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Analysis of Low Productivity in Public Sector Automobile Rebuild Organizations

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Abstract- Public sector automobile rebuild industry plays an important role towards national economy in developing countries. Nevertheless, productivity of these public sector organizations remains generally very low as compared to private sector organizations which thrive due to competitive market pressures and profitability. This paper attempts to identify reasons for low productivity in public sector automobile rebuild organizations of Pakistan. Towards this end, one of the biggest public sector automobile rebuild organization was selected. Primary data related to productivity measurement was collected from the selected organization. Thereafter, data regarding causes of low productivity was collected qualitatively by conducting semi-structured interviews with open ended questions from thirty two top and middle and supervisor level management professionals. Results indicate that reasons for low productivity in public sector automobile rebuild organizations are diverse variety of vehicles, poor classification/inspection of parts with diluted skill of inspectors, lengthy public procurement procedures, limitation of trading-off between price and acceptable quality of spare parts, improper maintenance, use of outdated tools/test equipment, rework & quality issues, ignorance about productivity cycle, tools and techniques, shortage and imbalance of technical human resource/equipment, unsafe working environment, absence of performance audit, non-agility, limited automation, huge inventories, supply chain anomalies, lack of accountability, bureaucratic culture and deviation from standard engineering practices.

Keywords- Low productivity, automobile, rebuild, public sector

I. Introduction

Productivity of private and public sector automotive industry has significant contribution towards national economy. Extensive research work has been carried out to enhance the productivity of private sector organizations to maximize their profitability. However, public sector organizations have been neglected to identify the causes of low productivity [1]. Mahadevan [2] stated that role of public sector automotive industry is equally important for economy of developing countries and there is a dire need for active participation of public sector automobile industry to boost economic growth in developing countries.

Globally, automobile industry is one of the leading industries in rebuild sector with 70% of all rebuild organizations being in the automotive sector [3]. Moreover, rebuilding of automobile components is the most dominant out of all major products that are being rebuilt [4]. In developing countries like Pakistan, public sector organizations emphasize rebuild of vehicles instead of replacement to avoid burden on national economy and to ensure utmost utilization of old vintage equipment. Hence, enhancement in productivity of rebuild organizations is a major challenge for the developing economies and requires a thorough research.

Keeping in view the importance of rebuilt industry, research scholar has selected one of the biggest local public sector automobile rebuild organization in south East Asia for this research. Selected entity has been named as Organization-A. Target organization has 2541 employees and is well established covering an area of around 50 acres. Organization has the capacity to rebuild 700 vehicles per year.

In view of peculiar and distinct characteristics of public sector rebuild organizations, orthodox productivity improvement techniques and models are not fully applicable on these organizations. This paper attempts to identify shortcomings/grey areas leading to low productivity in public sector automobile rebuild organizations.

II. Literature Review

Rebuilding is emerging as a potent strategy for the organizations to meet sustainable goals [5]. Automobile rebuilding is a multi-tiered process and involves return of product/vehicle from customer, inspection, dis-assembly, cleaning, refurbishing,

upgrading and re-assembly to transform into a "like-new" product [6][7]. Rebuild industry accomplishes stabilization in prices, green economy and creation of jobs [8] as rebuild products are typically sold at 30–60% lower prices than the new products and energy is saved by around 70–80% as compared to manufacturing. Rebuild is a labor intensive industry and offers three times more opportunities for employment than general manufacturing [9]. Rebuilding is generally referred to as a "win-win-win" situation as customers make less payment for the rebuild products, rebuilding organizations earn more and environment benefits. In a nutshell, rebuilding contributes towards sustainability in the form of economy, environment and society [10].

In rebuild organizations, productivity is a vital indicator for achieving excellence in performance. Organizations improve productivity and enhance quality in order to remain sustainable [11]. Productivity actually implies competitiveness of an organization. Enhancement in productivity leads to improvement in profitability in private organizations and improvement in performance of public sector organizations. In contrast to private sector organizations, public sector enterprises are generally inefficient and ineffective especially in developing economies [12]. Organizations in public sector owing to sub-optimal performance are now being held accountable worldwide and are required to justify authentic use of public funds [13]. Trend of productivity measurement in public sector automobile rebuild organizations is swiftly changing and becoming popular amongst the developing countries [14]. Implementation of productivity measurement, monitoring and improvement program in public sector automobile rebuild organizations results in increased output and performance. Effort has been made to identify reasons for low productivity in these organizations.

Automobile rebuild cycle is carried out in four phases in Organization-A. In Phase-I, liaison is established with the customers to identify and finalize vehicles which have completed stipulated life and require rebuilt. Demand for release of funds is initiated by concerned Department. In Phase-II, automobiles are deposited by the customers, dismantled and thoroughly inspected with respect to which part/assembly is to be replaced, reused and rebuild. Parts to be reused and rebuild are segregated and dispatched to relevant sub Groups for cleaning and subsequent preparation for fitment whereas action for procurement of actually required parts/assemblies is initiated. In Phase-III, spares parts are received and inspected. Vehicle is re-assembled with a combination of reused, rebuild and replaced parts. Assembled vehicle is shifted to paint Group for painting. In Phase-IV, complete rebuild product is checked and tested for quality and performance. After testing, customer is informed to visit and check rebuild product as per their requirements. In case of any observation, vehicle is returned back to concerned Group to address the issue. Thereafter, product is handed over to customer with a warranty period of three years.

