RESEARCH ARTICLE

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An Explorative Study on Quality Management Success Factors and Performance Metrics for Inventory Control in Manufacturing Industries

Ritu Shrivastava[1*], Sheina C Shekhar[2]

[1]PhD Scholar BIT Durg, Chhattisgarh, India.

[2]Prof. BIT Durg, Chhattisgarh, India.

ABSTRACT

Mechanization plays a significant t role in the advancement of economic conditions of a establishing country like India. Indian manufacturing industries contribute a lot in growth and economic expansion in the country. Manufacturing industries have contributed to 17% of our GDP. Hence, the importance and need to evaluate this sector is justified.

This study successfully describes a research Model for improving the performance of the manufacturing industries and related issues. The reliability estimate and validity results of research instrument (Questionnaire) show that the instrument can be used as a standard for collecting data related with manufacturing industries. Further confirmatory factor analysis revealed six independent factors (performance improvement factors).These are :Top Management, Process Management ,Quality Management, Organizational Culture, Employee Involvement, Human Resource Management and Government Policy. The dependent factors of performance measures are, Productivity Performance , Quality Performance, Employee Satisfaction , Financial Performance and Time Dimension.

Another important aid of this study is that it connects the performance improvement factors with the manufacturing industries performance measures. In order to do this Correlation analysis was carried out and also thirty five hypotheses were derived and verified. Multiple regressions analysis was carried out to investigate the magnitude of more than one performance improvement (input) factor on performance measure (output).

The multiple regression results make it evident that all performance improvement factors significantly influence the performance of manufacturing industries.Testing of data is done under following heads :

- Sample Adequacy
- Normality
- Validity
- Reliability

The ultimate objective of this research is not merely developing the models but to find out best set of independent variables,which will result in optimization of objective function. For this Optimization of model was also done.

Finally, model is validated by conducting case studies in two industries in Chhattisgarh,India. Statistically it is proved that all the respondents agree with the recommendations of developed performance improvement model. The research instrument has been successfully developed that can be used to evaluate various improvement factors which will be implemented in manufacturing organizations.

Keywords: Inventory, CSFs, Performance Improvement Factors, Explorative research.

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INTRODUCTION

Every organization requires inventory to keep its operations functioning smoothly. It connects the distribution and production processes. In the majority of businesses, the largest portion of current assets and working capital is invested in inventory. Therefore, having good inventory control and management is crucial. Inventory management aims to minimize investment in stocks while still guaranteeing the availability of goods in appropriate quantities as and when needed. Therefore, in this research, we analyze several

Corresponding Author: Ritu Shrivastava, PhD Scholar BIT Durg, Chhattisgarh, India, e-mail: mechritu05@gmail.com

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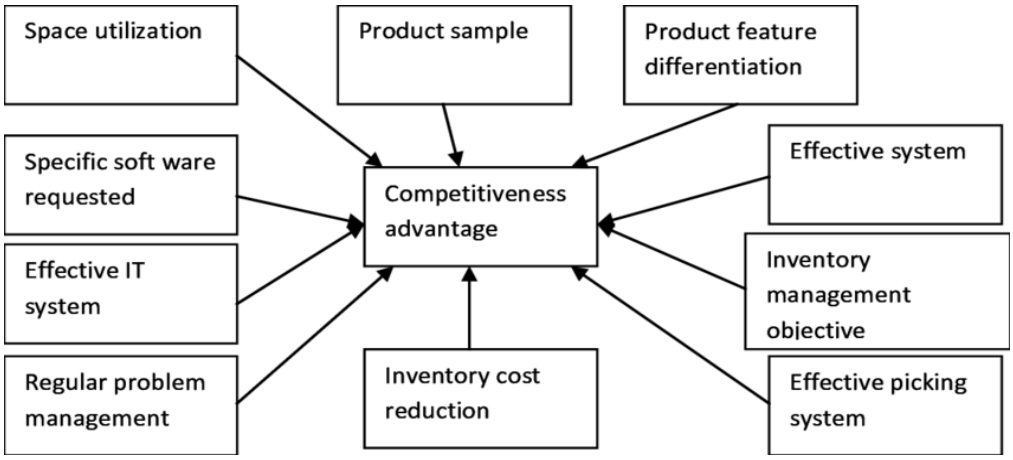

Figure 1: Inventory management system

inventory control strategies for an effective inventory management system in order to understand the nature of the organization's inventory management.

