# DEVELOPMENT OF BENCHMARKING MODEL IN SELECT SERVICE INDUSTRY

**THESIS**

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***by***


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# CANDIDATE'S DECLARATION

I hereby declare that this thesis entitled **DEVELOPMENT OF BENCHMARKING MODEL IN SELECT SERVICE INDUSTRY** by **BHUPENDER SINGH**, being submitted in fulfilment of the requirements for the Degree of Doctor of Philosophy in MECHANICAL ENGINEERING, at Faculty of Engineering & Technology of YMCA University of Science & Technology Faridabad, during the academic year 2016-2017, is a bonafide record of my original work carried out under guidance and supervision of **Dr. SANDEEP GROVER and Dr. VIKRAM SINGH PROFESSOR, MECHANICAL ENGINEERING** and has not been presented elsewhere.

I further declare that the thesis does not contain any part of any work which has been submitted for the award of any degree either in this university or in any other university.

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# CERTIFICATE OF THE SUPERVISOR

This is to certify that this thesis entitled **DEVELOPMENT OF BENCHMARKING MODEL IN SELECT SERVICE INDUSTRY** submitted in fulfilment of the requirement for the Degree of Doctor of Philosophy in **MECHANICAL ENGINEERING** under Faculty of Engineering & Technology of YMCA University of Science & Technology Faridabad, during the academic year 2016-2017, is a bonafide record of work carried out under our guidance and supervision.

We further declare that to the best of our knowledge, the thesis does not contain any part of any work which has been submitted for the award of any degree either in this university or in any other university.

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# ABSTRACT

The service sector has emerged as the fastest growing sector compared to all other sectors in the most economies. With increasing influence of service industry on the economy, more and more firms are showing concern about service and service management. Unlike tangible products service is a delivery system where designing and controlling delivery process is important in management of services. One of the most important issue in managing service delivery process is to find and improve inefficient process for the organization. Quality products and services are the foremost preferences for customers through which service industries became very competitive in current scenario. Assessment of service is the main management concern for any type of industries and requires more improvement to become benchmark in their respective field. Benchmarking is the decisive instrument for enhancement which is proficient over assessment from former organizations predictable as the best within reason. It provides an external focus which forces the organization to seem what the competitors are adopting. It is difficult to recognize appropriate benchmarking technique for superlative solution in industries.

The rationale of this thesis is to review the benchmarking technique with the help abundant survey which identifies many benchmarking techniques used in Indian service industries. In realistic problem for service industries, it is difficult to identify the benchmark model in competitive scenario to sustain better in their areas. The major intent of this study is to recommend a benchmarking model of service quality for Indian service industries and provide suitable benchmarking techniques for them to enhance quality system on continuous basis. Thus, it becomes more complex to select the best benchmarking technique for implementation in industries. The selection of decisions becomes multifaceted as decision makers in service environment have to assess wide range of alternatives based on contradictory criteria. These decisions are more intricate as the numbers of attributes depend up on critical success factors for particular industry.

Therefore, the constraint of novel methods which may recognize paramount decision for selection of critical success factors by Multi Attitude Decision Making (MADM) methods. The customer's subjective opinion and linguistic labels are used to describe factor's weights like tangibles, reliability, empathy and many more which will quantify intangible attributes by using Fuzzy MADM approach and provide basis for

several critical success factors like Planning, Reliability, Standardization, Time Behaviour, Usability, etc. as the part of benchmarking system. A combined approach of Graph Theory with application of Fuzzy logic has been designed to synthesize the inter-relationship among dimensions of benchmarking and their attributes to provide a synthetic score for this research work. To convert the linguistic data for critical success factors into crisp score the 11 point scale has been used which helps for comparison in better utilization of linguistic data. The comparative score show dimension for better result of utilization while streamlining the benchmarking attributes in service industries. Some important factors have also been analyzed and modelled by using the Interpretive Structural Modelling (ISM) approach for each phase of the benchmarking system in Indian scenario.

