REFORMULATION OF PRODUCTIVITY IMPROVEMENT MODEL FOR PUBLIC SECTOR AUTOMOBILE REBUILD ORGANIZATIONS

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ABSTRACT

Public sector automobile rebuild industry contributes significantly towards national economy in developing countries. Nonetheless, productivity and output of public sector rebuild organizations remains very low despite huge budgetary disbursements. On the contrary, private sector organizations achieve high productivity and output as these organizations work to maximize their profit. This paper attempts to identify reasons for low productivity and reduced output of public sector automobile rebuild organizations of Pakistan. Input in this research was sought primarily from top, middle and lower management of public sector automobile rebuilt organizations. Data from a total of two hundred and sixty-two respondents representing twenty-one different automobile rebuild organizations was compiled through quantitative survey and analyzed statistically through SPSS. Results implied that public sector automobile rebuild organizations due to certain peculiar characteristics possess low productivity and essentially require a distinct productivity improvement model. Based on the shortcomings/inadequacies identified through literature review, qualitative and quantitative analysis, an inclusive productivity enhancement model for public sector automobile rebuild organizations was reformulated. Proposed model when implemented holistically in rebuild organizations can produce positive results whereas implementation of proposed practices in piecemeal/isolation may not accrue true and optimal outcomes. The findings of this research will facilitate top and middle management to enhance productivity and output of public sector automobile rebuild organizations of developing countries in general and Pakistan in particular.

KEYWORDS: *Low productivity, output, automobile, rebuild, productivity model*

INTRODUCTION

The globalization of world trade and emergence of new markets has made productivity a critical success factor for any country in the world (Sheikh Zahoor Sarwar et al., 2011). Challenges posed by the contemporary competitive environment compel organizations to instill productivity and performance enhancement initiatives in operations to improve their competitiveness. In contemporary era, productivity has been recognized as the most serious challenge for the industrial management. Changes brought by heightened competition on the supplier side and intense volatility in customer requirements on the demand side have compelled researchers to explore new dimensions for productivity measurement and improvement (Ashok K. Gupta, David L. Wilemon, 1990). Concept of incisive and periodic productivity analyses of industries and organizations has gained importance worldwide. The economic development of a country is entirely dependent upon its industrial paraphernalia. In this context, contribution of the automotive industry is considered to be the most significant towards economic growth, technology and GDP (Bernd Gottschalk, Ralf Kalmbach, 2007). Productivity analysis of automotive industry reveals that it adds significantly to the GDP of developing countries. Extensive research work has been conducted in private sector automotive industry owing to its importance in the economic growth of developing countries. However, there is a dire need to push public sector automobile industry for enhanced participation in economy of developing countries (Mahadevan, 2002). Notwithstanding above, non-availability of a standard tool for measuring and improving productivity of automobile industry remains a glaring issue (Sumanth, 1994).

Research was initially restricted to productivity measurement and enhancement in manufacturing sector as it is the biggest contributor to economy in developing countries. However, developing countries owing to financial crunch rely on rebuilding of automobiles rather than substitution especially in public sector organizations. Therefore, contribution of public sector automobile rebuild organizations towards economy in developing countries is considered significant and at par to manufacturing industry. Rebuild process can be described as a process in which used products are restored to as

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good as original products. Concept of rebuild is largely applicable to automotive industry. Rebuilding of automotive assemblies constitutes two third of overall rebuild industry and is capable to produce the same product in almost half the cost of a new one (Statham S, 2006). United States consists of multi-national companies undertaking rebuilding of automotive parts with sales around US$ 553 billion in 2011 (USITC, 2012). Furthermore, Volkswagen is associated with rebuild since 1947 (Zhang, T. et al., 2012). Therefore, rebuild sector contributes significantly towards national economy especially in developing countries. Notwithstanding above, rebuild industry especially in public sector domain faces many obstacles and challenges which must be dealt with in order to reap full benefits.

Different productivity improvement models have been designed and formulated in the past, however their emphasis has been on private manufacturing sector due to profitability factor. Therefore, importance of measuring and enhancing productivity of public sector rebuild organizations has been focused by the researcher. In this regard, productivity data of a public sector automobile rebuild organization was measured and analytically analyzed to identify causes of low productivity in such organizations. The selected organization was spread over an area of 50 acres and had around 2541 employees with massive rebuild capacity of 700 vehicles per year. In order to fulfill confidentiality/secrecy, the selected organization was re-named as Organization-A. Data of selected organization was utilized to measure and analyze productivity of rebuild organizations. Productivity of public sector automobile rebuild organizations was found to be very low as compared to private sector organizations. Therefore, this paper seeks to evaluate the causes of low productivity of public sector automobile rebuild organizations and recommends a proposed model for productivity improvement in these organizations.

LITERATURE REVIEW

Productivity is the most vital performance indicator for organizations aspiring for excellence in business (Sanger M, 1998). Concept of productivity measurement and enhancement in different industries has been studied by lot many researchers during last few decades (Sumanth, 1994) (Azadeh, 2000) (Kumar, 2006) (Wang and Szirmai, 2008) (Sheikh Zahoor Sarwar et al., 2011). These studies concluded that enhancement in productivity ultimately affects the performance and outcome of any organization (Sanyala, M.K. and Biswasb, S.B., 2014). Therefore, different productivity models have been developed for private sector industries to enhance competitiveness and profitability of these organizations. However, productivity enhancement in public sector organizations has not been studied holistically by the researchers probably due to the fact that these organizations are governed by government rules/procedures and are not profit oriented. The public sector is usually considered as a slow technology and low productivity growth sector in the economy of a developing country. (Thomas F. Burgess, 1990). In comparison to private sector organizations, public sector enterprises are generally inefficient and ineffective especially in developing economies (Tatiana Kossova & Maria Sheluntcova, 2015). Organizations in public sector owing to low productivity and low output are now held answerable worldwide to justify use of public funds (Mohamad Azizal Abd Aziz et al., 2015). Therefore, tendency of measuring productivity and performance of public sector rebuild organizations is increasing rapidly amongst governments of developing countries (Yaseen Ghulam & Shabbar Jaffry, 2015).