Almost all business types, whether they are product- or service-oriented, must prioritize inventory control. Practically every aspect of operations is impacted by inventory control. A good balance must be achieved to keep adequate inventory with the least possible financial effect on the client. The tasks involved in maintaining stock levels at predetermined levels are known as inventory control. Inventory control focuses on material control in production since the physical product is the main concern.

The term "inventory" refers to a physical stock of commodities kept on hand to ensure the efficient and effective operation of an organization's future operations at the lowest possible cost to the money trapped in inventories. The primary justification for maintaining an inventory is because it is both physically impossible and economically prohibitive for every stock item to arrive precisely where it is supposed to.In the research work various input factors and output factors are identified and proper framework and workable model is prepared in manufacturing industries where it can lead to proper management of inventory which prepared in every firm using steps (Figure 1).

Literature Review

A large number of related works are available in the literature; a concise number of works are reviewed & summarized below:

Ahuja et.al.(2008) evaluated the challenges before Indian manufacturing organizations for adapting to proactive Total Preventive Maintenance initiatives. They formulated Critical success factors to overcome obstacles for implementation of TPM to face global challenge. In their proposed model they stated that the organizational, cultural, behavioral, technological, operational, financial, departmental barriers are the main obstacles for implementation.

Aleksander Janes et. al. (2013) have explored & clarified the cause & effect relations between key performance indicators which significantly contribute to the benefits of the business processes exploitation.

Amol Lokande (2014) has carried out his studies on Indian industries with respect to remanufacturing industries. He identified 10 Critical Success Factors including 74 variables for establishment of Remanufacturing Industry in India.

Darshak Desai et.al (2012) highlighted Critical Success Factors of six sigma implementation in Indian manufacturing industries. They carried exploratory research work with the help of questionnaire to study the impact of different CSFs of six sigma implementation in different sizes & sectors of Indian manufacturing industries.

Harjeev K. Khanna et.al.(2011)have reviewed critical success factors of Total Quality Management & ranked them for Indian Manufacturing Industries. Research instrument used was a systematic questionnaire. They concluded that process management, top management leadership, customer focus are the top three factors for implementation of TQM in Indian manufacturing industries.

J Udaya Jebisha(2019) explained in the paper that the objective of this paper is to study the different literatures about inventory management and identify the importance of inventory management and also the factors affecting inventory management.In addition to this in this paper it is also explained about how the software SPSS is used for testing of data Statistics included in the base software: Descriptive statistics: Cross tabulation, Frequencies, Descriptive, Explore, Descriptive Ratio Statistics ;Bivariate statistics: Means, t-test, ANOVA, Correlation (bivariate, partial, distances), Nonparametric tests ; Prediction for numerical outcomes: Linear regression; Prediction for identifying groups: Factor analysis, cluster analysis (two-step, K-means, hierarchical), Discriminate.

ManishaLande et. al. carried out her work for lean six sigma in Small and Medium enterprises and identified 17 Critical Success Factors in her study for Indian industries. He carried out exploratory research & identified attributes for Critical Success Factors for Quality and Productivity improvement with TQM management approach.

Minhaj A.A. Rehman et.al. (2015) carried out his studies on Automobile industries. He identified 12 critical success factors with 42 variables for Green Supply Chain Management in automobile industries in Maharashtra, India.