A novel hybrid methodology of ANP (Analytical Network Process), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and MOORA (Multi objective optimization on basis of ratio analysis) is applied for evaluation of the benchmarking model developed by this study. Thus, the endeavour is to give a benchmarking model which gives confidence for executives to adopt benchmarking for attaining their goals in industries. The findings of this model are extremely convenient to identify appropriate benchmarking process in developing countries like India which accommodates to adopt lead role in competitive market. Mutual spirit of experts will provide the identical results for the study and assurance for managers of service industries. An implementation of such quality model can help the service industries to grow and survive in the rapidly changing environment.

Results of this thesis convert the subjective decision into objective process by giving appropriate model of benchmarking implementation. The growing competitiveness of Indian industrial sector have inspired service industries to assess and implement benchmarking. In the existing scenario, world becomes competitive every day, Indian service industries should be continuously improved by improving their assets. The escalating competitiveness of the Indian industrial sector is resulting from changing customer's requirements that has motivated service industries to evaluate and implement benchmarking.

The usage of benchmarking in its different arrangements will add more erudition to the industries and evaluate their ability to compete in global market. Most of the industries in Indian scenario, are accepting a comparatively traditional approach for

similar comparative organizations with an attention on gladly computable activities. Although benchmarking in Indian service sector is a moderately new concept and it has been embraced universally as an instrument of continuous improvement. Requirement of Indian service industries is to look beyond their immediate managerial limitations for benchmarking partners. However, there is need of selecting appropriate benchmarking process for their industries which will eliminate the executive's confusion for implementing the desired benchmarking. Thus, this study will enhance the overall efficiency of Indian service industries by increasing competitiveness. For the ambiance of leadership, industries are adopting various benchmarking techniques consequently.

This study can support in providing a clear picture of convincing performance and give ways for improving quality system in industries. It can also connect to the barriers and effects of benchmarking while implantation as a resultant. Thus, this study will motivate the managers of Indian Industries to optimize benchmarking practice in their processes.

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# LIST OF ABBREVIATIONS

| Symbol | Description |
|---|---|
| ANOVA | Analysis of Variance |
| ANP | Analytic Network Process |
| AOD | Accuracy of data |
| NBA | Non Beneficial Attributes |
| CC | Cultural Change |
| DOF | Degrees of Freedom |
| X bar | Mean of Sample Subgroup |
| FGTA | Fuzzy Graph Theoretic Approach |
| TOPSIS | Technique for Order Preference by Similarity to Ideal Solution |
| ANP | Analytical Networking Process |
| BA | Beneficial Attributes |
| GTA | Graph Theory Application |
| IRM | Initial Reachability Matrix |
| ISM | Interpretative Structural Model |
| MIC-MAC | Cross-Impact Matrix – Multiplication Applied to Classification |
| SPC | Statistical Process Control |
| TSC | Traditional Supply Chain |
| MS | Mean Square |
| MSR | Medium Scoring Responses |
| LCL | Lower Control Limit |
| UCL | Upper Control Limit |
| TQM | Total quality Management |
| MSA | Measurement System Analysis |
| VPM | Variable Permanent Matrix |
| MOORA | Multi Objective Optimization on the basis of Ratio Analysis |
| MADM | Multi-Attribute Decision Making |
| DOF | Degrees of Freedom |
| SS Between | Sum of Squares for Variance Between the Samples |
| SS Within | Sum of Squares for Variance within Samples |
| FMEA | Failure Mode and Effects Analysis |

| | |
|---|---|
| PASW | Predictive Analytics Software |
| SOPs | Standard Operating Procedures |
| TQM | Total Quality Management |
| CTQ | Critical to Quality |
| CSFs | Critical Success Factors |
| CSE | Customer Support Executive |
| SSIM | Structural Self-Interaction Matrix |
| RM | Reachability Matrix |
| QM | Quality Manager |
| FRM | Final Reachability Matrix |
| CI | Competitiveness Index |
| PIS | Positive Ideal Solution |
| NIS | Negative Ideal Solution |
| SB | Strategic Benchmarking |
| IB | Internal Benchmarking |
| EB | External Benchmarking |
| FB | Functional Benchmarking |
| PB | Performance Benchmarking |
| GB | Generic Benchmarking |
| CB | Competitive Benchmarking |