Concept of rebuild or remanufacturing was first formalized in late 1920s. Thereafter, rebuild industry saw a radical change in 1976, when a MIT Professor Robert Lund conceptualized and produced the first comprehensive study in 1983. Today, rebuilt has found a wide application in a large array of industries, automotive being the most dominant (Diane M. McConocha Thomas W. Speh, 1991). Rebuild is synonymous to remanufacturing and significantly differs from recycling, repairing, reconditioning or refurbishing (Monsuru O Ramoni & Hang-Chao Zhang, 2012).

Rebuilding a product instead of manufacturing a new one results in reduction of substantial number of activities such as procurement of new raw material, processing and machining of material etc. Thus rebuild results in utilization of reduced resources, energy consumption and emission (Liu et al., 2016). Rebuild products are generally cheaper by 30–60% as compared to new products whereas energy and resources are saved by around 70–80% as compared to manufacturing (Zulfiquar N. Ansari et al., 2018). Rebuild is also a labour intensive process and generates job opportunities three times more than manufacturing (Hong-Yoon Kang et al., 2018). Therefore, rebuilding is frequently resorted to in developed as well as developing countries. In USA, estimated contribution of rebuild industry towards national economy is valued around $43 billion (Jonas P. Jensen, 2019).

Automotive industry is one of the leading industries in the rebuild sector. Out of all rebuild organizations, 70% companies are from the automotive sector (Steinhilper et al., 2011) (Zhang et al., 2011). Automotive rebuild consists of a series of industrial processes through which worn out or technologically deficient vehicles are remade to a condition at least as good as new with a modest investment and a viable warranty (Monsuru O Ramoni & Hang-Chao Zhang, 2012). An automobile rebuild process consists of six steps which include deposit of used product by customer/user, dismantling/stripping of vehicle, cleaning of dismantled components, classification inspection for segregation of parts to be rebuilt, replaced and reused, re-assembly followed by testing of rebuilt vehicle (David A. P. Paterson, 2018).

Conventional automotive manufacturing tools and techniques are not fully practically implementable in public sector automobile rebuild sector because of substantial disparity in planning and managerial parameters (Guide, 1999). Challenges faced in automotive rebuild process include uncertain condition of the returned/used product e.g. varying amount of wear, variation in number of missing components etc. Similarly, operations and time required for rebuilding a product and number of components required to be replaced solely depends on condition of returned product (Gaudette 2003). This uncertainty regarding condition of returned/used products makes forecasting, controlling and monitoring of rebuild operations more complex. Variety of products to be rebuilt is another challenge in the automotive industry as the products are continuously upgraded due to use of new technologies for improvement in performance (Margarete A.Seitz, 2007). In addition, products are not ideally designed for dis-assembly and may get damaged during dismantling thus resulting in higher operational costs (Ron Giutini & Kevin Gaudette, 2003). Hence, rebuild processes are more intricate and less predictable as compared to conventional manufacturing. Therefore, automobile rebuild organizations have to confront diverse technical issues.

Application of lean and agile manufacturing within the ambit of rebuild industry has been studied by researchers. Amalgamation of lean practices into rebuilt operations results in enhanced process efficiencies in rebuild industry (Margarete A.Seitz, 2007). Fargher (Neil Fargher & Audrey A. Gramling 2003) concluded that application of lean and agile practices in rebuilt industry accrues different benefits including reduced lead-time, compact work in process, improved quality, improved delivery and optimal shop floor utilization. Therefore, lean and agile practices are fully applicable to automobile rebuild industry. Rebuild cycle being followed in public sector Organization-A is shown diagrammatically in Figure 1.

In this backdrop, initially productivity of a public sector automobile rebuild organization was measured and analyzed. Overall productivity of Organization-A was measured as 29.10% for the year 2017/18 and Organization-A had rebuilt 208 vehicles against the designed capacity of 700 vehicles per year. In order to study the complete productivity trend of the organization, total productivity of the Organization-A was measured for the last 10 years and shown in Figure 2. It is highlighted that total productivity of the Organization-A rose from 21.9% in 2008/09 to 29.10% in 2017/18 during period of 10 years. Productivity of selected organization slightly increased during period under review. Still total productivity of Organization-A during span of last 10 years remained below 30% which clearly indicates non-awareness about productivity measurement, analysis and improvement tools and techniques. It was concluded that certain distinct characteristics of public sector automobile rebuild organizations in tandem with inefficient, ineffective and orthodox engineering practices resulted in low productivity and sub-optimal performance of the Organization-A (Muhammad Qasim Khan & Syed Athar Masood, 2018).

In Phase-II, data was collected qualitatively through semi-structured interviews with open ended questions from thirty-two rebuild experts/professionals. The respondents had sufficient experience of rebuild and were serving in different public sector automobile rebuild organizations including Organization-A. Results highlighted a multitude of cogent reasons leading to low productivity in these organizations. Details are shown in Table-1. Based on these identified causes of low productivity, suitable variables were derived through literature