M.D. Singh et.al. (2006) have proposed Knowledge Management involves strategies & processes of identifying, capturing & leveraging knowledge to enhance competitiveness. He collected data from 71 industries to access the impact KM practices in Indian manufacturing Industries.

Nurul Hidayana Mohd Noor, Amirah Mohamad Fuzi(2025),explained in their paper that,an instrument is a tool used to collect data in research. The data collected using specific instruments will be described and attached or used to test the hypothesis proposed in the research. Validity is the extent to which an instrument performs its function or measures what it is supposed to measure. This means the extent to which an instrument is accurate and precise in performing its function. Reliability shows the extent to which the instrument can be trusted.The more it matches the actual score, the higher the reliability. Instrument validity and reliability are two fundamental concepts in research, and they are interrelated. With instrument validity and reliability, the research can produce meaningful findings, and the conclusions drawn from the research will be questioned .

Shrivastava S. et. al.(2014) carried out his research on Indian cement industries & has Identified 9 (nine) Critical Success Factors consisting of 43 attributes for attaining Quality management goals.

Untawale S.P.et.al. (2004) carried out his work on Indian manufacturing industries &has listed seven (7) Critical Success Factors for performance improvement. He has also developed a model for Quality and Productivity improvement in Indian Manufacturing Industries.

Vinod S. Gorantiwar et.al. (2014) carried out his research in sponge iron industries for Quality-Productivity management and identified 50 attributes of prime consideration.

RESEARCH METHODLOGY

The chapter signifies the need for developing an instrument for data collection needed for explorative research. It describes the procedure for developing a questionnaire which works as instruments for data collection. The instrument is developed in two stages. In stage 1, pilot questionnaire is developed which helps in deriving a refined final questionnaire. The data thus collected is analyzed and the information obtained is used for developing the model of Critical Success Factors (CSFs) and Performance Measures (PM) in quality management for inventory control of products. A large number of input factors or variables influence the performance measures. This calls for validation of the model through experimentation in steel industry or related to it. To achieve this, two case studies were carried out at manufacturing industries.

Thus, keeping in mind the academic research in integrating CSFs and Performance Factors in manufacturing industry and the urgent need for performance improvement model, hence this study experiment study was planned for manufacturing industry (Table 1).

Data Collection Design

Design of Questionnaire

A pilot questionnaire, the data collection instrument, is a formalized set of questions for obtaining information from respondents. A questionnaire is the main means of collecting quantitative primary data. A questionnaire enables quantitative data collection in a standardized way so that the data are internally consistent and coherent for analysis. The Likert Scale, which is one of the most widely used scale, is used in this research to obtain responses for each statements. The respondents were requested to indicate their degree of agreement by ticking one of five response categories such as Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree. Likert Scale is easy to construct, execute and simple for respondent to understand.

The Pilot Questionnaire consists of four parts:

Part – I:

- Respondent preliminary information.
- Organization background, facts and practices in manufacturing industry.
- Respondent Perception/Current status.

Part - II

Input Factors (Critical success Factors) for products of various manufacturing industry.

Part - III

Output Factors (Performance Measures).

Part - IV

Open Ended Questions (Expectation of respondent) (Table 2).

Pilot Study (Pretesting of Questionnaire) Finalization of Questionnaire

In the pilot test, 190 expert's viz managers, technicians and industry professionals were requested to indicate their

Table 1: Flow chart of research

L	Literature Review
A	Analysis Of Literature
I	Identification Of Parameters
P	Pilot Questionnaire
D	Data Collection
F	Final Questionnaire
D	Data Collection & Pretesting
A	Analysis Of Data
C	Csfs Framework
V	Validation Through Case Studies

Table 2: Phases of field work

	Outcomes
Preliminary Research	Identification of research sample
Phase-I	Interviews and their evaluations
Phase-II	Pilot survey and participative observations from various manufacturing sectors
Phase-III	Preliminary impressions and evaluations of the framework
Phase-IV	Final survey and participative observations from manufacturing sectors in steel producing regions/Areas

responses to each statement in the questionnaire by ticking the categories of agreement or disagreement using a 5 points likert scale (Table 3).