# CHAPTER I INTRODUCTION

***Chapter Objective***

*This chapter presents the essential structures of benchmarking system. The development of service and benchmarking in the industries are discussed. Further this chapter delivers evidences about the role of benchmarking system in fulfillment of quality system for service industries. Moreover this chapter discusses the organization of the thesis.*

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The service sector has emerged as the highest mounting sector compared to other sectors. By increasing influence of service industry, more firms are concerned about service and their management. Unlike tangible products, service is a deliverance arrangement, where designing and controlling process is extremely decisive. Globalization has placed industries into healthy competition where Customers are enjoying high quality of products and services with lesser prices. Regular manufacturing and service methods are not adequate for endurance in this incessantly closing world, thus there is requirement for industries to accept new methods and techniques to improve their effectiveness in systems such as Total Quality Management, Just In Time, Flexible Manufacturing System, Quality Models and numerous other for achieving Benchmarks. These newer technologies offer excessive advantages on each operation, however industries are ineffectual to yield the predicted assistances completely through numerous critical success factors which occurs complex nature of these technologies. Thus, there is constraint for sustaining services to customers which causes benchmark model for industries to preserve service quality as group leaders.

## 1.1 BENCHMARKING

In the current society, with an increasing trend and complexity of information the main focus of industrial enterprises is to have continuous improvement. Since, due to close competition in market the percentile of various levels of satisfaction is engaged to review. Wong (2008) defined benchmarking as a organization tool that is valuable for searching organized procedure of best practices and new ideas to continuous improvement. It is identical valuable tool for improving the weakness over development processes where industry measures its

performance against best in the group (Saunders & Smith, 2007). Benchmarking is mostly adopted by industries to identify how they are performing in market relative to their competitors. As per Padma et al., (2009) computing the quality of service which helps service providers to enhance value for their individual processes based on feedback as per customer satisfaction. In the process of benchmarking, management identifies the best firm from the industries and compares the results of those processes with them. It is a well defined tool for refining the weakness by upgrading processes in which an industry measures its performance beside market leaders (Saunders, Mann & Smith 2007).Benchmarking is the process of accepting what is important for industry's success, understanding processes, finding and learning from others whose processes are better, then adapting learning process to improve the performance. It involves self-assessment with capability to explain practices which can make effort in alternative setting into a process suitable to their association. Benchmarking is a well-planned and systematic process of innovation and learning which can be measured as its fundamental origin and compares against best organizations inside or outside in any sector. It has clear objectives and mechanisms to measure performances.

The essence of benchmarking is the process of identifying the maximum standards of dominance for products, processes and then marks the changes to reach these standards (Dattakumar and Jagadeesh 2003). It is acceptable distinct tool for refining the weakness through improved processes in which a company measures its appearance beside best of market. It can be used to identify what management procedures are valuable to apply in one's industry in order to attain desired recital goals. Spendolini (1992), defined benchmarking as an unceasing, methodical process for assessing the products and work procedures of governments that are recognized as representing best practices. It can be understood as a tool for improvement more than just comparing, ranking and goes ahead for the establishment of standards, norms and investigate the practices that support the benchmarking. Some of the important definitions which are given by different authors are:

According to O. Jurevicius (2014) benchmarking is a strategy tool used to compare the performance of the business processes and products with the best performances of other companies inside and outside the industry.

As per EFQM (2012), European Benchmarking Code of Conduct – 2009, it is the process of identifying and learning from good practices in other organizations.

Kumar et al., (2006) discussed benchmarking as the procedure of recognizing and adapting remaining performs from administrations anywhere in the world to assist an organization and recover its performance.