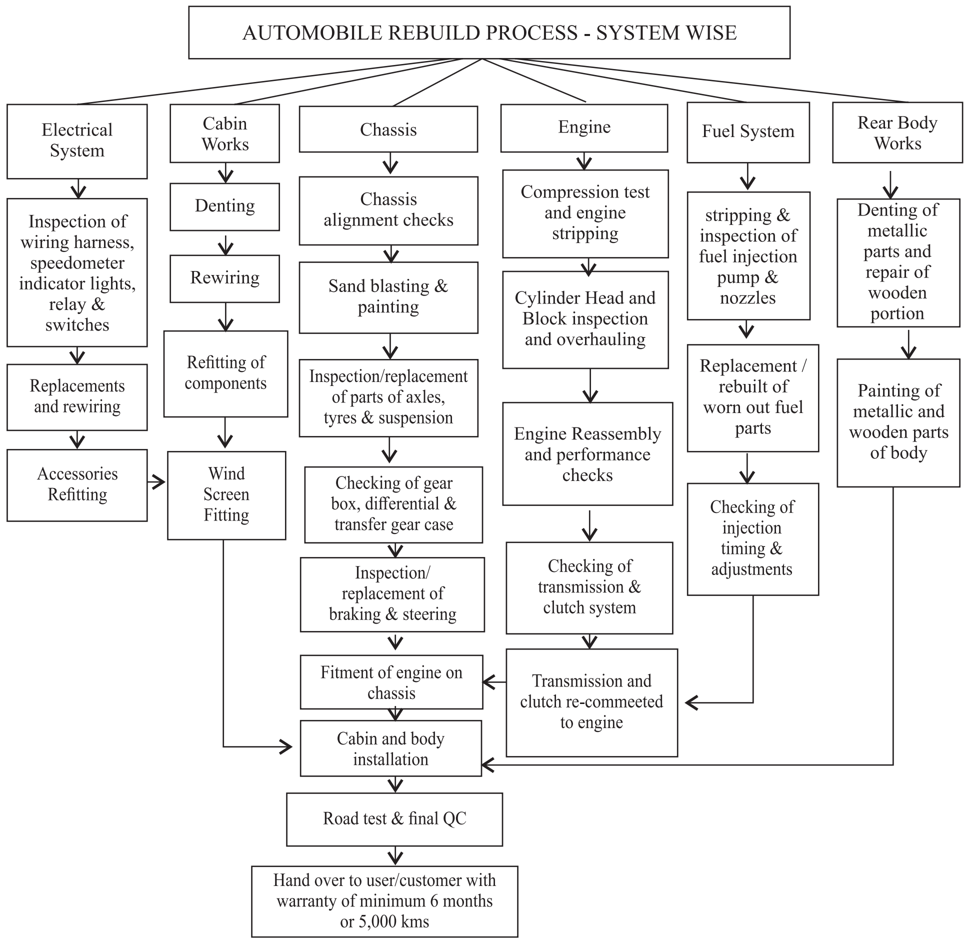

Fig. 1: Automobile Rebuild Process (Md Yusuf et al., 2009)

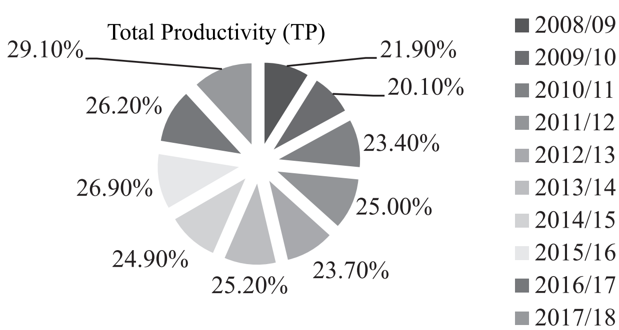

Fig. 2: Total Productivity (M. Q. Khan et al., 2019)

review and application of Delphi method. A Delphi panel of twelve productivity experts was shortlisted based on minimum twenty years of experience in public rebuild sector. Consensus amongst the panelists was achieved after conduct of three questionnaire rounds. Ranking of these causes of low productivity was done by Delphi panel as high and low impact. High impact causes have been highlighted in italics in Table-I. Resultantly key variables were derived along with their criticality for public sector automobile rebuild industry (M. Q. Khan, S.A. Masood, S.N. Qureshi, 2019).

Different productivity enhancement models primarily designed for private sector are partially applicable to public sector. These have been summarized in a tabulated form by the researcher. Two productivity improvement models from technically advanced countries and three models from developing countries have been shortlisted which recommend different combinations of best practices for enhancing productivity. Complete details are reflected in Table 2.

All aforementioned models specify different combinations of tools, techniques and practices which boost productivity of specific manufacturing sectors worldwide. Since public sector automobile rebuild organizations in

Table 1: Causes of Low Productivity

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

Table 2: Productivity Enhancement Models

Model / Strategies (Author)	Description
Herron and Braiden Model (2006) UK based	It emphasizes on utilization of productivity enhancement techniques used in manufacturing industry especially in UK by suggesting 17 best practices.
Pyke, Farley and Robb Model (2002) China based	It focused on 16 best practices successfully adopted in Chinese manufacturing sector for better performance and productivity including EDI, Automated assembly lines. etc.
Laosirihongthong and Dangayach Model(2005) India & Thailand based	Authors jointly conducted an empirical research on automotive industry of India and Thailand. In India, TQM and in Thailand, JIT were suggested as most effective. ones.
Laosirihongthong, Paul & Speece Model (2003) Thailand	Model entails 15 top successfully implemented productivity improvement techniques in Thailand with problems faced and their solutions.
Analytical Productivity Improvement Model Sumanth, D.J.(1994)	It deals with productivity evaluation, forecasting and subsequent enhancement in organizations through 54 productivity improvement techniques.

developing countries exhibit unique and peculiar dynamics, therefore these organizations essentially require a dedicated and focused model consisting of an optimal blend of different productivity improvement techniques. This paper attempts to identify reasons for low productivity in public sector automobile rebuild organizations and reformulates a productivity improvement model duly addressing issue of low productivity by combining and optimizing best practices for public sector automobile rebuild organizations.

METHODOLOGY

Research was carried out quantitatively to study the relationship between selected variables and productivity in public sector automobile rebuilt organizations. To help organize the research work, this study adapted the questionnaire based on lean productivity attributes framework evolved by (Gupta et al., 2013) (Raju Sheshrao Kamble & Lalit Narendra Wankhade, 2018) (Gusman Nawanir et al., 2013). Keeping in view the research objectives i.e to validate causes of low productivity in public sector automobile rebuild organizations, thirty items/operational dimensions extracted out qualitatively and from above mentioned publications stood relevant to intended productivity study in rebuild sector. Therefore, questionnaire comprising of thirty close-ended non-ordered choice questions was finalized commensurate to selected six independent variables and one dependent variable as per their characteristics (Table 1). These included Human Resource Management (HRM), Technology Management (TM), Public Sector Rebuild Dynamics, Spare Parts Management (SPM), Supply Chain Management (SCM), Quality Management (QM) as independent variables and Productivity Management as dependent variable.