Expert opinions that could aid the design of data collection tools were taken into consideration.

Figure Research Methodology Adopted in the Research work.

Internal Consistency Analysis

Internal consistency is one of the methods that can be used for assessing reliability It indicates how well the different items of a scale measure the same concept and it is generally measured by means of a reliability coefficient such as Cronbach (α) coefficient alpha. A value of alpha range between 0 and 1.0, higher values of alpha indicates higher reliability. The value of each factor, as measured by each item on the scale of 1 to 5, is computed using the reliability analysis procedure.

Data Collection (Sample Design)

Data collection is an important aspect of this research study. In this research Quantitative method is used for data collection. Quantitative method relies on random sampling and structured data collection instruments that fit diverse experiences into predetermined response categories. They produce results that are easy to summarize, compare, and generalize. Quantitative data collection methods play an important role in impact evaluation by providing information useful to understand the processes behind observed results and assess changes in people's perceptions of their well-being. It is used to improve the quality of survey based quantitative evaluations by helping generate evaluation hypothesis, strengthening the design of survey questionnaires and expanding or clarifying quantitative evaluation findings.

Statistical Package for Social Sciences (Spss)

SPSS is one of the most popular statistical packages which can perform highly complex data manipulation and analysis with simple instructions. SPSS is capable of handling large amounts of data and can perform all of the above analyses covered in the text and much more.

Data Testing and Analysis

This section of work analyses the information provided by the respondents to the survey conducted for improving the quality performance in inventory control of products. The purpose of this section is to show the data is chosen, collected and prepared for the further analysis. The explanation is given for convenience of over viewing the data and drawing conclusions.

Data Collection and Initial Screening

This study employed the following methods to collect data: In depth interviews with the stakeholders of various manufacturing industries, participative observation on working sites, and distribution. It involved preparation of structured questionnaire for complete survey. The qualitative techniques, in depth interviews and participants observation are suitable and applied to gain additional information on multiple linkages and explore the role of manufacturers and other stake holders.

This utilized a survey approach with a closed questionnaire, which was distributed within stakeholders of manufacturing industries basically in various regions of Chhattisgarh such as Durg, Bhilai, Raipur, Raigarh and Korba. Survey observed different production sectors with respect to multiple linkages with all stake holders, competitive behavior of manufacturers, technology and properties of societal preference issues. It explicitly considered social background because its relevance directly comes from its interconnection with the economic and institutional aspects of production sub systems. The respondents were randomly chosen in each region and sector, which consisted of all stakeholders of manufacturing industry. To ensure proper representation of manufacturing stakeholders from various steel producing sectors and samples were stratified.

The field work was conducted in four phases as seen in table.Initial phase consisted of interviews of local sub samples of respondents only.The author also conducted first survey with a closed questionnaire in this phase. It covered 40 respondents in varied background from managers, stock controllers, supervisors, etc.

Table 3: Likert scale

1	2	3	4	5
Strongly Disagree	Disagree	Medium	Agree	Strongly Agree

Table 4: Response rate of the previous studies

S. No	*Author*	*Response rate (%)*
1.	Saraph,J.V., Benson P.G. and Schroeder R.G 1989	91.0
2.	Shrivastava R.L., Mohanty R.P., Lakhe R.R 2006	57.08
3	Sahu A.R, Shrivastava R.L 2016	48.05
4	Chadge R.B, Shrivastava R.L , 2014	49.00
5	Lande M, Shrivastava R.L,2016	38.85
6	Shrivastava S , Shrivastava R.L	69.40

Response Rate and Profile of Respondents

The continuous follow up with the respondents resulted in receiving 180 valid responses with the response rate of 66.7%. The response rate is quite encouraging. The response rate of the previous studies data were collected through questionnaire (Table 4).