Rebuild process is required to be completed within a fiscal year in a public sector organization. Timelines to carry out rebuild of vehicles include one month for Phase-I, three months for Phase-II, seven months for Phase-III and one month for Phase-IV. These timelines are generic and may vary as per the make, type and brand of vehicles. Rebuild of vehicles is carried out in batches of similar brands and make and types by Organization-A. Complete automobile rebuild cycle with stipulated timelines and activities being followed in Organization-A is shown schematically in figure 1.

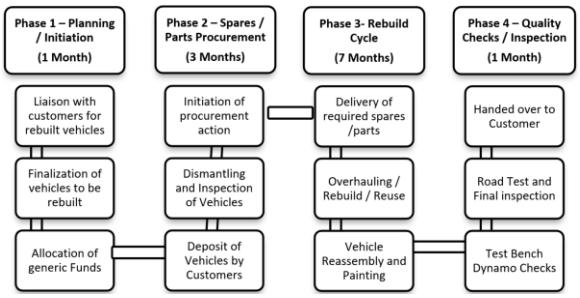

Fig. 1 Automobile Rebuild Cycle

Automobile refurbishment process in a public sector organization includes complete disassembly of a returned vehicle up to chassis level. All dismantled components are sent to respective sub Groups such as chassis, engine assembly, axle, transmission, suspension, paint, fuel tank, tires, battery, seats, speedometer, alternator, self-starter, etc. A detailed inspection is carried out by each Group after cleaning to ascertain fitness and serviceability status of different parts/assemblies. This inspection process involves testing of certain critical assemblies/parts to ascertain their serviceability whereas some parts are inspected visually for their correctness. Change of parts/components is governed by must change, condition based and time based parameters. A consolidated requirement of spare parts/assemblies which are to be procured, reused and rebuild is generated by all sub Groups. Subsequently, the master list is processed for procurement of essential spares/components while raw material is procured separately for parts to be rebuild and remaining parts are checked for reuse.

Organization-A is having dedicated Quality Assurance Department (QAD) and Quality Control (QC) paraphernalia. Quality is monitored and checked at source i.e workshop floor by QC representatives to ensure correct inspection and measurement of dismantled parts. Thereafter, inspection of newly procured spare parts and stage inspection is managed by QC whereas final inspection and testing of

finished product/vehicle is carried out by QAD. Test gauges and measurement tools available with QAD are of old vintage and not calibrated.

Procurement time for spare parts and raw material for rebuild is the most critical aspect of rebuild organizations. Timely delivery of rebuild product to customer is entirely dependent on the timely procurement and availability of spare parts and raw materials to the sub Groups. Engine is overhauled and tested on dynamometer with full load. Automobile is re-assembled again on main assembly line with a mix match of certain parts/components replaced, certain parts/spares reused whereas remaining parts are rebuild. Optimal balancing of this assembly line plays a critical role in enhancing overall productivity of the rebuild organization. Balancing of main assembly line in automobile rebuild organizations significantly contributes towards productivity enhancement of the organization [15]. Productivity improvement in any industrial sector depends upon concept of 5M which includes optimal balancing of man, machines, material, methods and efficient management for improved output/performance [16]. Different methodologies for balancing of assembly line include uniform distribution of workload among work stations, no of work stations, no of machines/equipment etc [17]. Notwithstanding above, concept of balancing of assembly line in automobile rebuild organizations is still naïve and generally ends up in low productivity of the organization.

In order to ensure quality of rebuild product, vehicle is road tested alongside separate quality checks of all systems by the QAD of organization. After successful quality checks, customers/users are informed for testing and collection of finished product/vehicle. Customers carry out detailed checking of rebuild vehicle including road testing. In case of any customer observations and additional requirement, rebuild vehicle is reverted to relevant sub groups to address the anomalies. Refurbished vehicle is handed over to customer after complete satisfaction with a warranty of three years. Complete process is shown diagrammatically in figure 2.

Procurement of spare parts for more than 100 types/variants of vehicles is carried out in the Organization-A. Moreover, it is pertinent to highlight that more than 750 spare parts/components per vehicle are being procured in addition to the parts which are being reused as well as rebuild. Procurement of this huge number of spare parts of different qualities with varying cost effects while remaining within the Government rules/regulations is the biggest challenge for a public sector automobile rebuilt organization. Procurement cycle of spare parts takes around 3-4 months due to official procurement procedures and audit requirements. These include tendering, comparative statements, issue of order to lowest bidder while making a trade-off between quality and cost.