Pilot Survey

In order to ascertain the causes of low productivity in public sector automobile rebuild organizations, a detailed "Questionnaire with thirty items" was designed to identify root causes of low productivity. To ascertain relevance and degree of applicability of these questions to productivity in public sector automobile rebuild organizations, a pilot survey was carried out on selected representative sample of automobile rebuild industry. Questionnaire was initially vetted for the language content and ease of readability by language experts. Thereafter, it was floated among twenty-eight academic and industrial productivity professionals/experts for its lucidity, construction and understandability. Testing of questionnaire was conducted to check its feasibility for applicability of selected variables, use of simple words, ease of understanding, inbuilt clarity in questions, self-explanatory nature of questions, whether single question or not, suitable length of question and appropriateness of five-point scale. Based on this pilot survey, respondents recommended rephrasing and modification of three questions to make these simpler and easier. Also, response rate and time consumed by respondents compelled the authors to change duration of recall period from five days to ten days. Hence, pilot survey resulted in improving construct and accuracy of questionnaire thus making it more relevant to the objectives of research. Questionnaire is attached as Appendix A.

Identification of Population, Sampling Technique and Sample Size

Identification of population within which the phenomenon of interest is to be studied is of foremost importance while conducting exploratory research. Population targeted for this research included all the public sector organizations having automobile rebuild facility. Therefore, organization was the unit of analysis. As per the statistics made available by Implementation and Economic Reforms Unit, Finance Division, GoP for FY 2013/14, there are 190 Public Sector enterprises. Out of these, 137 are commercialized units having collaboration with private setup for a joint venture. Remaining 53 public sector organizations out of 190 were targeted. These organizations had large vehicular fleet and had dedicated automobile rebuild setups with overhaul and rebuild facility. This aspect led to the fact that probability sampling technique was the best option for collection of sample data. Top, middle and lower management (supervisor level) of public sector automobile rebuild organizations were targeted for data collection and thus constituted the desired sampling frame (Managing Director/Deputy Managing Director, General Managers, Managers and supervisors). Researcher resorted to internet in search for sample size calculation. (Israel, Glenn D., 2003) provides a simplified formula to calculate sample sizes. Formula is as under:

$$n = \frac{N}{1 + N(e)^2}$$

where n is the sample size, N is the population size, and e is the level of precision. Population size was taken as around 700, confidence level was considered 95%, and value of precision e was taken as 0.05. Therefore, sample size for this research was calculated and finalized through aforementioned formula and final figure achieved by the research scholar came out to be a minimum of

255 respondents.

DATA COLLECTION

To formulate an inclusive productivity improvement model, most important aspect is to compile a reliable, valid and detailed data set covering all essential factors leading to low productivity. In order to make the research more meaningful and objective, three hundred and fifteen respondents from twenty-one public sector rebuild organizations were selected to keep the sample size large enough to have discrete regression results. Rebuild organizations having minimum 700 employees were shortlisted as these organizations usually employ productivity improvement techniques more often as compared to smaller entities (Rachna Shah & Peter T Ward, 2003) (Rachna Shah & Peter T Ward, 2007). Harvey (Harvey et al., 1985) suggested that construct-irrelevant variance is caused by intricate response scales. Therefore, respondents were required to answer data pertaining to selected variables on a simple five-point Likert scale which included strongly agree (5); agree (4); I am not sure (3); disagree (2) and strongly disagree (1). Since negatively worded items cause factor structural issues, therefore positively worded items were utilized (Raju Sheshrao Kamble, Lalit Narendra Wankhade, 2018).

Respondents Profile

Keeping in view sample size of two hundred and fifty-five, questionnaire was administered to three hundred and fifteen respondents including top management, middle management and lower management comprising of supervisors. Respondents were approached physically as well as through web and were requested to complete the survey questionnaire within 10 x days. Nevertheless, respondents took considerable time and were constantly pursued by the researcher for early response. A total of two hundred and seventy-one questionnaires were received duly filled as per instructions on the subject. Therefore, response of respondents for the survey remained 86%. However, on scrutiny, this number was further reduced to two hundred and sixty-two based on incomplete/ duplicate information, non-filling of personal information and outliers. Information pertaining to respondents was compiled in the form of age, education, designation and experience in automobile rebuild organizations. These included 22 x top management officials, 170 x middle management officials and 70 x supervisor level staff of rebuild organizations.

Establishment of Reliability and Validity

Most important aspect for data collection is to establish reliability and validity of the data. (Cooper, D.R. and Schindler, P.S, 2003) explained that researchers are required to ensure that tests should measure what is actually required to be measured (validity) and should verify consistency in measured results (reliability). Factor analysis was carried out to examine construct validity of each construct separately because of the limitation of sample size (Hair et al., 2010). Construct reliability was assessed by using Cronbach's α. As per [251], values exceeding 0.70 are acceptable. Table 3 shows that Cronbach Alpha's values range from 0.77 to 0.83 whereas Average Variance Extracted (AVE) values ranged from 0.785 to 0.892. Thus, internal consistency and construct validity were found acceptable and satisfactory which reflected correctness of data compiled for this research study. Table 3 depicts the values of Cronbach Alpha's and Average Variance Extracted (AVE).

Table 3: Reliability and Construct Validity

Construct	Cronbach Alpha	Average Variance Extracted
TM	0.770	0.812
HRM	0.792	0.817
PSRD	0.731	0.810
SPM	0.797	0.796
QM	0.830	0.785
SCM	0.787	0.860
PM	0.813	0.892

Linear Correlation between Variables

Cohen (Jacob Cohen, 1988) reported the commonly used set of descriptors for the interpretation of correlation coefficients. Pearson correlation for all variables was found positively associated with one another and significant at 0.01 thus indicating a high correlation. Results are shown in Table 4.

