, commitment at top of the hierarchy yields high production with higher quality whereas low commitment at top level yields the primary predictor of product quality such as customer focus, empowerment and the quality management system in their sub-supplier system. Akira Takeishi and Takahiro Fujimoto (2001), worked on increasing attention on modularization in the auto industry, this modularization is a phenomenon based on three facets comprising 1) Product Design, which define the functional interdependence and the structural interdependencies where functional interdependence leads towards the measurement of product function through a only one subsystem and the structural interdependence is the handling of parts collection as one unit. 2) Production System, that addresses product structure and the product processes process 3) Inter-Firm System, which leads to outsourcing production of auto parts which is the major attention of the Western automaker under three circumstances of the lower labor cost, diminishing the investment cost, and reduction in the first-tire vendors, and in doing so they are taking risk of shifting more responsibilities to their vendor, beside gaining pay back on their investment. This research also proven price of auto parts being produced and supplied by the auto vendors situated near original equipment manufacturers reflect their investment cost where as the vendors of small scale business pay higher investment cost. Western automakers greatly focus on the self-contained quality system in which parts and or subassembly is being inspected not on the stage if final inspection at the time while product is leaving its manufacturing premises but on the completion of part and subassembly and in so doing worker and management can gain a real sense of accomplishment. That is why the Japanese are increasingly shifting on new self-contained lines. As compare to single part the use of subassembly also has some demerits such as its handling and logistic due to weight and size requiring additional jigs and fixtures for packaging and transportation which ultimately increase the cost, perfection in fitness onto main vehicle, accuracy in integration of parts. Fujimoto and Ge (2001) stated the importance of approved drawing for certain parts for clearly define the responsibilities of quality control because the outsource subsystem can undertake this responsibility as an independent sefl-contained units and the development and production be outsources with confidence building for sharing and standardization to a certain extent by vendors. The engineers engaged in product design, process and procurement must take a careful decision within these boundaries because these decisions are interrelated. These cost, inter-firm relationship building and the self-contained

quality is still in the trail and error across the world. Sako and Murray (1999) shared their argument on the correlation of these three facet of modularization, further close coordination between intra-firm and inter-firm should be focused. Langlois and Robertson (1992), stated that Society of Automotive Engineers (SAE), (1910) focused on standardization for auto parts for more efficient assembly for automakers but it did not become a reality because unfortunately only small scale auto vendors advocated SAE and faced resistance from major original equipment manufacturers such as General Motors and Ford Motors who did not intended to lose their strong monopolistic position and stuck to their own standards. Nakamura Masao, Sakakibara Sadao, and Schroeder Roger (1998), focused on integrated approach of quality management (QM) in achieving sustainable organizational performance in attaining defect free quality performance in organization wide cross functional areas at all levels and in so doing organization meet higher customer satisfaction. Their research also reveals that some organization do not consider effects of QM on cost, whereas application of some statistical process control tools particularly the sampling inspection positively effects on cost explicitly. Customer satisfaction also enhance when they play their ultimate role as they provide valuable quality feedback about the plant's quality performance.

3.1 Conceptual Framework



3.2 Hypothesis

Sampling Inspection by attribute has become increasing demand of national and international Original Equipment Manufacturers and their associated vendors who also expect the defect free and improved suppliers from their sub-vendors. Most of the OEMs in USA, Europe, and in other countries are using ABC-MIL-STD-105E as important tools in their random sampling inspection. These sampling inspection are not necessary be followed at the stage of their final inspection but also at arrival of lot from their sub-vendors as well as during process sampling standards also being followed by using a little sample size at all or targeted respective process stages, evident that, if Sampling techniques are used with its real practical approach, it enable the organization in enhancing their customer confidence and beside it reduces the cost.

Hypothesis 1

ABC-MIL-STD-105E Sampling Standard reduces the cost of Inspection.

Hypothesis 2

ABC-MIL-STD-105E Sampling Standard provide rules for Shifting more sever acceptance criteria.

Hypothesis 3

ABC-MIL-STD-105E Sampling Standard provide criteria for switching over from one supplier to another.

Hypothesis 4

ABC-MIL-STD-105E Sampling Standard is one of the tool in enhancing customer's confidence building.

