# Chapter No.6

## Discussions and Outcome of the Research Project

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6.0 Findings

Before the research, a gap was perceived between the customer expectation from a product and the designer idea of a product. However, after a thorough literature study, the gap was well established and corroborated by the field studies. These findings after in-depth analysis have revealed several facts. These are reported at various stages of research project.

The conclusion of the research project is the sum of total of the results mentioned below. A discussion enabling one to draw the conclusions from the findings is carried out. It is as per Sadhu, (1994: 113) who say, "The discussion should be critical, creative and revealing instead of being a mere translation of figures into words. A researcher must describe his findings in a scientific and logical style and leave it to the reader to feel and convinced or otherwise." A brief discussion to finalize the conclusions is presented in the following sections.

6.1 Findings and Discussions Regarding Optimization of Design Parameters for any Product

6.1.1: Design parameters were ranked after taking an average of the weightage assigned by all the stakeholders to various design parameters and these are reported in Table No 515.

Design parameter, reliability, occupies the first position in the ranking of the design parameters. Reliability implies that while performing, the products should confirm to the given specification. After reliability, quality, performance, safety life, etc. occupy the position in the same order. A customer prefers quality to other parameters especially in complex products like pumps or equipments used for agricultural use.

6.1.2. ABC analysis of design parameters is carried out. 'A' class customer requirements are defined, as 'Must' requirements, 'B' class customer requirements are defined as 'Demand' requirements and 'C' class customer requirements are defined as 'Wish' requirement.

Weightage of design parameters is calculated after considering all stakeholders' opinions. Ranking of design parameters is reported in the Table No515. The percentile is calculated and those
customer requirements, which have scored, more than 70% percentile are called ‘A’ class customer requirements. Customer requirements in between 60% to 70% are called ‘B’ class customer requirements and those below 60% are called ‘C’ class customer requirements. This is as per the Cross method (Pahl and Beitz: 1996, Cross: 1994), Ullman methods (1992), and Huang. (1999:96) Improvements made in ‘A’ class are called category killer product.

The ranking method used in this study is different from the method used by Huang. He conducted his study in Taiwan and so ranked the customer requirements to suit his needs and geographical location. Here the ranking of customer requirements is modified to suit this study and considering opinions of all stakeholders.

Chart No 601: Graphical representation of ABC Analysis:

6.1.3 Perceptual gap about different design parameters is observed amongst different stakeholders. Energy, safety, life, transport, load, ergonomics, and cost are these parameters, where no perception gap exists among all stakeholders.

Using paired sample t-test hypothesis testing is carried out. This is used to test whether perception gap exists among different stakeholders. Theoretical t value is 1.699 for 90% significance level, and for 29 degree of freedom. This is as per the table attached in appendix no 5. When t actual value exceeds t critical value i.e. 1.699, null hypothesis is rejected. It means no perception gap exists, and vice versa. Parameters for energy, safety, life, transport, load, ergonomics, and cost are
such design parameters where no perception gap exists. Every stakeholder gives more priority to these parameters. However, for others perception gap exists.

6.1.4 Perception gap between different stakeholders is examined with the help of t-tests.

Perceptual gap between pairs of stakeholders is represented in Table No. 601.

Table No 601: Table for reporting perception gap.