Table 4: Pearson Correlations amongst Variables

		TM	HRM	PSRD	SPM	QM	SCM	PM
TM	Pearson Correlation	1	.737**	.853**	.805**	.853**	.658**	.853**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000
	N	262	262	262	262	262	262	262
HRM	Pearson Correlation	.737**	1	.785**	.720**	.765**	.720**	.665**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000
	N	262	262	262	262	262	262	262
PSRD	Pearson Correlation	.853**	.785**	1	.674**	.731**	.804**	.895**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000
	N	262	262	262	262	262	262	262
SPM	Pearson Correlation	.805**	.720**	.674**	1	.604**	.769**	.604**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000
	N	262	262	262	262	262	262	262
QM	Pearson Correlation	.853**	.765**	.731**	.604**	1	.604**	.774**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000
	N	262	262	262	262	262	262	262
SCM	Pearson Correlation	.658**	.720**	.804**	0.769**	.604**	1	.684**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000
	N	262	262	262	262	262	262	262
PM	Pearson Correlation	.853**	.665**	.895**	.604**	.774**	.684**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
	N	262	262	262	262	262	262	262

** Correlation is significant at the 0.01 level (2-tailed)

Multi-collinearity Test of all Independent Variables

Multi-collinearity test was carried out to check the interrelationship of independent variables amongst each other. Multi-collinearity was examined by considering the VIF and tolerance values of variables. Non-existence of multi-collinearity amongst variables is ascertained if the value of VIF is less than 3 and tolerance is greater than 0.2. It can be deduced from table 5 that VIF and tolerance values were within limits and no multi-collinearity exists amongst independent variables.

Normality Tests

In order to undertake statistical analysis, an important pre-requisite is to check normal distribution of data. For normality, skewness test was applied to find out asymmetry or symmetry and to ascertain positive skewness or negative skewness in data. Kurtosis was also calculated to test the bulginess of the bell curve. Skewness and kurtosis were both found within the limits. Results are shown in Table 6.

Calculation of R Square

Value of R depicts the correlation between the observed and predicted values of dependent variable. Value of regression coefficient (R Square) was found to be .621 i.e. between 0 and 1 and it highlights that 62.1% proportion of variance in the dependent variable is explained by the independent variables. Therefore, model describes almost 62.1% variation in the dependent variable as evident from Table 7.

Table 5: Coefficients

Model		95.0% Confidence Interval for B		Collinearity Statistics	
		Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	3.306	5.388		
	TM	-.011	.208	.874	1.145
	HRM	-.058	.071	.983	1.017
	PSRD	-.008	.167	.965	1.036
	SPM	-.099	.101	.938	1.066
	QM	-.128	.156	.914	1.094
	SCM	-.405	-.117	.937	1.068

Table 6: Statistics

		TM	HRM	PSRD	SPM	QM	SCM	PM
N	Valid	262	262	262	262	262	262	262
	Missing	0	0	0	0	0	0	0
Mean		4.1679	4.0225	4.2277	4.1637	4.3298	3.9420	4.1626
Median		4.1500	4.0000	4.1429	4.2000	4.4000	4.0000	4.1000
Mode		4.00	4.00	4.00	3.80	4.40	4.00	4.00
Std. Deviation		.40282	.58492	.50065	.44497	.31766	.30915	.36407
Skewness		-.137	-.655	-.266	.170	-.480	.267	.292
Std. Error of Skewness		.150	.150	.150	.150	.150	.150	.150
Kurtosis		-.421	.897	.686	-.537	.143	.210	.163
Std. Error of Kurtosis		.300	.300	.300	.300	.300	.300	.300

Table 7: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.788a	.621	.612	.31998

a. Predictors: (Constant), SCM, PSRD, SPM, QM, TM, HRM

Table 8: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	42.840	6	7.140	69.737	.000b
	Residual	26.108	255	.102		
	Total	68.948	261			

b. Predictors: (Constant), SCM, PSRD, SPM, QM, TM, HRM

Table 9: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.501	.250		-2.006	.046
	TM	.241	.048	.249	5.065	.000
	HRM	.234	.067	.195	3.473	.001
	PSRD	.201	.049	.204	4.102	.000
	SPM	.140	.051	.127	2.747	.006
	QM	.181	.058	.153	3.114	.002
	SCM	.180	.056	.151	3.200	.002

a. Dependent Variable: PM

ANOVA Test

ANOVA test was conducted to check how the regression model predicts the dependent variable. Results of regression reveal value of significance i.e. 'Sig.' less than 0.05. Therefore, regression model significantly predicts the dependent variable i.e., productivity as evident from Table 8.

Regression Analysis

Multiple regression was run using SPSS 22.0 and the results are reported in Table 9.

$PM = \beta 0 + \beta 1TM + \beta 2HRM + \beta 3PSRD + \beta 4SPM + \beta 5QM + \beta 6SCM + \varepsilon$

Regression Equation

Productivity (PM) = -.501 + (0.241) TM + (0.234) HRM + (0.201) PSRD + (0.140) SPM + (0.181) QM + (0.180) SCM + ε

Regression equation elucidates that all independent variables had positive coefficients and had positive influence. So, it was verified that all the six variables had positive impact on dependent variable i.e, productivity.

DISCUSSION

To understand the productivity dynamics of public sector automobile rebuild organizations, an in-depth analysis of causes of low productivity of these organizations has been carried out. Results indicate that the aspect of productivity measurement and enhancement in automotive rebuild industry of Pakistan is almost non-existent probably due to ignorance. This is evident from the fact that productivity measurement, evaluation, planning and enhancement cycle has not been undertaken in any of the public sector automobile rebuilt organizations in Pakistan. These organizations do not have a dedicated productivity department and services of productivity professionals are also not hired for performance enhancement. Conduct of regular productivity audits facilitates identification of inefficient and ineffective inputs. Based on outcome of these audits, organizations adopt corrective course of action for productivity and performance enhancement. This aspect was found absent in public sector automotive rebuild organizations of Pakistan.

