

## Abstract

The contribution of Micro Small and Medium Enterprises (MSMEs) to the economy and employment market is growing. They are involved in manufacture of products that range from simple to complex in terms of engineering and design. However, it is widely known that MSMEs in India are slow in adopting innovation practices. MSMEs are slow in focusing on the need for innovation in line with current government initiative and policies that encourages as many products as possible to be made in India. However, it is observed that most small and medium enterprises have not developed inherent capacity for absorbing subsidies and funds earmarked for innovation by the Government nor do they have resources for practicing Innovation. As a result, MSMEs in India lag behind those in other Asian countries such as China, Singapore and Malaysia in embracing the practice of continuous innovation and benefit from it.

Initial studies on small enterprises conducted in the course of this research reveal that enterprises lack methods of incorporating innovation during the design upgradation phase in their product development process. Most medium scaled enterprises depend on vendor industries to give them designs along with job orders which they produce. They seem to be content at being ancillary to industries. They have not developed in-house Design capacity and capabilities. Reverse engineering is relied upon. Small enterprises and medium enterprises seem to be clueless as to how to innovate, how to generate new ideas and how to continuously improve their products' quality and variety. The research reported in this thesis aims to investigate the state of art as prevalent amongst MSMEs with respect to their practices and efforts to improve product quality and thereupon propose novel methods to measure and incorporate innovation through design which is specifically developed for the type of products manufactured by them.

This thesis reports the studies that have been done to answer the questions for MSMEs such as how to innovate effectively and quickly? Where to focus during product designing phase to enable value addition? What are the variables that influence innovation? How to measure innovation and metricize comparative benefits? How to compare competitive products for their innovative content?

This thesis proposes a new method involving a systematic series of steps and procedure to add value to products through Design so as to achieve innovation. The frame work proposed aims at locating specific components/subassembly/parts of a products' design wherein innovation, if done, would result in higher value addition to the overall product. A new human centered design based frame work for innovation was developed through product analysis, leading to improvements by generating new concepts, selecting the most promising concept by a metric frame work, based on linkographs.

The innovation frame work developed in this thesis is based on the principles of Usability engineering as contained in ISO (ISO 9241, ISO 13407) standards. Products manufactured by MSMEs are deconstructed using disassembly tools such as Fish bone diagram, Value analysis trees, Usability testing protocols, linkography and weighted matrices. In the method proposed in this thesis, prioritization of design elements was done from the user's 'usability' and products

'utility' point of view rather than solely on engineering, material or manufacturing point of view. The products chosen for experiments were utility consumer household products. The word 'Design' used here indicates Creative concept generation process as in User Centered Design and does not confine itself to 'routine design' process of machine elements. As such domain knowledge from multiple disciplines such as User centered product design, Mechanical Engineering, and Management Science (operations management) have been used in an interdisciplinary way throughout the thesis.

In order to validate the proposed frame work developed for innovation, professionally trained designer (30) were asked to redesign products with a new innovation framework. A matrix framework based on pre and post design action was developed. This developed framework was further validated by trials with ten (10) MSMEs who applied it to their existing products in a demonstration exercise for feedback. The framework aids analysis of similar product designs by identifying spots within the product assembly that can be innovated. The frame work aids in attaining higher innovation and helps in measuring the innovation improvement differential. This thesis is in Product Design, it encompasses, Mechanical engineering, User centric design, Usability Engineering, and Industrial policy aspects concerning small and medium scaled industrial enterprises.

The thesis argues that by knowing the innovation index between two comparable products and identifying the exact spots of innovation, MSMEs can practice, design through innovation. Validation by feedback from MSMEs indicated that the new method and frame work is easy to understand and implement within a small or medium enterprise.