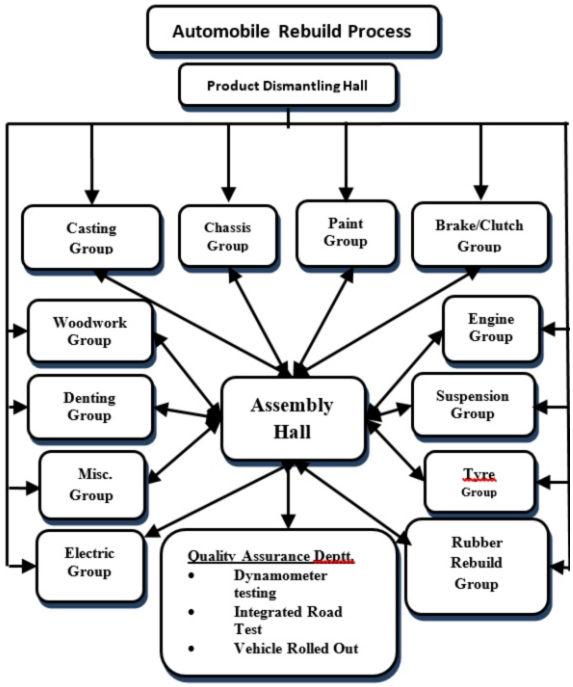

Fig. 2 Automobile Rebuild Process

Selection of appropriate quality of spare parts is again a very critical aspect of automobile rebuild industry. Details of spare parts to be procured for one variant/model of Toyota Double Cabin are shown in Fig 3.

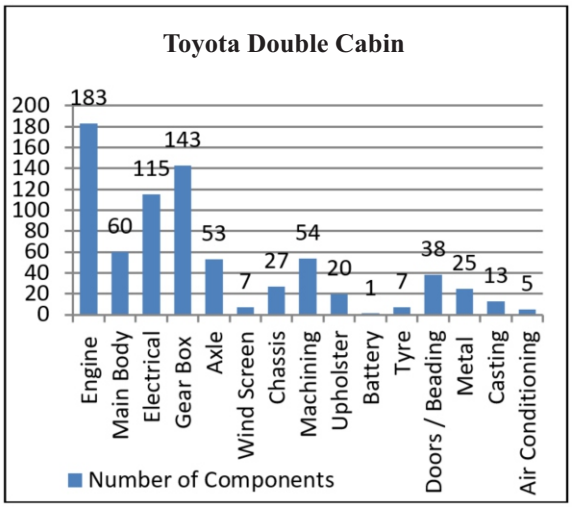

Fig.3 Spare Parts of Toyota Double Cabin

Overall total productivity of the Organization-A was measured as 29% for the year 2017/18 and organization has been able to rebuild only 200 - 210 vehicles against the capacity/target of 700 vehicles per year. In order to analyze productivity, total productivity of the Organization-A for the last 10 years was calculated and shown in Fig 4.

It is worth mentioning that productivity of the organization has risen from 21.9% in year 2008/09 to 29% in year 21017/18 during a span of 10 years. Although, productivity of public sector automobile rebuild organization has shown a minor increase during this period, yet total productivity is still far below desired standards probably due to absence of a viable mechanism to monitor and measure productivity. It has been observed that certain shortcomings in the system such as inordinate delays in procurement of huge number of spare parts, inefficient, ineffective and orthodox engineering practices culminate into sub-optimal performance of the Organization-A. Therefore, public sector rebuild organizations essentially require an in-depth productivity measurement and analysis review to identify the causes of low productivity and to have a dedicated model for productivity improvement in automobile rebuild organization.