Riberio and Cabral (2006) stated that benchmarking is a proportional study which can be based on gathering of qualitative and measurable indicators to measure the performance inside associations.

According to Pyo S (2005), benchmarking is the search for the business best practices that will lead to higher performance. Benchmarking is one of the learning processes. To perform benchmarking work, the process should be formalized first, performances should be compared to the industry leaders and performance gaps should be measured with identification of commitments.

Following Wober K.W. (2002), benchmarking is subjected to the search for specific practices that will enhance performance with a controlled allocation of resources. The efficiency can be improved by the discovery of specific practices and relying on simple engineering proportions.

American productivity quality center (1999) defined benchmarking as the process of identifying, understanding and adapting outstanding practices and processes from organizations anywhere in the world to help your organization to improve its performance.

Cook (1995) defined benchmarking as a kind of performance improvement process by recognizing, accepting and adopting unresolved practices from within the same association or it may be from additional association.

Kleine (1994) defined as an excellent process to use in order to identify a performance goal for improvement and identify partners who have accomplished these goals and identify applicable practices to incorporate into a redesign effort.

Colding (1992) described benchmarking as continuing process connecting to an association to perform against best in the industry after seeing perilous consumer's requirements.

Figure 1.1 shows the simple benchmarking process contains five main phases which starts with defining of process, where process is defined thoroughly afterwards data is collected

regarding the complete system in data collection phase. Then in analysis phase the data are analysed and compared with existing one and action will be taken to improve the process in action phase. Last phase is recalibration, where process is recalibrated as per requirement.

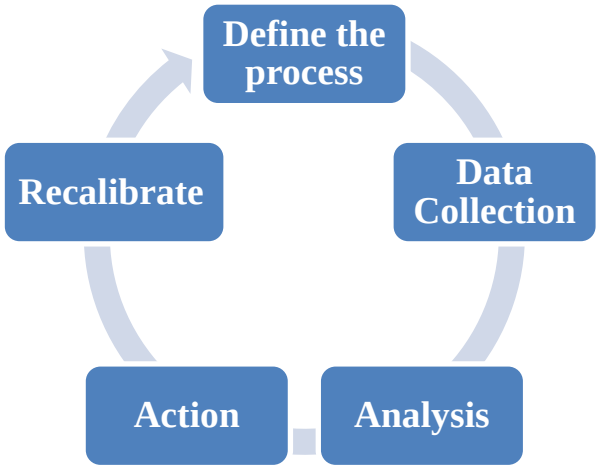


Figure 1.1 Benchmarking Process

## 1.2 TYPES OF BENCHMARKING

Besides the usage of benchmarking practice, it may be categorized into different phases. There is several classification of benchmarking.

### 1.2.1 Internal Benchmarking

It is the assessment between units inside one organization which enables organizations to attain immediate profit by recognizing their best internal practices and moving those to other parts of the organization. Internal benchmarking is the ability to arrangement with partners who are having a common language, culture and systems having easy access to data which give a baseline for forthcoming assessments. If one industry completes recovering to others, performance can be transferred within industry for improvement. The objective of internal benchmarking activity is to identify the internal performance standards of an association. According to Spendolini (1992), often significant amount of information is mutual for this type of benchmarking. Many organizations are able to realize instant improvements by

recognizing their best internal practices and then relocating that information to other organization.

### 1.2.2 Generic Benchmarking

This benchmarking emphasis on admirable work procedures rather than on business practices of a particular organization. It has potential of revealing the best of best practices. It is the assessment of work procedures with others who are having innovative work processes. Therefore, a certain amount of creativity is required. The term generic suggests, without a brand which is consistent with idea that this benchmarking concentrations on exceptional work processes other than the business practices on a individual organization. This approach may be applicable to all functions of business operation. Camp (1989) stated that generic benchmarking is the purest form of benchmarking because the approaches under investigation may be exposed and not be realized in the investigator's individual zone.