<table>
<thead>
<tr>
<th>Pairs of Stakeholders</th>
<th>Name of parameters for t-test fails i.e. no perception gap</th>
<th>Name of parameters for t-test accepted i.e. there is a perception gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer and Designer</td>
<td>Energy, material, performance life, cost, ergonomics, load, safety, and transport.</td>
<td>Maintenance, quality, dimension, value analysis, operation, assembly, environment, motion, manufacturing, schedule, aesthetics, reliability and signal</td>
</tr>
<tr>
<td>Customer and Engineer</td>
<td>Energy, life, ergonomics, maintenance, motion, safety, and transport.</td>
<td>Material, material, performance, cost, dimension, load, value analysis, operation, assembly, environment, manufacturing, aesthetics, reliability, quality, and signal</td>
</tr>
<tr>
<td>Customer and dealer</td>
<td>Energy, material, performance life, cost, ergonomics, safety, transport, Maintenance, load, dimension, value analysis, operation, environment, motion, manufacturing, schedule, and signal</td>
<td>Quality, assembly, aesthetics, and reliability.</td>
</tr>
<tr>
<td>Designer and Engineer</td>
<td>Energy, material, life, cost, ergonomics, safety, transport, load, dimension, operation, environment, quality, aesthetics, and reliability, manufacturing, schedule, and signal</td>
<td>Performance, assembly, maintenance, motion, and value analysis.</td>
</tr>
<tr>
<td>Designer and dealer</td>
<td>Energy, material, performance, life, cost, safety, transport, load, dimension, quality, reliability, and signal</td>
<td>Ergonomics, manufacturing, assembly, operation, maintenance, schedule, motion, aesthetics, environment, and value analysis,</td>
</tr>
<tr>
<td>Engineer and dealer</td>
<td>Energy, life, cost, ergonomics, safety, transport, maintenance, load, dimension, motion, quality, aesthetics, reliability, and signal</td>
<td>Material, performance, manufacturing, operation, schedule, assembly, environment, and value analysis.</td>
</tr>
</tbody>
</table>

6.1.5: The perceptual gap that exists for ranking of different design parameters amongst stakeholders like customers, design engineers, other engineers, and dealers. Difference of opinion for preferences of design parameters is observed in different ranking. Ranking of design parameter is the
order of preferences for different design parameter. The ranking of design parameter by different stakeholders is tabulated in Table No. 515.

Every stakeholder has his own preferences for design parameters as shown in table No. 602. Customer’s preferences, for first ten preferences are reliability, life, safety, performance, energy, quality, maintenance, cost, and materials.

Designer’s preferences are in this order quality, safety, reliability, performances, maintenance, life, Assembly, cost, value analysis and operation. Engineer’s preferences are in this order quality, performance, cost material reliability, safety, energy, life operation and manufacturing. Dealer’s preferences are in this order quality, reliability, performance, life, cost, safety, energy, maintenance, material, and assembly.

Table No. 602: Top ten Parameters of all stakeholders

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RELIABILITY</td>
<td>QUALITY</td>
<td>QUALITY</td>
<td>QUALITY</td>
</tr>
<tr>
<td>2</td>
<td>LIFE</td>
<td>SAFETY</td>
<td>PERFORMA</td>
<td>RELIABILITY</td>
</tr>
<tr>
<td>3</td>
<td>SAFETY</td>
<td>RELIABILITY</td>
<td>COST</td>
<td>PERFORMA</td>
</tr>
<tr>
<td>4</td>
<td>PERFORM</td>
<td>PERFORMA</td>
<td>MATERIAL</td>
<td>LIFE</td>
</tr>
<tr>
<td>5</td>
<td>ENERGY</td>
<td>MAINTENANCE</td>
<td>RELIABILITY</td>
<td>COST</td>
</tr>
<tr>
<td>6</td>
<td>QUALITY</td>
<td>LIFE</td>
<td>SAFETY</td>
<td>SAFETY</td>
</tr>
<tr>
<td>7</td>
<td>MAINTENANCE</td>
<td>ASSEMBLY</td>
<td>ENERGY</td>
<td>ENERGY</td>
</tr>
<tr>
<td>8</td>
<td>COST</td>
<td>COST</td>
<td>LIFE</td>
<td>MAINTENANCE</td>
</tr>
<tr>
<td>9</td>
<td>MATERIAL</td>
<td>VALUE ANALYSIS</td>
<td>OPERATION</td>
<td>MATERIAL</td>
</tr>
<tr>
<td>10</td>
<td>ERGONOMICS</td>
<td>OPERATION</td>
<td>MANUFACTURING</td>
<td>ASSEMBLY</td>
</tr>
</tbody>
</table>

Cus_pref.: customer preferences, Des_pref.: designers preferences, Eng_pref.: engineers preferences, Deal_pref.: dealers preferences

6.1.6: This study has identified twenty-two design parameters. These parameters are presented in Table No. 401. Using the data reduction technique (factor analysis), new eight factors were extracted. These factors were presented in Table No. 522 of this report along with the proposed factor definitions.