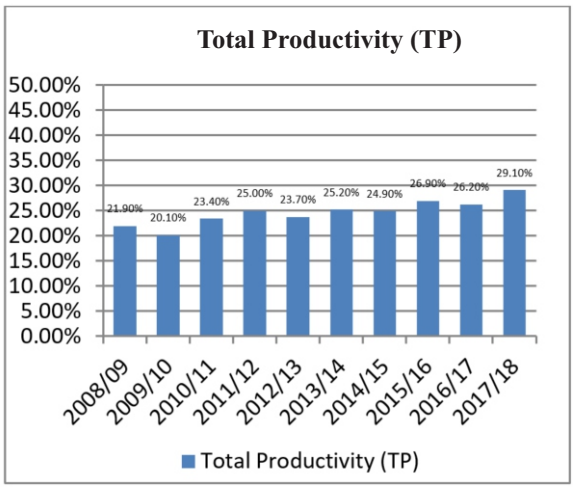

Fig.4 Total Productivity of the Organization from Year 2008/09 to Year 2017/18

III. Methodology

Research was carried out qualitatively to investigate reasons for low productivity and low output/performance in public sector automobile rebuilt organizations. Primary data related to productivity measurement was collected from the selected organization. Thereafter, data regarding causes of low productivity was collected qualitatively by conducting semi-structured interviews with open ended questions. A total of thirty two respondents which included top management, middle management and supervisor level from different public sector automobile rebuild organizations were interviewed with open ended questions. Keeping in view the objectives of this research, it was mandatory to interview only those experienced public sector professionals who had a deep insight into the productivity dynamics of public sector automobile rebuild industry. The selected respondents were serving in different public sector rebuild organizations. To ensure external reliability, qualitative interviewing was conducted using interview guide [18-23] consisting of 10 items extracted from published material. Duration of interviews was from half to an hour with special focus on low productivity in public sector rebuild organizations. Main themes of interviews remained the same; however formulation of questions varied with respect to experience and background of professionals being interviewed. Respondents were sent framework of interview questions in advance. Maximum interviews were conducted face-to-face with few exceptions via telephone. Results obtained and concurrence of researcher's ideas confirmed internal reliability and validity of this research. Research was carried out using ethno methodology. Ethnography and participant observation coupled with qualitative interviewing was conducted for holistic qualitative analysis. Triangulation methodology was adopted to avoid bias among the respondents. Out of thirty two respondents, fifteen were from Organization-A and seventeen from five different public sector rebuild organizations. It is necessary to mention that only those rebuild organizations were selected for data collection which had minimum of 1000 employees. Data collected qualitatively was evaluated utilizing qualitative content analysis. Focus of analysis remained on content and meaning rather than expression or construction of text. Finally, data was classified methodologically in a chronological sequence to address the objectives of this research.

IV. Data Collection

Based on the interviews and scrutiny of documentary evidence, data related to reasons for low productivity and low output/performance of public sector automobile rebuild organizations was collected. Subsequently, data was sifted and organized in a sequential manner to extract relevant information and identify reasons for low productivity in these organizations. Details of data collected are discussed in the following paragraphs:-

A. Diverse Variety of Vehicles in Public Sector Organizations

Respondents highlighted that as per procurement rules, public sector rebuild organizations are bound to purchase vehicles from lowest bidder within similar category of automobiles. Moreover, requirement of vehicles with respect to make, type and brand in public sector organizations keeps on varying with the change in policies and priorities of government. As a result, vehicles of different make and type with varying brands are procured in public sector organizations and concept of standardization of equipment is not in practice. Documentary evidence provided by Organization-A regarding rebuilt of vehicles with different make,

type and brands verified the opinion of respondents. This aspect leads to serious repair, maintenance and rebuild issues as technicians are not properly trained and well equipped to manage effective rebuild and repair of all available vehicle variants. In addition, procurement of different types of rebuild spares for such diverse variety of vehicles further compounds the issue as it leads to dependence on different suppliers, separate checks/quality standards for spares of each brand, lack of technical expertise, non-standardization of rebuild processes, etc.

B. Poor Classification of Stripped Parts for Reuse, Rebuild and Replacement

Industrial experts/professionals interviewed informed that in rebuild process, a vehicle is completely stripped and dismantled to component level. Thereafter, dismantled parts are distributed to relevant Groups for inspection by experts for segregation of faulty components. During inspection/assessment, critical decision is to be made regarding selection of parts and assemblies which are required to be reused, replaced or rebuild. A wrong assessment/decision by an inspector leads to time delays as rebuild process for that lot of vehicle will stop till that specific part is procured or rebuild. Respondents were of the view that poor classification of stripped parts leads to low productivity in public sector rebuilt organizations. In this context, few examples extracted from the record made available by Organization-A regarding complications faced by automobile rebuild sector are as under:-

1) Fuel Injection Pump Assembly

Fuel injection pump of Toyota Hiace van is stripped into 160 parts for rebuild purpose. After assessment, 90 parts are to be cleaned and reused, 10 parts are to be rebuilt and 60 parts are to be replaced.

2) Gear Box Assembly

Gearbox of Double Cabin comprises of 143 sub parts. After inspection, 106 parts are to be cleaned and reused, 11 items are to be rebuilt whereas 26 parts are to be replaced / procured.

3) Engine Assembly

Engine is stripped for overhauling into 183 sub parts. In engine assembly, parts are either replaced or reused to ensure viable life cycle after rebuilt. 93 parts are replaced and 90 are reused in engine of a utility truck.

C. Lengthy Procurement Procedure for Spare Parts

As per documentary evidence provided by Organization-A and information gained through interviews, procurement of spare parts in public sector rebuild organizations takes around 3-4 months due to limitations of rebuild process and lengthy public procurement rules/procedures. Process of vehicle deposit, dismantling, dispatch to relevant Groups for detailed inspection, finalization of lists of spare parts requiring procurement takes around one month. Hence, requisitions for spare parts are initiated after a lapse of almost one month after arrival of vehicles which is an inherent delay and limitation in rebuilt system. After finalization of demands, tendering is done. Lowest bidder in tendering is awarded supply order for provision of spare parts. Almost another month is consumed in this process. In view of experts interviewed, even after issue of supply order, a lot of time is wasted by suppliers to locate required spare parts in the market and deliver to rebuild organization which indicates voids in the relationship between the supply chain echelons. Acceptance and physical fitment of spare parts is further delayed due to inspection/testing procedures, paper formalities, difference of opinion in Country of Origin, quality issues, etc. Delayed delivery of spare parts by vendors disrupts complete rebuild project cycle and timelines. Resultantly, backlog is created as most of activities are interlinked within different rebuild Groups.