Most critical factor affecting productivity of any organization is the technology (Azadeh M.A., 2000) (Azadeh, M.A. & Ebrahimipour, V. 2004). As per the results of this study, role of technology (β=0.249) and Public Sector Rebuild Dynamics (PSRD) (β=0.204) have been found to be the most dominant for enhancing productivity of public sector automobile rebuild organizations. Therefore, public sector rebuilt organizations of Pakistan need to focus on investment in technology instead of investing in land, building paraphernalia and equipment. Moreover, factors specific to public sector highlighted in PSRD need to be addressed to boost productivity of these organizations. Adoption of latest productivity improvement technologies/practices like Lean Manufacturing (LM), Just-In-Time (JIT), Agile Manufacturing (AM), Computer Aided Designing (CAD), Computer Aided Manufacturing (CAM), Total Quality Management (TQM), Total Preventive Maintenance (TPM), 5S, Kaizan, Kanban, Benchmarking, 7Ws, Toyota Production System (TPS), 3Rs and Supply Chain Management (SCM) can significantly impact and enhance productivity and performance of these organizations. Based on causes of low productivity compiled in Table 1, thirty CSFs (Critical Success Factors) were derived for public sector automobile rebuild organizations to achieve optimal productivity and output. Details are shown in Table 10. CSFs for public sector automobile rebuild organizations were deduced based on literature review, qualitative and quantitative inputs. These CSFs form the basic essential requirements for enhancing productivity and performance of public sector automobile rebuilt organizations.

Based on these CSFs, combination of different productivity enhancement tools and techniques were considered in order to facilitate management of these public sector rebuild organizations by formulating an optimized and inclusive productivity enhancement model. All relevant tools and techniques were shortlisted against derived CSFs while remaining cognizant to managerial aspects. However, in order to have a simple, practical and workable model especially from management point of view, these CSFs were bifurcated into High Impact CSFs and Low Impact CSFs. High impact CSFs including standardization of vehicles, superior classification inspection, short procurement procedures, superior quality OEM spares, optimal automation, minimum rework, preventive maintenance, latest project management tools and techniques, culture of accountability and non-bureaucratic attitude, safe work place and environment, sequential layout of shops/work centers, modified lean inventory, application of productivity tools and techniques, productivity measurement and improvement cycle, appointment/hiring of productivity professionals and balanced human & technical resource are some of those key factors which have a direct significant impact on productivity enhancement in these organizations (Qasim, 2019). Therefore, these factors form the basic platform to boost productivity of public sector rebuild organizations and their application will result in substantial enhancement in productivity. Productivity enhancement model based on High Impact CSFs is shown in tabulated form in Table 10 whereas schematic layout is depicted in Figure 3. Another important outcome of this study is that all public sector automotive rebuild organizations must focus on measurement, evaluation, planning and improvement of productivity. Dedicated Productivity departments must be incorporated in organizational hierarchy and productivity specialists/experts must be hired to enhance productivity of these organizations. Similarly, Productivity enhancement model based on low impact CSFs has been framed separately. These include standard engineering practices, allocation of human and tech resource as per design capacity, rewards & recognition, multiple skilled workers, superior workmanship, latest tools/test equipment, superior stage inspection, backup for unique model vehicle spares, latest universal test benches, performance audits, agility (flexible resources), periodic time & motion studies, supplier relationship and customer satisfaction. Productivity enhancement model based on Low Impact CSFs is shown in tabulated form in Table 10 whereas schematic layout is depicted in Figure 4. It is pertinent to highlight that both these models are fully applicable to public sector automobile rebuild organizations, however, application of model with high impact CSFs is required to be initially adopted and employed to ensure basic corrective actions to establish a viable platform for boosting productivity in these organizations. It is expected that application of this model will yield significant enhancement in productivity up to 60 to 70% since it addresses the basic core issues confronted by public sector automobile rebuild organizations. However, model with low impact CSFs may be applied in phase-II in order to further enhance and optimize productivity.

Pearson correlation coefficients of independent

Table 10: CSFs for Public Sector Automobile Rebuild Industry

S/No	Causes of Low Productivity	Critical Success Factors (CSFs)	Relevant Tools/Techniques for Enhancing Productivity
High Impact CSFs			
01.	Diverse variety of vehicles	Standardization of vehicles	Procurement of selected brands of vehicles
02.	Poor classification inspection of parts	Superior classification inspection	Hiring & training of certified quality inspectors
03.	Lengthy procurement procedures	Short procurement procedures	Formulation of standardized demand templates for replacement spares
04.	Trade-off in cost and quality of spares	Superior quality OEM spares	Procurement of only OEM spares on JIT basis
05.	Limited automation	Optimal automation	Application of CIM, CAD, CAM, ERP
06.	Rework and quality issues	Minimum Rework	Six Sigma, TQM philosophy i.e workers empowerment, use of statistical tools including check sheets, control charts, Pareto etc.
07.	Improper maintenance	Preventive maintenance	TPM (Total Productive Maintenance)
08.	Non-application of latest project management tools	Latest project management tools and techniques	PERT, CPM, Gantt Charts, WBS (Work Breakdown Structure) etc
09.	Accountability & bureaucracy issues	Culture of accountability and non-bureaucratic attitude	Accountability of all stakeholders output and performance. Worker recognition and awards, optimal worker participation, frequent communication etc
10.	Ignorance about productivity tools and techniques	Application of productivity tools and techniques	Lean methodology, Kaizan, knowledge management, 7Ws, 5S, 3Rs
11.	Non-implementation of productivity measurement & improvement cycle	Productivity measurement and improvement cycle	Periodic application of productivity measurement, evaluation and productivity improvement cycle, Deming's wheel (PDCA)
12.	Absence of productivity professional/expert	Hiring of productivity professionals	Permanent appointment of productivity manager in public sector organizations
13.	Imbalance of human and technical resource	Balanced human & technical resource	Job allocation of employees in line with held equipment machines.
14.	Unsafe working environment	Safe work place and environment	Application of OHSAS18002 (Occupational health and safety standards), ergonomic design of workplace, well-lit and clean conditions
15.	Improper layout of shops/work centers	Sequential layout of shops/work centers	Sequential layout of shops and work centers as per rebuild processes.
16.	Huge inventories	Modified lean inventory	Stocking of basic inventory of spares & procurement of additional spares on JIT basis.
Low Impact CSFs			
01.	Non-standard engineering practices	Standard engineering practices	Process optimization through 7Ws, 3Rs, 5S techniques, Six sigma etc
02.	Shortage of human and technical resource	Allocation of human and tech resource as per design capacity	Authorization of workers and equipment commensurate to designed capacity
03.	Non-provision for rewards & recognition	Rewards & recognition	Rewards and recognition of good workers
04.	Specific trade expertise	Multiple skilled workers	Training of workers for multiple tasks on multiple machines to form cross functional teams
05.	Poor workmanship	Superior workmanship	Continuous emphasis on quality culture, TQM