### 1.2.3 Performance Benchmarking or Competitive Benchmarking

This is the assessment of performance procedures for the purpose of decisive that how good our establishment is as compared to others. Performance benchmarking refers to the comparison of the organizational by key processes, products and services. According to Bogan (2004), this benchmarking generally gives attentions on fundamentals of technical quality, product features, reliability and other performance characteristics. These performance measures may determine how good one's organization is compared to others. The objective is to compare industries in the same sector that competing services eg, Maruti Vs Tata, Bajaj vs Hero Honda. It denotes to a contrast with direct competitors only.

### 1.2.4 Strategic Benchmarking

In strategic benchmarking, the focus goes beyond the performance leadership and correlating strategic ideas with commercial decisions. This can be important information to the company's own strategic planning. Strategic benchmarking has become increasingly popular because it requires only a limited investment and a small professional team. This benchmarking is assumed when an attempt is being made to change the strategic direction of business with comparing strategies of other industries. In general terms strategic benchmarking examines how organizations are competitive. Benchmarking process may be

used to analyze strategic goals in search for alternative activities as part of the strategic planning process. It is the assessment of strategic selections and dispositions made by other companies for the collecting information to improve strategic planning and positioning (Andersen & Pettersen 1996). The setting of short term and long term goals may belong to strategic planning. Therefore, short term goals may be adapted from one benchmarking partner and long term goals from another.

### 1.2.5 Process Benchmarking

It means seeking the best practices through face to face studies and observation of key business processes regardless of what is the best practice. Process benchmarking requires the participation of subject experts, the owner of a process and process work team. It gives weightage on improving precise critical processes and operations. Process benchmarking always includes making process charts to enable comparison and analysis. This type of benchmarking is required from administrations that accomplish similar work or deliver similar services.

### 1.2.6 External Benchmarking

External benchmarking requires a comparison of work with external organizations in order to discover new ideas, methods, products and service. The objective is to improve one’s own performance by measuring how it performs, comparing it with that of others and determining how others achieve their performance levels. External benchmarking is divided into generic and relationship benchmarking. This type of benchmarking is used by companies to seek the help of organizations that succeeded on account of their practices. This kind of benchmarking provides an opportunity to learn from high end performers.

### 1.2.7 Functional Benchmarking

Functional benchmarking denotes the proportional research and attempt to appeal world-class superiority through associating business performance against the best business operating in comparable fields with same activities. It shows comparison of methods with those of industries with similar processes in the same function outside one's industry. Functional experts from one organization generally focus on their own area of expertise. The key distinction in this type of benchmarking is that it can focus on any organization in any

business, the common element being the analysis of excellent functions and practices. There is great potential for identifying efficient participants or leading industries to benchmark. It is not too difficult to determine the leading organizations in selected functions.

## 1.3 ADVANTAGES OF BENCHMARKING

- Benchmarking provides an organized approach for quality improvement.
- It brings a peripheral hub for internal activities.
- Benchmarking utilizes accessible knowledge regarding the effectiveness of processes.
- It identifies innovative ideas and technologies.
- Benchmarking exposes the requirements for modification.
- It establishes the scope of expansion required and provides a skeleton for change.
- Benchmarking reduces subjectivity in decision making and targets them on tough data.
- Benchmarking enables the incorporation of `best practices' into one's organization.
- It encourages a learning culture which is open to new ideas and promotes contacts and networks.
- Benchmarking improves practices, services and learning about best practices from others.
- It is an ongoing process which encourages new and innovative ideas for problem solution.