D. Trade Off between Price and Acceptable Quality of Spare Parts

Respondents during course of interviews shared that quality of spare parts being procured by public sector rebuild organizations is one of the biggest issues which ultimately affect the overall quality of finished product besides causing delay in delivery to customer. In light of the record made available by Organization-A, few important issues being faced by public sector automobile rebuild organizations with regards to quality of supplied spare parts are as under:-

1) Variation in country of origin as per supply order and physically delivered spares.
2) Sub-standard quality spares in fake original packing.
3) Refurbished parts in new packing.
4) Slight difference in physical appearance between local and genuine spares, resulting in premature failure.
5) Counterfeit parts causing failure at testing stage damaging more parts than actual, thus wastage of time and money.

E. Old Vintage Engine Test Benches / Dynamometers

Industrial experts/professionals interviewed highlighted that a huge variety of vehicles with different make, type and brands are rebuilt by the public sector organizations. In order to ensure quality, rebuilt engines are tested on universal test benches and dynamometers with load prior to fitment in vehicles. Owing to non-standardization of vehicles, most of the test benches and dynamometers do not support testing of complete range of engine assemblies of all variants of vehicles. In addition, documentary evidence provided by Organization-A reveals that calibration of held test benches and dynamometers is also not been

done which affects the essential parameters required for checking of engine statistics. Furthermore, analogue dynamometers are being used instead of digital which are more accurate and furnish precise test parameters. Therefore, quality of rebuild engines ultimately gets compromised.

F. Non Availability of Spare Parts of old Vintage or Unique Model Vehicles

Respondents shared that one of the biggest challenges for rebuild organizations is non-availability of spare parts/components of old vintage or some unique model vehicles in market. Concept of standard modular replacements is still very naïve in developing countries. Record made available by Organization-A reveals that most of the time, requirement is of those spares/components which are part of a sub-assembly and are not easily available in local market and sometimes even internationally. Manufacturing of these parts has either been done by the OEM or design alterations have been made by OEM in upgraded versions. In such cases, rebuild organizations have to make original part reusable by some sort of modification or redesign the component through reverse engineering which consumes time. Rebuild operations for that particular lot of vehicles thus get delayed till availability of required parts.

G. Frequent breakdown of the Machines / Test Equipment

As per documentary evidence provided by Organization-A and information gained through interviews, frequent breakdown of the machines/test equipment is experienced in public sector organizations which affect timely completion of ongoing rebuild operations thereby causing a delay in delivery of product to customer. Frequent breakdown of machines/equipment signifies that employees are not involved in maintenance and not held accountable for a machine failure. Non-implementation of preventive and proactive maintenance strategy by the management is evident in Organization-A.

H. Use of Outdated tools / Test Equipment

Respondents were of the opinion that use of old and non-standard service tools/test equipment by the employees and ignorance regarding benefits of using standard service tools (SSTs) directly affects quality of rebuild products. It results in premature fatigue of technicians thereby degrading output and compromising quality besides increasing unproductive man hours. Record of tools/test equipment in Organization-A fully supports the above stated facts. Practice in public sector organizations is to continue using old and non-standard service tools as lengthy public procedural formalities are involved for its disposal and replacement.

I. Lack of Test Jigs / Fixtures for Specific Assemblies

Industrial experts/professionals were of the strong opinion that certain automobile assemblies require specialized test jigs/fixtures for standalone testing for rebuilt purpose. Examples of non-availability of test jigs for turbochargers, superchargers, steering hydraulic pumps, speedometers, coil springs etc with Organization-A is a case in hand. Due to non-availability of specialized test jigs/fixtures, newly procured assemblies as well as assemblies retrieved out of returned vehicle are temporarily accepted based on knowledge of experienced employees, but are tested after fitting and complete assembling of the vehicles. At this stage, if some assembly is found faulty, a lot of work needs to be redone which invariably involves multiple rebuild Groups. Due to this rework, overall rebuild operations get delayed besides wastage of time, effort and resources.

J. Capacity of Rebuild Sub Groups Not Consistent with Overall Output

Respondents shared that performance of public sector automobile rebuild organizations in a fiscal year is ascertained against their designed output. In order to achieve overall rebuild target at organizational level, capacity of all sub-groups must be in consonance with overall output of organization as in manufacturing organizations. System experts are of the opinion that just like manufacturing organizations, limited capacity of certain rebuild sub groups obstructs the overall output of rebuild organizations and thus becomes a bottleneck in the system. In this regard, example of Painting Group of Organization-A was observed. Organization-A having 2 x paint booths can accommodate 2 x vehicles for painting at any point in time whereas 3 x vehicles are being received daily from other Groups. Therefore, paint Group by virtue of its limited capacity is a bottleneck in Organization-A. Due to bottleneck, backlog is built up thus affecting timely completion of finished products besides causing delay in delivery to the customers. Therefore, capacity of test equipment held with any sub Group in rebuild organization should be in consonance with overall output of the organizations.

K. Dispersed Location of Rebuild Facilities

Respondents shared that different technical Groups within the organization are located in a dispersed pattern and their physical layout do not commensurate with sequential flow of rebuild activities/operations. This erratic layout results in wastage of time due to excessive and haphazard movement of assemblies and vehicles within the Groups. For example, a vehicle screw jack has to be rebuild in Casting Group in Organization-A. This assembly is required to be threaded prior to dispatching it to Miscellaneous Engineering Group for fixing of base plates. Screw jack will be carried away to a distantly located machine

Group and next day it will return back to same shop for further dispatch. Such activities cause wastage of time, effort and resources.