06.	Outdated tools/test equipment	Latest tools/test equipment	Procurement of relevant tools & test equipment
07.	Improper stage inspection	Superior stage inspection	Quality at source, Quality circles
08.	Unique model vehicle spares	Backup for unique model vehicle spares	Dedicated inventory for unique/old vintage vehicles
09.	Old vintage test benches	Latest universal test benches	Phased wise procurement of latest digital universal test benches
10.	Absence of performance audit	Performance audits	Performance review against designed capacity,
11.	Non-agility (Non flexible)	Agility (flexible resources)	Flexible Manufacturing System (FMS) and agile concept against customer changing requirements
12.	Absence of time and motion studies	Periodic time & motion studies	Process optimization through periodic process review and benchmarking
13.	Supplier related anomalies	Supplier relationship	Supply chain synchronization, value chain management & value stream mapping
14.	Customer feedback irregularities	Customer satisfaction	CRM (Customer Relationship Management)

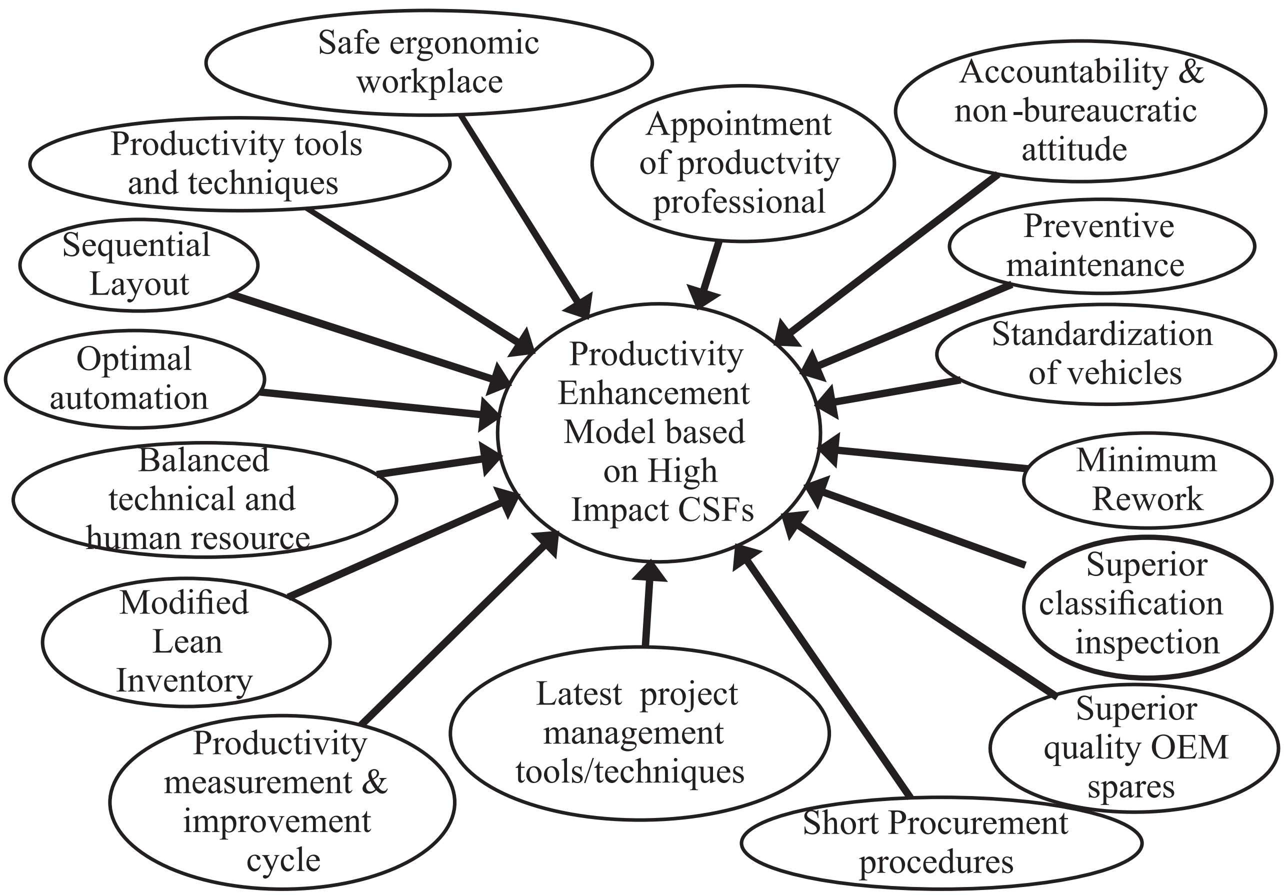

Fig. 3: Productivity Enhancement Model (High Impact CSFs)