## 1.4 COMMON PROBLEMS OF BENCHMARKING

Although there are many benefits of benchmarking reported in the literature, still maximum benchmarking related problems are originated from uncertainties. There is an optimistic attitude towards implementation of benchmarking concepts in industries but identification of appropriate benchmarking partner is considered as the main problem among Indian industries (Jain et al., 2008). Service benchmarking becomes more problematic than manufacturing benchmarking because it seems those things which are significant to consumer and can differ suggestively from one to another service industry (Narayan et al., 2008). Minimum

acceptable ecological standards could be imposed through industry wise consensus in Indian scenario, where public access of performance indicators can be ensured under intended consent (Amin and Banerjee, 2010). Benchmarking provide the method by which management can pursue the quantity and increase efficiency which can take initiatives for the appraisal of the performances and identifying gaps between existing best practices with other not so good practices (Vishwakarma et al., 2012).

## 1.5 NEED OF THE STUDY

It is problematic to recognize appropriate benchmarking technique for superlative solution in industries. However, the critical importance of capturing and combining a group of opinions with some integrated quality approaches has been highlighted in literature of benchmarking area. But the comparison among these techniques and selection of appropriate benchmarking specially for Indian service industries had not applied in the literature, thus it is required for validation of decision making method about selection of appropriate method. Result of this research converts the subjective decision into objective process by giving appropriate model of benchmarking implementation. The growing competitiveness of Indian industrial sector and moving customer's necessities has inspired service industries to assess and implement benchmarking. In the existing scenario global market becomes competitive every day, Indian service industries must be continuously improved by improving their assets. The usage of benchmarking in its different arrangements will add more erudition to the industries and evaluate their ability to compete in globally market. However, there is need of benchmarking model for their industries which will eliminate the executive's confusion for improving the success factors of service quality. Thus, this study will enhance the overall efficiency of Indian service industries by increasing competitiveness. Most of industries in Indian scenario, are accepting a comparatively traditional approach with an attention on gladly computable activities and similar comparative organizations. Though benchmarking in Indian service sector is a moderately new concept and it has been comprised universally as an appliance of constant improvement.

## 1.6 MOTIVATION FOR THE STUDY

In India, there is a positive attitude towards adoption of benchmarking concepts in manufacturing and service industries but identification of suitable benchmarking partner is considered to be the most important problem among Indian manufacturing companies (Jain et al., 2008). Service benchmarking is made more difficult than benchmarking in manufacturing because it appears that those things, which are important to a customer, can differ significantly from one service industry to another (Narayan et al., 2008). Minimum acceptable ecological standards could be imposed through industry wise consensus in Indian scenario, where public access to performance indicators can be ensured under intended consent (Amin and Banerjee, 2010).

The Escalating competitiveness of the Indian industrial sector resulting from globalization and changing customer's requirements has motivated service industries to evaluate and implement benchmarking. In the current scenario, where world is becoming competent every day, Indian service industries should be continuously improving by enhancing their strengths and eliminating their weaknesses. The use of benchmarking in its different forms will add more learning to the industries and evaluate their ability to compete in globally market. Requirement of Indian service industries is to look beyond their immediate managerial limitations for benchmarking partners. However, there is need of selecting appropriate benchmarking process for their industries which will eliminate the executive's confusion for implementing the desired benchmarking. Thus, this study will enhance the overall efficiency of Indian service industries by increasing competitiveness. Although benchmarking in Indian service sector is a moderately new concept and it has been embraced universally as an instrument of continuous improvement.

## 1.7 RELEVANCE OF THIS STUDY

This study can support in providing a clear picture of convincing performance and give ways to behave for the distinct industries. It can also connect to the barriers and effects of benchmarking as a resultant. As mentioned above, economic growth of the country is opening new gates of chances, benchmarking in service industries can be attitude changer, time reducer and improve overall satisfaction level. Through rapid development in industries,

India's growing market has placed itself constructively as the core competitive. Most of the changes are done in a limited time period of about 10 to 20 years in the Indian economic conditions. India is being perceived as an emerging industrial power to be estimated with and the foremost industrials hubs around the world. The International competition has placed incredible stress on Indian industries to achieve better customer satisfaction, enhanced business effectiveness with in the global market. Thus, this study will motivate Indian Industries to optimize benchmarking practice in their processes.