4.0 DATA ANALYSIS AND PRESENTATIONS

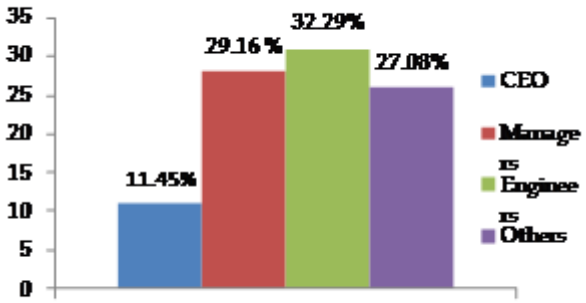
This small scale quantitative research based independent study is a determination of conceptual impact of ABC-MIL-STD-105E on the four of its basic attributes affecting ultimately on the ultimate on their average outgoing quality levels. The sample of 96 vendors out of 166 were selected for analysis through getting responses against the perception vide structured questionnaire during the Auto Part Show 2014 by using convenience sampling. The descriptive summary of quantitative analysis is illustrated in the chart given below. The copy of SPSS data sheet also attached.

Descriptive Summary of the Data						
Q	*Particulars*	*St. Disagree*	*Disagree*	*Neutral*	*Agree*	*St. Agree*
1	*100 % Inspection*	*1.04 %*	*3.125 %*	*29.17 %*	*31.25 %*	*35.41 %*
2	*Sampling Inspection leads towards no inspection*	*1.04 %*	*3.125 %*	*28.13 %*	*30.26 %*	*33.33 %*
3	*MIL-STD reduced the cost of inspection*	*2.08 %*	*3.125 %*	*21.90 %*	*28.13 %*	*44.79 %*
4	*Reduced inspection provide nonfinancial incentives*	*2.08 %*	*2.08 %*	*15.62 %*	*47.91 %*	*32.29 %*
5	*MIL-STD improved level of quality involved less insp.*	*1.04 %*	*2.08 %*	*14.58 %*	*42.70 %*	*39.58 %*
6	*1/20 defect lot shall accepted but inspect discontinuted*	*1.04 %*	*4.16 %*	*15.62 %*	*37.5 %*	*41.26 %*
7	*Levels in MIL-STD ensures little change of rej.*	*1.04 %*	*4.16 %*	*18.75 %*	*45.83 %*	*28.12 %*
8	*When normal insp is in effect, tighten insp……..*	*1.04 %*	*2.08 %*	*23.95 %*	*41.66 %*	*31.25 %*
9	*When 2/5 consecutive lots rej tighten insp instituted*	*1.04 %*	*3.125 %*	*18.75 %*	*33.33 %*	*43.75 %*
10	*MIL-STD provide criteria for switching suppliers*	*1.04 %*	*5.20 %*	*17.70 %*	*47.91 %*	*28..13 %*
11	*MIL-STD provide criteria for direct delivery at belt*	*1.04 %*	*3.125 %*	*19.79 %*	*45.83 %*	*31.24 %*
12	*MIL-STD data provide performance record*	*1.04 %*	*2.08 %*	*15.62 %*	*33.33 %*	*47.91 %*
13	*MIL-STD data also used for vendor's appraisal*	*1.04 %*	*2.08 %*	*23.95 %*	*28.13 %*	*44.80 %*
14	*Relationship b/w AOQL and customer's satisfaction*	*-*	*3.125 %*	*15.62 %*	*46.87 %*	*34.38 %*
15	*AOQL is strong enabler gaining market share*	*1.04 %*	*3.125 %*	*15.62 %*	*33.33 %*	*46.80 %*
16	*AOQL is strong for global auto buyer's satisfaction*	*1.04 %*	*-*	*29.17 %*	*40.62 %*	*29.17 %*
17	*MIL-STD widely being used automotive industry*	*1.04 %*	*3.125 %*	*21.90 %*	*45.8 %*	*28.13 %*

4.0 Data Analysis & Interpretation

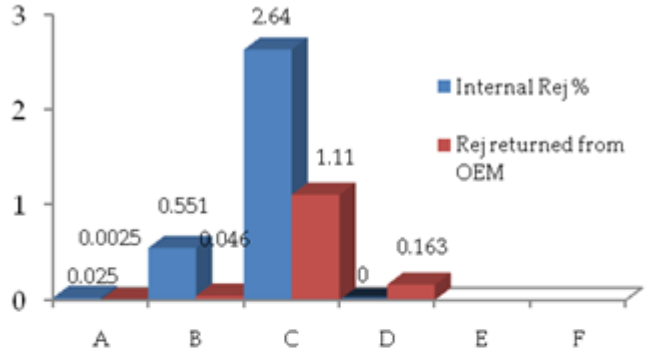
Statistics of Respondents.