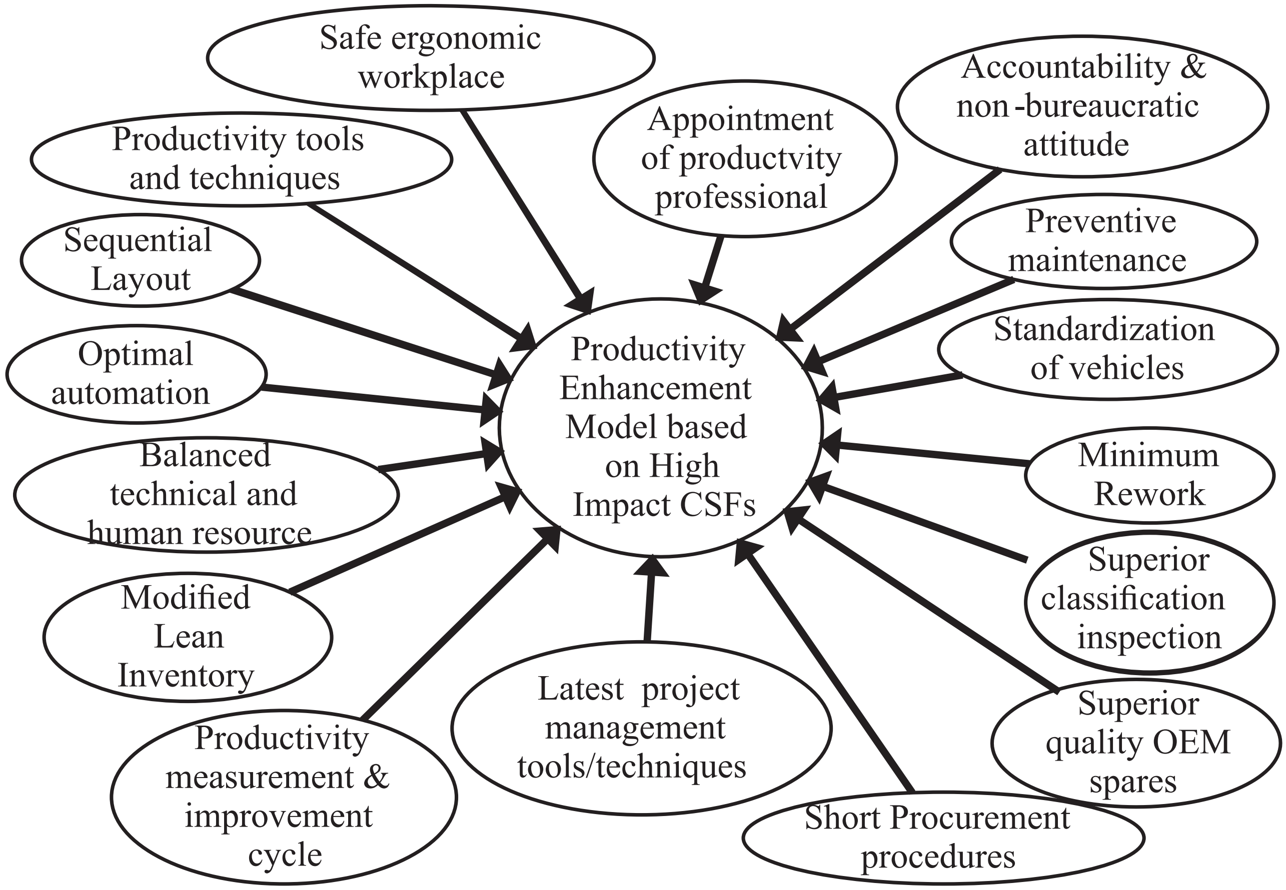

Fig. 4: Productivity Enhancement Model (Low Impact CSFs)

variables suggest that all productivity related technologies and practices should be implemented collectively and holistically because each practice is interdependent. This is theoretically appropriate; productivity improvement practices should not be implemented in piecemeal or in isolation. Feld (Feld, W.M. 2001) argued that productivity measurement and improvement practices in rebuild organizations are required to be implemented holistically owing to inter-connectivity amongst the practices. He posited that each practice is equally important and relevant. Therefore, combined application of all practices will yield significant improvement in productivity of rebuild organizations.

CONCLUSION

This study has identified root causes of low productivity in public sector automobile rebuild organizations and has proposed an optimized and inclusive productivity enhancement model. Results of the study have been empirically and theoretically supported. Study has been instrumental in confirming the strong relationship between selected critical variables and productivity. Research study has contributed to the body of knowledge by bringing out clear evidence that implementation of aforementioned techniques/practices result in enhanced productivity and performance of rebuild organizations. Shah and Ward (Rachna Shah & Peter T Ward, 2003) concluded that these techniques are fully implementable in all types of industries. Productivity enhancement model with high impact CSFs consists of sixteen tangible and quantifiable techniques and practices which can significantly boost productivity in these rebuild organizations. Nonetheless, these practices are required to be implemented holistically as all these practices are interdependent and are equally important. Integrated application of these practices at operational level leads to higher productivity and performance of automobile rebuild organizations.

LIMITATIONS AND FURTHER RESEARCH

Concerted efforts have been put in to make this study inclusive; however, like all other research ventures, this study is not without limitations. Survey conducted in this research was based on the postulation that the all the respondents had sufficient rebuild experience and knowledge to fill the questionnaire and had answered the questions with utmost truthfulness. Data utilized in this study is based on voluntary self-reporting basis primarily by top, middle and lower management of public sector automobile rebuild organizations. It is recommended that in order to ensure more precise results, future studies should incorporate collection of data from multiple sources. It is anticipated that this research venture has provided a basic platform and will therefore, inspire research scholars to focus on improving productivity in public sector automobile rebuild organizations.

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