Service sector industries such as maintenance of automobile vehicles, hotels, travels etc., plays an important role apart from design, manufacturing and marketing industry. Automobile industry has shown an exponential growth over the past two decades. Furthermore, the demand is expected to produce an increased rate for the next two decades or more unless and until the vehicles are properly maintained, the basic objective of mobility will not be served completely.

## 1.8 METHODOLOGIES ADOPTED

For achieving the research objectives, various techniques have been used for the thesis. Firstly, Quality enabled factors have been identified from systematic literature review based on benchmarking. Then with the help of experts a questionnaire based survey method was used to collect the responses from Indian service industries. The responses were validated by ANOVA method to identify f ratio for critical success factors. Furthermore, the hypothesis test was performed to validate the data. Now for prioritization of critical success factors the different MADM techniques have been used which are as follows:

### 1.8.1 Interpretive Structural Modeling (ISM) Approach

ISM is defined as a process aimed at assisting the human being to better understand what he believes and to recognize clearly what he does not know. Its most essential function is linkages of organizational. In this method, a set of diverse directly and indirectly associated elements are structured into a broad systematic model. It is a multi-criteria decision making technique for recognizing relationships among the specific items related to a particular problem or an issue (Sage, 1977). In the current work, ISM approach has been utilized for the

analysis of quality identified factors in order to understand their effectiveness in the benchmarking application.

### 1.8.2 Fuzzy Graph Theory Application (FGTA)

FGTA consists of a combined approach of Graph Theory with application of Fuzzy logic. The approach has been designed to synthesize the inter-relationship among different dimensions of benchmarking and their attributes to provide a synthetic score for the study. To convert the linguistic data for critical success factors into crisp score the 11 point scale has been used. It also takes account of directional relationship and inter-dependence among variables. In this modeling work, the different dimensions were selected for comparison in better utilization. The comparative score after analysis will show which dimension is being selected for better result of utilization while streamlining the benchmarking attributes in service industries.

### 1.8.3 Analytic Network Process (ANP)

Analytic Network Process (ANP) is the advanced general form of AHP which takes accountability of each attribute affecting other all attributes applicable for benchmarking. ANP is about integrating the responses and interdependent relationships among decision attributes and alternatives which is near to the accurate prediction. Here in study, ANP approach had been applied through Super decision software 2.0.8. Experts were asked to give rating of the pair wise comparison of the factors on 1-9 scale. On this basis, Super decision software generated un weighted, weighted super matrix and limiting matrix priorities of the alternatives were find out which will be directly used in TOPSIS approach.

### 1.8.4 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS is a extensively accepted multiple criteria method to identify solutions from a finite set of alternatives. It was firstly presented in the study of Chen and Hwang (1992), with reference to Hwang and Yoon (1981). The basic principle of TOPSIS is about to select alternative for the shortest distance from the ideal solution and the farthest distance from the negative-ideal solution in a geometrical (i.e. Euclidean) sense. The positive ideal solution is composed of all best values attainable of criteria, whereas the negative ideal solution consists of all worst values attainable of criteria. For the selection of best alternatives identified

through ANP, the decision matrix was solved by using TOPSIS approach and the results can also be utilized in MOORA approach.

**1.8.5 Multi Objective Optimization on the basis of Ratio Analysis (MOORA) Approach;** MOORA is defined as the process of simultaneously optimizing two or more conflicting attributes subject to some constraints (Attri& Grover 2013; Karande & Chakraborty 2012; Chakraborty 2011).This approach was introduced by Brauers (2004) and starts with a matrix consisting of performance measures of different alternatives with respect to various criteria. MOORA approach consists of basically two sections namely ratio system approach and the reference point approach. The results obtained from ANP and TOPSIS is utilized in MOORA approach for proper validation of output from the above techniques.

On the basis of outcomes, theoretical model related to problems is developed. The effectiveness of model has been carried out through case studies in Automobile Service Industry.