L. Random Location of Machines & Test Equipment inside sub Rebuild Groups

During interviews, rebuild professionals informed that machines and test equipment inside different rebuild Groups are not sited and installed as per process requirements in public sector automobile rebuild organizations. This ultimately results in delaying complete cycle besides unnecessary and haphazard movement of products. Machines are installed against the concept of batch methodology/work/cell centers in Organization-A and their location is not consistent with the work flow. This is a neglected aspect in public sector organizations where concept of continuous improvement is yet to be truly implemented in the organizations.

M. Rework & Quality Issues

Documentary evidence of Organization-A reveals frequent rejection and rework cases of finished rebuild products which depict quality issues in public sector automobile rebuild organizations. During course of interviews, it was highlighted that customers invariably pinpoint flaws in finished rebuild product which compels management to return vehicle to concerned Groups to address the observations whereas same should have already been addressed by Quality inspectors of that rebuild sub Group. Respondents highlighted that improper stage inspection by quality inspectors and non-utilization of statistical quality control tools lead to rework and quality issues in finished products. Rework leads to deviation from the scheduled timelines and delayed handing over of finished product to the customer besides wastage of time, effort and resources.

N. Non-Existence of Productivity Setup and non-application of productivity Improvement Techniques

Organization-A had no dedicated productivity setup with permanent human resource i.e productivity professional/expert rather an adhoc setup with makeshift arrangement was available. In view of the respondents, non-existence of permanent productivity setup and non-application of productivity tools and techniques are common features in public sector rebuild organizations. Furthermore, productivity improvement techniques like JIT, Lean operations, Kaizan, Kanban, TQM etc are also not implemented in Organization-A in particular and in public sector automobile rebuild organizations as a whole. However, rebuild organizations generally employ professionals of other sub Groups as a makeshift arrangement to run the Productivity Cell on adhoc basis which results in low productivity. Respondents further added that ignorance about productivity cycle including measurement, evaluation, planning and monitoring is another cause of low productivity in these organizations.

O. Non-provision for Rewards, recognition and financial Incentives

Organization-A, as per records available, has no provision in rules/regulations to allocate funds for application of employee based techniques including financial incentives, workers recognition and rewards, etc. Non-provision for such like financial incentives leads to lower morale and deny active participation of workers. This is evident from the productivity and output record of the organization for the last 10 years. Industry experts were of the opinion that non-provision for financed based productivity improvement techniques for employees in public sector automobile rebuild organizations is one of the causes leading to low productivity in these organizations.

P. Erratic Staffing & technical balancing of Facilities

Staffing and balancing of different rebuild Groups including Casting, Transmission and Brake in Organization-A was not in consistence with the role, scope and volume of that particular rebuild process. In view of industrial experts/professionals, erratic staffing and imbalance of human and technical resources in sub Groups in public sector rebuild organizations results in underutilization of resources besides wastage of time.

Q. Imbalance in Human and Technical Resources

Respondents shared that incorrect balancing of human and technical resources decreases the productivity in rebuilt organizations. Technical activities of main rebuild Assembly Line were not properly planned and coordinated in Organization-A. Durations of rebuild/overhaul processes of assemblies in different sub Groups were varying. Finished assemblies were delivered to Main Assembly Hall in a haphazard and hotchpotch manner which resulted in imbalance of technical activities, erroneous commitment of workers and resources leading to reduced output.

R. Poor Workmanship/Skill level viz-a-viz Technology

Respondents were of the opinion that technical skill and knowledge of employees viz-a viz latest technology in public sector automobile rebuild industry is very low. Poor workmanship affects the quality of the rebuild product. Lack of training, low educational background of employees, non-adherence to technical manuals/process sheets and deviation from standard procedures in Organization-A result in enhanced rejection/failure rate thus accruing additional cost to the project. Furthermore, owing to rapid transformation of technology, latest vehicles are being inducted with PCB based sensitive electronic systems. These systems require training and advanced skill levels. For rebuild purpose, in depth knowledge of

equipment is essentially required.

S. Unsafe Working Environment

Respondents during interviews highlighted that cluttered and unsafe working conditions contribute towards low productivity in public sector automobile rebuild organizations. Furthermore, efficiency of workers/operators was affected by improper ergonomic conditions in these organizations. Motivation, morale and loyalty of workers are assumed to be key elements which directly affect productivity. Organization-A had multiple work stations that were cluttered with raw material, scrap, insufficient light, inadequate safety precautions, improper ergonomic workplaces etc.

T. Non Application of Methods Engineering and Work Measurement Studies

Scrutiny of record of Organization-A and opinion of interviewers reflect that practice of periodic conduct of methods engineering and work measurement studies to raise productivity levels is not implemented in public sector rebuild organizations. Methods engineering and work measurement studies are extremely important to reduce process cycle time and to shed away inefficiencies from the rebuild process.