The experience survey was planned and was conducted based on the twenty-two design parameters, which were finalized previously. It was concluded that, there should be twenty-two
design parameters for such design considerations. As mentioned earlier in the section 3.14.2b the parameters are narrowed to the greater extent possible for the best possible solution. But, this is not at the cost of loss of data/information. Hence, the data reduction technique is used in a study, which has helped in narrowing the design parameters from 22 to 8 factors.

Chart No. 602: Graphical representation of Factor Analysis

6.1.7: The opinion of entrepreneurs from small-scale industry was considered for eleven design parameters.

From the literature study, eleven design parameters were selected and a survey was conducted with respect to these eleven parameters. Respondents were asked to rank these design parameters.

Entrepreneur plays several roles in his organization. There is highly centralized working environment in which the specialists are kept in a bay. But this is an unhealthy practice. Outcome this pilot survey is reported in Table No 404. According to preferences of small-scale industry owners irrespective of particular product, performance, reliability, maintenance, quality, aesthetics, load, and
value Analysis, producability, safety, Environment, and cost are design parameters in a top to bottom order.

6.1.8: As small scale industry lacks the R and D Culture, the Customer centric product design can result into customer satisfaction, which can replace the role of missing R & D culture.

Pilot survey reveals that the role of design in small-scale industry is either negligible or missing. Products are lagging behind in several characteristics compared to the products from large-scale industry. These findings can help small-scale industry to produce well-designed product with better quality and hence a large market share. This will help to small-scale industry to be successful.

6.1.9: Participatory design approach is useful for existing/new entrepreneur.

In the Entrepreneurship development programs, participatory design approach should be included. This will help the new as well as existing entrepreneurs to perform well. Consumer and other stakeholders feedback are one kind of reengineering. Products overall performance is enhanced by such a process. This is extremely helpful in competitive market for survival of any industry.

6.1.10: 'Design parks' or 'Design Schools' will help the industrialists to solve the design-related problems.

Literature study reveals that India has just about 4-5 design schools, compared to China or others, which has more than 100 design schools. Industries in developed countries work more on design. Decisions taken at the early stages are crucial to save substantial time and cost. So, design parks or design schools will help the industries to design quality products. This will be useful to them to enhance market share for their products. In India where industries do not have R and D Culture, this is an imperative.
6.2 Conclusions

6.2.1 Conclusions Pertaining to Design Parameters Optimization

6.2.1.1a The relative weighting of design parameters shows priority given to each variable by the stakeholders.

6.2.1.1b Perception gap is observed and proved by means of t-test among all stakeholders’ preferences. This gap is not fully considered by the studies conducted till now. It is necessary to satisfy customer to succeed in market. So, lot of work is required to be done in this area. There is ample scope for arranging out research project in this field.

6.2.1.1c There is a need for coordination among all stakeholders. Design engineer is not aware of what exactly a customer expects from a product, or of the problems faced by manufacturing engineers or dealers. There is a need of precise design theory aiming at designing a product for totality. This will act as a valuable database for advanced theory. This can be used as a tool in design labs.

6.2.1.1d This will provide a strategic tool to the designers, managers, and new or existing entrepreneurs. It will help them in finding important design parameters for problem formulation and product design selection. This will help them to satisfy customer, produce a product at optimum cost, and minimizing production lead-time.

6.2.1.1e Customer preferences for the product specifications or characteristics (reported in the literature) and the designer’s specifications are different. So there is a need to bridge the gap, along with considerations of engineers’ preferences and dealers’ preferences.

6.2.1.1f The decisions taken in the early stage have higher leverage than any other stage. These decisions may also save substantial time and cost. This study will provide a tool, to take early stage decision.