Testing of Data: It is carried out under four heads

- Sample Adequacy
- Normality
- Validity
- Reliability

Adequacy

According to Sloven's formula in the 2003 book (Elementary statistics a modern approach)

$n=N/1+Ne^2$

Where N=Total population, e=Error(0.05 for 95% confidence level), Here N= Total number of respondents = 357

$n= N/1+Ne^2$

where n= 357/ (1+357 *0.05*0.05) =189

Normality

The normality test results for input items and all output items done SPSS 20.Normality test refers the bell shape nature of the curve. It is necessary that data follows normal distribution i.e. the data should lie within the inverted bell shaped curve, with a clearance of 2.5% on either side as we are analyzing the data at a confidence level of 95% (Tables 5 and 6).

VALIDITY

Validity of Instrument is done in Three Stages

Content related validity

The literature and detailed evaluation by academicians, researchers and opinion of experts, for content validity was ensured at the stage of questionnaire formation by the selection of measurement items was based on exhaustive review.

Criterion related validity

Bivariate Correlations among the input and output factors is done which results in the positive and significant correlation coefficients obtained between all the factors.

Construct related validity

The principal component factor analysis helps to eliminate or check, if the items belong to the same group or not.The component matrix, Eigen value and percentage of variance for all input and output values are found out.

Table 5: Input variables

Normality test for input variables Case Processing Summary						
	Cases					
	Valid		*Missing*		*Total*	
	N	*Percent*	*N*	*Percent*	*N*	*Percent*
Input variables	43	100.0%	0	0.0%	43	100.0%

Table 6: Output variables

Normality Test for Output Variables Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Output	29	100.0%	0	0.0%	29	100.0%

Table 7: Input variables data

Reliability of input data Reliability Statistics		
Cronbach's alpha	Cronbach's alpha based on standardized items	N of items
0.880	0.874	34

Table 8: Output variables data

Reliability of output data Reliability Statistics		
Cronbach's alpha	Cronbach's alpha based on standardized items	N of items
0.877	0.874	24

Reliability

The alpha values are ranging from 0.651 to 1.000 for input factors. The alpha values are ranging from 0.707 to 0.889 for output factors (Tables 7 and 8).

Factor Analysis

Exploratory and Confirmatory Analysis are two types of factor analysis.The objective of Factor Analysis was to identify a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables.

Internal Consistency Analysis

Internal Consistency is one the methods that can be used for assessing reliability and it is generally measured by means of a reliability coefficient such Cronbach (α) coefficient alpha. The value of alpha range between 0 and 1.0, higher values of alpha indicates higher reliability.

Detailed Item Analysis

The Pearson correlation coefficient (r) is the most common way of measuring a linear correlation. It is a number between –1 and 1 that measures the strength and direction of the relationship between two variables. When one variable changes, the other variable changes in the same direction.

Factor Adequacy

Kaiser-Meyer-Olkin (KMO) measures factor adequacy. If the value is less than 0.50, it indicates either collect more data or re think which variables to include. As KMO value is more than 0.5 for all factors, the data is adequate.

Factor Score

After naming the factors obtained from factor analysis of independent and dependent variables, the score of all the input and output factors were calculated given in the table:

ANOVA

Analysis of variance is used when multiple sample cases are involved. The ANOVA technique enables us to perform this simultaneous test and as such is considered to be an important tool of analysis in the hands of a researcher. If the significance value of the F test in the ANOVA table is less than 0.05 then reject the hypothesis.

Regression Analysis

Regression Analysis (RA) is a statistical method for determining the relationships among number of independent variables and dependent variables.

Multiple Regression Analysis for Generalized Model

Multiple regression analysis for model is carried out with dependent variables as quality performance and independent variables as performance improvement critical success factors.Where Y is the Output and X are input.