U. Non-existence of Performance Audit

Respondents were of the view that performance audit of public sector automobile rebuild organizations is not carried out. Absence of internal and external performance audit in these organizations is one of the causes of low productivity. Conduct of regular audit to weigh the performance of public sector organizations against designed capacity leads to identification of flaws in the system. Record of Organization-A also highlights that performance audit has not been conducted in last 10 years.

V. Non-Agility of Public sector Rebuild Organizations

Respondents were of the opinion that public sector rebuild organizations are non-agile as these organizations function as per standard procedures and are designed for specific customized products. Case study of organization-A reveals that in case of a changed variant of vehicle or some specific change requirement of customer, complete rebuild cycle gets affected and delayed due to non-flexibility in the system. Non-agility of public sector rebuilt organizations thus causes low productivity.

W. Limited Automation/Mechanization in Public Sector Rebuild Organizations

Documentary record available with Organization-A reveals that efforts to automate and mechanize different rebuild processes were not made by the organization in last 10 years. Rebuild processes based on old orthodox engineering practices were followed by the organization. Respondents were of the view that limited automation/mechanization in public sector rebuild organizations leads to low productivity and output of these organizations.

X. Lean Inventory Management

Record of Organization-A revealed that public sector automobile rebuild organizations undertake rebuilt of more than 100 types of vehicle variants. It is extremely cumbersome as well as cost prohibitive to maintain updated inventory of all required spare parts of vehicles in these organizations. Nevertheless, sufficient inventory has to be maintained in warehouse to address impromptu requirements. As per respondents, public sector rebuild organizations have huge inventories covering maximum of vehicle variants to cater for any redundancy. Maintenance of huge inventories is very cost prohibitive and against the concept of lean inventory. Moreover, viable materials handling system is also not implemented in these organizations.

Y. Supply Chain Anomalies

Respondents admitted that one of the major issues faced by the public sector automobile rebuild organizations is the delayed procurement and delivery of spare parts. This results in delaying the complete rebuild cycle. Duration and delivery date of spare parts extracted from documents in Organization-A was a testimony to aforementioned fact. In contrast to the latest supply chain management concept, relationship between the public sector rebuild organizations and the suppliers is not based on mutual trust, long term affiliation and agreement. Due to the presence of bureaucratic culture prevalent in public sector automobile rebuild organizations, suppliers are expected and forced to deliver the spare parts as an outsider rather than involving them as a mutual working team member.

Z. Customer Feedback Analysis

Documentary evidence of Organization-A indicate that customer feedback regarding performance, quality and usage of rebuild vehicles is sought to identify shortcomings in the rebuild processes and accordingly make improvements in procedures. However, repetition of same faults in the rebuilt vehicles reflects that generally aspect of feedback is not given due importance in public sector automobile rebuild organizations. Respondents were of the opinion that a proper customer feedback system with an aim to correct the procedures/processes in public sector automobile rebuild organizations is essential to raise quality standards, avoid rework and improve productivity.

AA. Specific Trades / Expertise in case of Public Sector Employees

Respondents highlighted that an employee has a

specific technical trade and is trained to perform only his trade work in public sector automobile rebuild organizations. On the contrary, employees in private sector organizations are trained to perform multiple tasks in order to have desired multi-tasking proficiency. Respondents of Organization-A have verified that absence of experienced operators on critical machines becomes a bottleneck in the system. This aspect clearly highlights the importance of multiple tasking specialty of employees, job rotation and job diversification in public sector automobile rebuild organizations.

BB. Lack of Accountability and Prevalent Bureaucratic Culture in Public Sector Rebuild Organizations

Respondents with adequate experience of serving in public sector automobile rebuild organizations have emphasized during interviews that aspect of lack of accountability and bureaucratic culture in public sector automobile rebuild organizations is one of the major factors leading to low productivity in these organizations. Organization-A has not been able to achieve its target of rebuilding 700 vehicles per year during the last 10 years. In view of respondents, lack of accountability and bureaucratic culture are one of the leading causes for delayed delivery as well as low quality of finished products in public sector automobile rebuild organizations.

V. RESULTS

Conduct of interviews with system specialist experts/professionals and scrutiny of relevant documentary evidence reveal that despite adequate funding and resources, multitude of reasons lead to low productivity and output of public sector automobile rebuild organizations (Organization-A is a case in hand, Fig 4). This is primarily attributed to certain distinct characteristics and peculiar working environment of public sector automobile rebuild organizations. Significant number of respondents has highlighted identical reasons for low productivity. Results of qualitative survey have been tabulated duly indicating causes of low productivity alongside number of respondents. Data is shown in Table 1.

These are some of the problem areas which are highly specific to public sector automobile rebuild organizations. These inherent characteristics are the root causes leading to low productivity in these organizations.