6.2.1.1g From 22 design parameters, 8 factors are extracted by factor analysis. These eight factors are main design parameters and are to be considered while designing any product.
6.2.1.1h The optimization of design parameters for more market share or to provide greater customer satisfaction largely depends on product design.

6.2.1.1i The study provides optimized strategy for designing any product that will satisfy all stakeholders and will provide good market potential.

6.2.1.1j The awareness about design parameters and customer satisfaction among all small-scale entrepreneurs can be improved by providing the knowledge of optimized design parameters, assessment of market share, which is useful for survival and success of a unit.

6.2.1.1k SSI entrepreneurs are not much aware of design parameters. So, the losses are greater in terms of time and money, with low consumer satisfaction. Therefore, possibility of loosing market share is more.

6.2.1.1l The literature study mentions that design parameters are considered while designing a product in large-scale industrial units. Analytical study/detailed discussions of these factors are presented in the Thesis. This finding is confirmed by comparing the eight extracted factors for deciding the design strategy of any product.

6.2.2 Conclusions pertaining to the Capabilities of Entrepreneur

6.2.2a With the help of this study, the entrepreneurs can develop capabilities like, optimized strategy to design a product, consumer care, early stage decision making ability, market research and analysis, and planning and evaluation of strategy, etc.

6.2.3 Conclusion Pertaining to Entrepreneurship Development Education/Training

6.2.3.1a It is observed that the existing entrepreneurship training programs are mainly concentrating upon the psychological, physical, financial characteristics, etc. Other factors of greater importance in competitive era like customer satisfaction; innovation, etc. are not given due weightage. Hence, these training program need restructuring in order to achieve success for entrepreneur. These programs must be designed or based on all the extracted factors. Due weightage to all the extracted factors according to their importance should be given in training program.
6.3 Recommendations

6.3.1 Recommendations to Potential Entrepreneurs

6.3.1.1a It is recommended to designers, managers, or new/existing entrepreneurs, to study optimized Design Parameters, for problem formulation and product design selection. Necessary training for developing the desired qualities is highly recommended.

6.3.1.1b The product characteristics change with the product. To select a product for a SSI unit, it is necessary to study the major characteristics based on customer preferences and these are to be matched with the existing competitive product performances.

6.3.1.1c There is a need to bridge the gap found among all stakeholders.

Customer satisfaction plays a major role in success of any organization. From this study, difference between customer expectations and the other stakeholder is found out. For ex. Customer gives priority to energy considerations, which is absent in designers’ preferences. All stakeholders are required to give priority to customer’s expectation. In this connection, more work is required.

6.3.2 Recommendations to Existing Entrepreneurs

6.3.2.1 It is recommended to assess the performance of the SSI units periodically by using the questionnaire of experience survey and consumer feedback about the product. This assessment should identify the area where the product is lagging in performing its functions. For taking the corrective action, it is recommended to use the decision aid as optimized product design parameters for redesign.

Ex. An American Firm named Sonic Rim Corp.; in San Francisco established by Ex-NID student Mr. Uday Dandvate does such a kind of activity. He is using the participatory design approach.
6.3.3 Recommendations to Educational Training Institutes

6.3.3.1a The educational/training programs for technical entrepreneurs are to be designed in a manner that they addresses the needs of customer satisfaction and product design by participatory design approach. Syllabus should be designed to give due importance to the design theory, industrial design, product design, etc.

6.3.3.1b The existing training programs should be restructured and should emphasize on training for the design and all extracted factors.

6.3.3.1c It is recommended that the syllabus committee should concentrate more on design theory in preparing syllabus for educational institutes.

6.3.4 Recommendations to Government

6.3.4.1 It is observed that the generation of employment in the SSI unit is higher. Undesired performance is one of the major reasons for the sickness in SSI units. Hence, it is recommended to increase number of Design Schools/Parks to facilitate designing of product, design formulation for the SSI entrepreneurs.