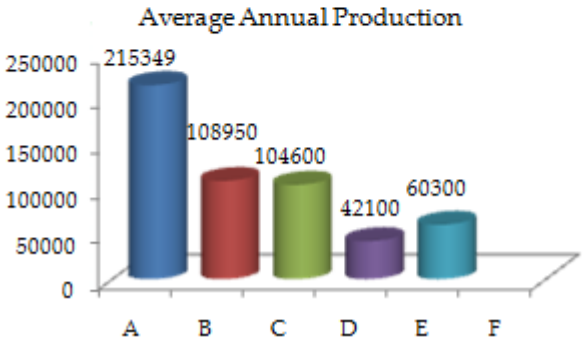
Designation	*Frequency*	*Percent*	*Valid*	*Cumulative*
CEO	*11*	*11.45*	*11.45*	*11.45 %*
Managers	*28*	*29.16*	*29.16*	*30.61 %*
Engineers	*31*	*32.29*	*32.29*	*62.9*
Other Staff	*26*	*27.08*	*27.08*	
TOTAL	*96*	*96*	*100.0*	*96*



Vendors Category	Vendor Classification	Size	Production (units)	Internal Rejection %	Rejection from OEM %
A	Org following ABC-STD.MIL-105E Sampling Plan	28	215349	0.025	0.0025
B	Org following fixed Inspection	16	108950	0.551	0.046
C	Org following 100 % Inspection	23	104600	2.64	1.11
D	Org following No-Inspection	9	42100	0	0.163
E	Org shared production data but not provided rejection data	14	60300		
F	Org not provided production and rejection information	6			

Comparison of Vendor's Rate of Rejection Vs Rate of Rejection returned by OEMs





5.0. FINDINGS AND INTERPRETATION

5.1 Testing of Hypothesis

Hypothesis tested using SPSS, to determine what mathematical model supported to the perceptions asked to respondent.

H1: ABC-MIL-STD-105E Sampling Standard reduces the cost of Inspection.

In this hypothesis vendors capability determined whether what are their perception in terms of ABC-MIL-STD-105E Sampling Standard impact on cost of their inspection.

One-Sample Test

	N	Mean	Std. Deviation	Mean Difference	T	Sig. (2-tailed)
Reduce_Cost	96	4.0563	.46855	**.05625**	**1.176**	.242

This table indicates the value for the one sample t-test, the degree of freedom also shows the significance value. By using this significance value, statistical conclusion could be finished as to whether or not the population mean and the sample mean are equal. If the significance value is less than the encoded significance level, which is 95% confidence interval or .05 value of significance. If the designed mean value is greater than the investigation value, and the sig., value is greater than the investigation value , and the sig value is greater than .05 it mean that there is no difference between null hypothesis and conclude that the mean of the test value and sample are statistically equal. If the sig. value is less than .05 its mean that difference is exist between the sample mean value and the test value or investigation value, after getting sig. value the mean difference value has been checked whether it is positive difference or negative difference. If the dissimilarity is positive its mean sample value is greater than test value again hypotheses would be accepted.

According to the above table, the sig. value of *'reduce the cost'* is significant but mean difference is positive which is .05625 , this hypothesis can be accepted on the basis of mean difference.

H2: ABC-MIL-STD-105E Sampling Standard provide rules for shifting more sever acceptance criteria.

In this hypothesis perception addressed that ABC-MIL-STD-105E Sampling Standard provide rules to shift to tighten level if the supplier's desire average out going quality level is not met or shift to reduced level if the satisfaction level due to higher improved average out going quality level is excellent and up to the mark.

One-Sample Test

	N	Mean	Std. Deviation	Mean Difference	T	Sig. (2-tailed)
Provide_Rules_More_	96	4.0479	.42227	.04792	1.112	.269

On the basis of which OEMs shift business orders from those vendors who are failed to provide desired average outgoing quality levels. Hence this standard helps in getting higher customer satisfaction and in so doing getting more market share.

According to the above table, the sig., value of '*shifting more sever acceptance criteria'* is significant but mean difference is positive which is .04792, this hypothesis can be accepted on the basis of mean difference.

H3: ABC-MIL-STD-105E Sampling Standard provide criteria for switching over from one supplier to another.

This hypothesis include the perception whether ABC-MIL-STD-105E Sampling Standard impact on the supplier switch over criteria and vendors are using historical data recorded through use of MIL-105 standard for appraising supplier prior switching over to an other supplier.