TABLE I
RESULTS OF QUALITATIVE SURVEY

Ser No	Causes of Low Productivity	No of Respondents
01.	Diverse variety of vehicles	30
02.	Poor Classification inspection of parts	31
03.	Lengthy public procurement procedures	30
04.	Trade-off between cost and quality of spares	31
05.	Old vintage test benches	27
06.	Non-availability of spares for unique model vehicles	25
07.	Improper maintenance	29
08.	Non-application of latest project management tools/ techniques	29
09.	Outdated tools/ test equipment/ test jigs	27
10.	Imbalance of technical and human resource	26
11.	Improper layout of shops/ work centers	27
12.	Rework & quality issues	30
13.	Ignorance and non-application of productivity tools and techniques	31
14.	Shortage of technical and human resource	25
15.	Non-provision for rewards and recognition	26
16.	Poor workmanship	27
17.	Unsafe working environment	28
18.	Non-existence of time and motion studies	26
19.	Absence of performance audit	26
20.	Non-agility (non-flexibility)	25
21.	Limited automation	29
22.	Huge inventories	27
23.	Supplier related anomalies	26
24.	Customer feedback irregularities	25
25.	Lack of accountability and bureaucracy culture	30
26.	Specific trades/ expertise	27
27.	Non-standard engineering practices	30
28.	Absence of productivity professional/ expert	29
29.	Improper stage inspection	28
30.	Non-implementation of productivity measurement & improvement cycle	30

VI. Discussion

Results achieved through qualitative analysis explicitly indicate reasons for low productivity and low output/performance of public sector automobile rebuild organizations. Role of aforementioned factors in causing low productivity in these organizations cannot be overemphasized. Delphi method [24] was resorted to by the research scholar to extract suitable variables along with ranking based on aforementioned causes of low productivity. A Delphi panel of ten productivity experts was shortlisted based on minimum twenty years of experience in public rebuild sector. Anonymity amongst the experts was ensured. Consensus amongst the panelists was achieved after conduct of three questionnaire rounds. Causes of low productivity ranked most critical by Delphi panel have been highlighted in italics in Table II. These causes of low productivity were grouped as per their application and impact by Delphi panel. Resultantly key variables were derived for public sector automobile rebuild industry. Details of variables generated are shown in Table II. These variables were also verified through literature review.

TABLE II
GENERATION OF VARIABLES & RANKING BASED ON QUALITATIVE SURVEY & DELPHI METHOD

Ser No	Causes of Low Productivity
Human Resource Management (HRM)	
01.	Poor workmanship
02.	Specific trades/ expertise
03.	Non-provision for rewards & recognition
04.	Shortage of technical & human resource
05.	Imbalance of technical & human resource
Technology Management (TM)	
06.	Limited automation/ mechanization
07.	Outdated tools/ test equipment/ test jigs
08.	Old vintage test benches
09.	Unsafe working environment
10.	Ignorance about latest project management tools / techniques
Spares Parts Management (SPM)	
11.	Lengthy procurement procedures
12.	Trade-off in cost & quality of spares
13.	Non-availability of spares for unique model vehicles
Quality Management (QM)	
14.	Poor classification inspection of parts
15.	Improper stage inspection
16.	Rework & quality issues
Public Sector Rebuild Dynamics (PSRD)	
17.	Diverse variety of vehicles
18.	Improper maintenance
19.	Lack of accountability and bureaucracy culture
20.	Improper layout of shops/ work centers
21.	Non-agility (non-flexibility)
22.	Non-existence of time & motion studies
23.	Absence of performance audit
24.	Non-standard engineering practices
Supply Chain Management (SCM)	
25.	Supplier related anomalies
26.	Customer feedback irregularities
27.	Huge inventories
Productivity Management (PM)	
28.	Ignorance and non-application of productivity tools and techniques
29.	Non-implementation of productivity measurement & improvement cycle
30.	Absence of productivity professional/ expert

Notwithstanding above, some of the reasons for low productivity in automobile rebuild organizations are critical and have a stronger impact on productivity in light of views proffered by respondents. In this regard, application of Pareto Principle (80%-20% rule) is a feasible option to resolve this issue [25]. According to the rule, roughly 80% of the effects come from 20% of the causes. Therefore, Pareto rule was applied to aforesaid causes of low productivity. 20% of the causes form the backbone and are recommended to be adopted by public sector automobile rebuild organizations in the initial phase. These include lengthy public procurement procedures/rules, huge variations in quality of spare parts, diverse variety of vehicles, inappropriate inspection procedures with diluted skill of inspectors, rework and quality issues, lack of accountability, bureaucratic culture, ignorance about productivity techniques, non-application of latest project management tools/techniques, improper maintenance, non-implementation of productivity measurement and improvement cycle, absence of

productivity expert and deviation from standard engineering practices. Public sector automobile rebuild organizations are therefore required to initially address these 20% root causes of low productivity which will partially resolve 80% of the remaining issues.

VII. Conclusion

Productivity of public sector automobile rebuild organizations is intrinsically low as compared to private organizations. Based on results of qualitative analysis carried out in this research, public sector automobile rebuild organizations possess certain distinct characteristics and peculiar environment which lead to low productivity. Root causes of low productivity in these organizations need to be addressed. Placement of technologically enabled professionals in these organizations, ensuring proper accountability and optimized use of human and technological resources are certainly required to improve the productivity of public sector automobile rebuild organizations. Application of latest productivity measurement and improvement tools and techniques in automobile rebuild organizations is essentially required to overcome the causes of low productivity. Finally, it can be concluded that public sector automobile rebuild organizations basically require a formal, dedicated and customized productivity improvement model.

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