The model can be written as: Y=a+bX1+cX2+dX3+eX4+fX5+gX6+hX7

Hypothesis Testing

In order to analyze the impact of critical success factors on the performance improvement of manufacturing industries the hypothesis are developed.Based on multiple regression analysis above 35 hypothesis were tested. Positive relationships are found amongst seven Critical success factors (CSFs) and five Organizational Performance Measures. The regression analysis gave strong relationship amongst the input and output factors. The strong relationships were used to accept the hypothesis. Based on these relationships following 22 hypotheses are accepted and 13 hypotheses are rejected (Figure 2).

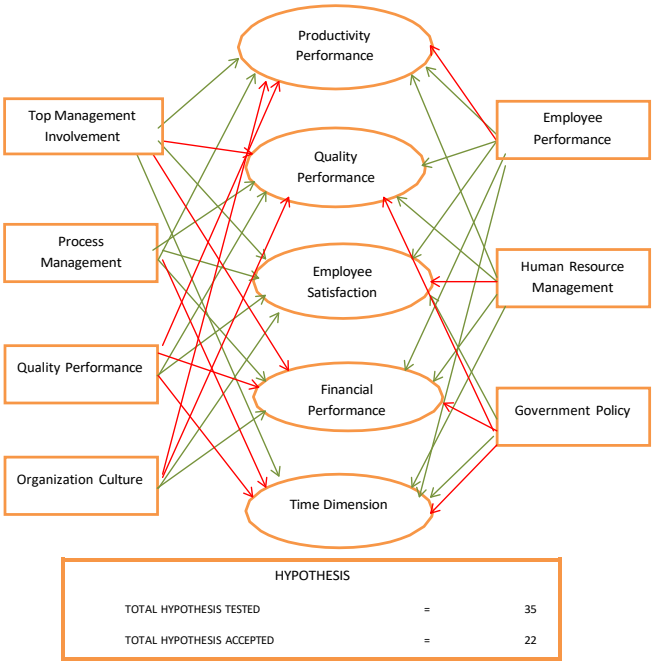

Figure 2: Generalized model

Results And Conclusion

This chapter summarizes the findings of research study (Survey) for each research objectives based on the analysis of overall responses of the stakeholders from manufacturing sectors. The studyexplores various performance improvement factors (Critical Success Factors) and Performance Measures Factors for various manufacturing industries and correlation between them. This chapter presents an overview of the study along with the implication of the research. The chapter also presents valuable insights into the functional implications and discussions for each research objectives, implications and scope for further research.

Establishing Relationship between Input and Output Factors

Multiple regression analysis were carried out to establish relationship between input and output factors.

Optimization of Performance Measures (Output Factors)

The five performance measures were optimized using linear programming technique. The optimization was carried out with the objective function of maximization.

Integration of Performance Improvement Model

These five optimized performance improvement models were integrated to develop the framework of overall performance improvement model. This developed model was validated.

Findings of the Research Work

The explorative research was carried out to identify the success factors for performance improvement of Manufacturing Industries. An instrument was developed for collection of information needed to this research. This research instrument (questionnaire) distributed among various stake holders in industries. The data was analyzed using various statistical techniques. Following are major findings of the research work.

Benefits of CSF's

Regardless of industry, it's important to define what organizational success means by identifying the various factors that help the company achieve its mission and goals effectively. Critical success factors allow companies to determine what to implement to achieve important goals and objectives more quickly. Learning what critical success factors and how you can identify them can help you improve productivity and enhance operations.

Critical success factors are the various elements that are necessary for an organization to fulfill a specific goal. These factors help teams and individuals determine what to accomplish to complete a project and while also allowing them to compare their progress to the goals they previously set. Determining the critical factors of a business can make it easier to create value for customers and produce quality goods or services. The specific critical factors of a business typically vary depending on the industry. There several categories where CSFs are considered but main focus is on the manufacturing.

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