6.3.4.2 The government should motivate more researchers to do research in this area by providing appropriate schemes, and scholarships, etc.

Table No. 603: Recommendations based on duration for implementation.

<table>
<thead>
<tr>
<th>Short term</th>
<th>Entrepreneurs</th>
<th>Education Institutes</th>
<th>Government</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1. Encourage communication between Designers, Engineers with dealers and customers.</td>
<td>1. Arrange dealers and customers meet with involvement of engineers and designers. 2. Arrange training programs on design theory and use of design parameters for customer satisfaction to SSI entrepreneurs.</td>
<td>1. Provide finance, sponsorships to organise dealers and customers meet with designers and engineers.</td>
</tr>
<tr>
<td></td>
<td>2. Periodic review of customer expectations about product.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Training about design theory, use of design parameters for customer satisfaction. 2. Use of participatory design approach.</td>
<td>1. Improve correlation between design and manufacturing using concepts like design for manufacturing, design for assembly, etc. 2. Include eight design factors in study of design theory.</td>
<td>1. Based on experience of developed countries, Asian countries like China, Taiwan, Korea, etc. establish more design schools, design parks. 2. Enhance research in product design, design theory, design optimization techniques, etc.</td>
</tr>
</tbody>
</table>

Long term
6.5 Contribution of the Research Work

The contribution is presented below.

6.5.1 Awareness about design, design theory, and design parameters among entrepreneurs, engineers, & manager's etc. is addressed in this study.

6.5.2 Participatory design thinking in the Indian business environment is introduced in this work.

6.5.3 Following concepts are needs to be emphasized while designing new products.

(1) Driving innovation in a manner that is responsive to user needs and aspirations,
(2) Consumer satisfaction consideration while designing any product, and
(3) New issues like user participation in designing a new product are addressed here in this research project.

6.5.4 Twenty-two design parameters are extracted in eight groups by applying the data reduction techniques of factor analysis.

6.5.5 Perception gap in between designers' preferences, customers' preferences, manufacturers' preferences, and marketers' preferences are underlined and this needs to be bridged.

6.5.6 In the present Indian environment, the influence of design, need of customer centric product design for success/failure of the small-scale units is identified. This knowledge can be used to prevent the sickness/bad performance of the Small-Scale Industrial units.

6.5.7 The Findings/Conclusions have created the basis for educational/training programmes and to improve the market share of the SSI units or technical entrepreneurs.

6.6 Future Scope

6.6.1 Web Usability:
Studies are needed for effective utilization of the Internet for design practices.

6.6.1.1a Studies are needed design practices for the effective utilization of the web-based medium.
6.6.1.1b In these web-based models, User factor should be main consideration rather than technology driven consideration.

6.6.1.1c E-design can be made available to all its users. It will provide web-based services, linkage through connectivity with experts and peers, opening an opportunity for trade and commerce, etc.

6.6.2 Future Scope in Optimization Methods:

6.6.2.1a Several optimization methods like, Analytical Hierarchy Method; Graph Theory can be used for the optimization of design parameters. Genetic algorithm technique is another technique, which, can be used to optimize design parameters.

6.6.2.1b Use of computers should be made in product design formulation developing programs to design any product.

6.6.2.1c Studies are required to find out the impact of participatory design in actual market before and after the use of the theory.

6.6.2.1d There is a need to develop a theory for designing of products and this can be done by vigorous research activity. Studies are required to carry out this type of study for different products.

6.6.2.1e Studies are required to fathom the depth of customer satisfaction.

6.6.3 Future scope in enhancing qualities of entrepreneur:

6.6.3.1a Studies can be carried out to see how effectively the theory is implemented to enhance the skills of entrepreneur in product design formulation.

6.6.3.1b Studies are required to develop the Educational and Training Programs for entrepreneurs based on the findings and conclusion of the present study.

6.6.3.1c Comparative study of ED education throughout the country is recommended in order to improve the success rate in the SSI units in our country.

6.6.3.1d Studies are recommended to understand the effect of optimized design parameters on customer satisfaction.