One-Sample Test

	N	Mean	Std. Deviation	Mean Difference	T	Sig. (2-tailed)
Switching Criteria	96	4.0972	.37632	.09722	2.531	.013

According to the above table, the sig. value of criteria for *'switching over from one supplier to another'* is significant but mean difference is positive which is .09722

, this hypothesis can be accepted on the basis of mean difference.

H4: ABC-MIL-STD-105E Sampling Standard is one of the tool in enhancing customer's confidence building.

This hypothesis perceived that A BC-MIL-STD-105E Sampling Standard enhance customer's confidence building, by providing improved average outgoing quality level and on the basis of which OEMs shifts business orders from those vendors who are failed to provide desired average outgoing quality levels. Hence this standard helps in getting higher customer satisfaction and in so doing getting more market shares.

One-Sample Test

	N	Mean	Std. Deviation	Mean Difference	t	Sig. (2-tailed)
Customer_ Satisfaction	96	4.0182	.47050	.01823	.380	.705

According to the above table, the sig. value of '*customer's confidence building'* is significant but mean difference is positive which is 0.01823, this hypothesis can be accepted on the basis of mean difference.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study concluded and reveals that a larger quantity of automotive vendors are either following ABC-STD-MIL-105 Standard for sampling process at their incoming, during process, as well as at their final inspection prior delivering a lot to their customers, or most of vendors has attained the level of their maturity who randomly use this standards at all stages and ultimately their system are so matured that they are directly delivering their finished product without inspection and quantitative data reveals that the rejection rate are not only zero at their final inspection but their customer rejection rate are also zero. Which determine the higher customer satisfaction. Beside this study proven that 100 % sampling incurred high cost and this does not ensure the stable average out going quality levels (AOQL).

6.2 Recommendations.

1. This is highly recommend that vendors in all areas of automotive and engineering sectors as well as in allied sector such as glass container manufacturers, pharmaceuticals industries, must use this standards to save their inspection and process cost.
2. OEM and Vendor should make a contractual agreement on the Inspection Level, AQL in order to avoid discrimination in judgment of final inspection, OEM must well aware through which criteria their vendor has tendered their consignment.
3. Vendors are recommended to leave the practices of 100 % inspection as it incurred high labor cost beside inspection by sampling for a large volume lot always may skip critical, major defects which ultimately hinder OEM's process during assembly of cars and ultimately their confidence building will not maintain with OEMs.
4. Vendors are also encouraged to apply statistical process control technique frequently at all levels as this provide higher level of prevention in defectives and control or reduce the cost of failure also.

7.0 AREA OF URTHER STUDY

Research should be conducted on other standards such as ANSI, Poka Yoke, Statistical Process Control, Process Capability to highlight the problem faced by manufacturers if not applying these tools and techniques.

Study also needed to research whether these core tools, techniques and standards are covered by professional education institutions.

HEC is advised to focus on these tools including Six-Sigma, lean manufacturing and award scholarship for study on these disciplines to enhance the productivity and quality level.

REFERENCES

[1] Akira Takeishi (2001), "Modularization in Auto Industries"

[2] American Society for Quality (2013)

[3] Doner, Richard F., Gregory W. Noble, and John, Ravenhill (2006) "Industrial competitiveness of the auto parts industries in four large Asian countries : the role of government policy in a challenging international environment.

[4] Dr. Shingo Shigeo, Ohno Taiichi (1989), A Study of the Tovota Production System From an Industrial Engineering Viewpoint

[5] Elisabeth J. Umble, The Implications of Deming's Approach.

[6] Fujimoto and Ge (2001), "Modularization in Auto Industries"

[7] Khan, A Tariq (2005); "Japanese Management –A Pactical Approach with Indus experience"

[8] Langlois and Robertson (1992), "Modularization in Auto Industries"

[9] Leavenworth S. Richard & L. Grant Rugene (1987) Statistical Quality Control

[10] Nakamura Masao, Sakakibara Sadao, and Schroeder Roger (1998); "Adoption Jist-in-Time Manufacturing Methods at U.S. – and Japanese-Owned Plants: Some Empirical Evidences.

[11] Rashid Abdullah, Maharjan Keshav Lall and Kimbara Tatsuo, (2008), Supplier Development Framework in the Malaysian Automotive Industry: Proton's Experience.

[12] Sanjay L. Ahire (1996), The role of top management commitment in quality management: an empirical analysis of the auto parts industry.