ABSTRACT

Productivity is a key determinant of competitiveness in any industry. The major sources of productivity in an industry are men, materials, machinery, money, maintenance, method and management. The textile industry is a very important sector after agriculture in India. Nearly 3400 textile fabric processing units and their chemical allied industries are functioning in Erode, Tirupur and Karur districts of Tamil Nadu, South India. In this region, nearly 1250 industries could not function efficiently till 2006 not because of the government’s stringent pollution and environmental norms but due to poor utilization of resources, poor maintenance, improper production planning etc. These drawbacks resulted in their inability to measure, manage, maintain and evaluate the resources available in textile and fabric industries.

The present research work focuses on designing the robust framework by identifying and implementing the solution tools of the risk dimensions which affect the productivity in textile fabric processing industries.

In most of the papers studied under the literature review, productivity along with the quality of products or services has been discussed. The present work focuses mostly on papers relating to the productivity and a few papers also relating to quality have been considered, studied and reviewed. In productivity related literature analysis, the majority of papers are related to manufacturing, healthcare and banking sectors. However, productivity analyses in the declining textile fabric industries are still a relatively new topic for research. The literature review has proved that fuzzy linguistic assessment and evaluation are better than crisp value of human thinking. A fuzzy Failure Mode Effect Analysis (FMEA) with productivity Measurement, Evaluation, Planning and Improvement (MERI) for enhancing productivity is very rarely found.
Based on the literature review, an empirical study of productivity and quality instruments has been carried out in the present work leading to the design of a robust framework for productivity improvement. The objectives of the work are as follows:

- To identify the risky dimensions for improvement of Productivity and Quality (PQ) through an empirical study.
- To design a robust framework for improvement of productivity and quality in the declining textile fabric processing industries.
- To demonstrate the framework with case studies from medium scale textile industries.
- To investigate and forecast the future of productivity by applying different phases of productivity cycle.

In order to carry out the above objectives, a robust framework has been proposed and demonstrated by means of various case studies. The three stages that follow are identified, implemented and the results are earmarked. The stages include the following:

**Stage 1: Validate the questionnaire by Multivariate analysis:**
After an extensive literature review, the first stage of the research work identified ten Productivity and Quality Dimensions (PQDs) for improvement of productivity and quality in textile fabric industry. A questionnaire had been prepared and the data was collected from various experts in the textile and chemical industry. They ranged from executives, engineers and managerial level people for all PQD. These dimensions or instruments have been empirically analyzed and validated using Confirmatory Factor Analysis (CFA). This multivariate CFA tools have ensured the reliability, content validity, convergent validity and criterion related validity. A traditional FMEA and fuzzy FMEA have been investigated in order to prioritize the high risk dimensions. After this identification of PQD, productivity enhancement phase has been started in the industry through case studies. Further, the influence of dimensions for Productivity and Quality (PQ) improvement tools
have been measured and analysed by using the results obtained from the research tools.

**Stage 2: A traditional FMEA and fuzzy FMEA:** A failure mode and effect analysis is an analytical technique that combines both technology and experience of people. It identifies foreseeable failure modes of dimension in order to plan their elimination. In this regard, the various steps have been followed:

- The multiplication of Severity (S), Occurrence (O) and Detections (D) factors has given the Risk Priority Number (RPN) for dimensions in FMEA. The ten PQD have been precisely evaluated in a traditional FMEA. These results may not be realistic in real applications.

- The various combinations of S, O and D produced the same value of RPN. But their hidden risk implications lead to waste of time, cost and resources. In some cases, the high risk factors or important dimensions remained unnoticed.

- The experts from the industries may have different set of knowledge and judgments. So constructing the fuzzy if then rules is nearly impossible because of inconsistent judgements and bias of different experts.

- To overcome the above difficulties, fuzzy FMEA has been used which was expressed in a linguistic way such as important, likely important, highly important and so on.

- A mathematical Fuzzy Weighted Geometric Mean Method (FWGMM) has been applied instead of building if then rules and crisp RPNs. A fuzzy linear programming approach has been used for aggregating the level of alpha sets. Finally, the high risk dimension has been identified by alpha level sets of FRPNs.
Stage 3: Productivity Cycle (PC): The concept of Productivity Cycle (PC) has been used with regard to the identified high risk dimensions. PC consists of productivity measurement, evaluation, planning and improvement. This phase along with the results have been applied and investigated in the textile fabric industries.

The results have been demonstrated after implementing productivity improvement tools such as Total Productive Maintenance (TPM), Theory of Constraints (TOC), and Quality Function Deployment (QFD). This crucial phase has been successfully completed through the Total Productivity Model (TPML). The major inferences have been arrived at from the three stages of the present research work include:

- An empirical research study identified and validated the productivity and quality dimensions. The study shows importance of productivity and factors affecting productivity in the textile fabric processing industries.
- The high risky dimensions were mathematically prioritized and identified by using FWGMM for improvement of productivity and quality. It proves that FWGMM can overcome the drawbacks and practical implications in crisp values of traditional FMEA process and fuzzy if then rules.
- As the risk dimensions and their relative weights are computed in terms of linguistic values rather than in crisp values, the aggregation of assessment is mathematically proved and found to be relatively easier.
- The integrated results of productivity tools have been investigated through various case studies and they pinpoint the significance of partial productivities in industries.
- This systematic procedure and comparison of combinations of tools in the design of robust framework will positively influence productivity planners to make strategic decisions.
- This robust framework can be positively applied for other declining chemical or mechanical industries also.