## 1.9 OBJECTIVES OF RESEARCH

The main objective of the study is to design and development of quality management system in the form of Benchmarking in service industries. To accomplish this objective the following work is proposed:

- To study the technique of Benchmarking and its applications in manufacturing sector.
- To study the application of different techniques in Service industries for Quality Enhancement.
- To develop a model for implementing the Benchmarking technique in service industries.
- To conduct a case /field study for implementation of Benchmarking in select service industry.
- To evaluate the effect of Benchmarking in service industry using systematic approaches.

## 1.10 ORGANIZATION OF THESIS

The thesis consists of eight chapters which starts with introduction of study and completes with the limitations with future scope of the research work.

The first chapter starts with a background leading to the purpose of benchmarking and then relevance in service industries. The terms are very broad and a discussion of how they will be used in this thesis is therefore necessary. This chapter is concerned about the purpose of this study, relevance of the study, scope of the thesis. The chapter investigates the historical back ground of the benchmarking, applications of different benchmarking and common problems of benchmarking and how it can be useful for Indian scenario.

The second chapter, which is the frame of reference, (Literature reviews) starts with a more thorough explanation of benchmarking and scope of benchmarking into service industries. The content of benchmarking is however only described on a conceptual level and it is therefore necessary to clarify the content. This is done with a description of benchmarking techniques which include different models of benchmarking process. The literature of benchmarking is thoroughly studied and research frame work is prepared. To validate the frame work, frequencies of attributes of benchmarking in service industries are obtained. The strength of attributes is recognized by its frequency found in various literatures.

The third chapter gives the detailed evolvement of benchmarking in industries. It explains the refined concept of the benchmarking. From the conclusion of previous chapter benchmarking applications in different industries are considered. The application of benchmarking in manufacturing and service industries are followed, The application of benchmarking has also been classified in different phases.

In the fourth chapter, study of the benchmarking effect in industries, several aspects are to be explained properly for service and manufacturing industries. It is also found that survey method can be best working tool to know the concept thoroughly which are practiced in industries. That is why this chapter is intended to explore the trend of benchmarking practices in Indian Industries. This chapter highlighted the methodology used in collection and analysis of data. Identification of parameters associated with the benchmarking system, key parameters such as basic activities involved in each phase; department involved in performing these activities; critical success factors and sub-phases of benchmarking system

have been identified. Hypothesis test with ANOVA method is also applied for proper validation of survey data.

The fifth chapter illustrated the suitable modeling work for selection of benchmarking model in Indian service industries. In this chapter, quality enabled factors have been analyzed and modeled by using the Interpretive Structural Modeling (ISM) approach for each phase of the benchmarking system for Indian service industries. Application of Fuzzy Graph theory (FGTA) methodology has also been used to help in investigation of important attributes of benchmarking.

The sixth chapter discussed the case study for implementation of benchmarking in Indian service industries. Where, a leading automobile car industry from NCR region of India is taken as example for implementation of benchmarking model. The various phases of benchmark model have also been implemented with the help of experts team. The example from competitor industry has been taken for proper implementation of benchmarking model. The suitable results with some barriers have been found during implementation of benchmarking model.

The next chapter investigated the effectiveness of benchmarking model in select service industry. For this Analytical Networking Process (ANP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) have been used for finding out effectiveness. The research may be an insightful in making efficient and customer oriented. Quality enabled factors are prioritized by using these MADM approach in order to evaluate their impact of the benchmarking model for Indian service industries with application of MOORA method, firstly a decision matrix is formed. Relative coefficients obtained by TOPSIS method are solved by this method easily, where Beneficial (BA) and Non Beneficial (NBA) factors will be selected for problem solution.

The eighth chapter consists of discussions on results basis. The resultant points are briefly discussed to summarize the present thesis. This chapter presents the summary, implications and limitations of the present research work. Final conclusion of this research and scope of future work for this research have also been presented in this chapter. This study consists of eight chapters as shown in figure 1.2.

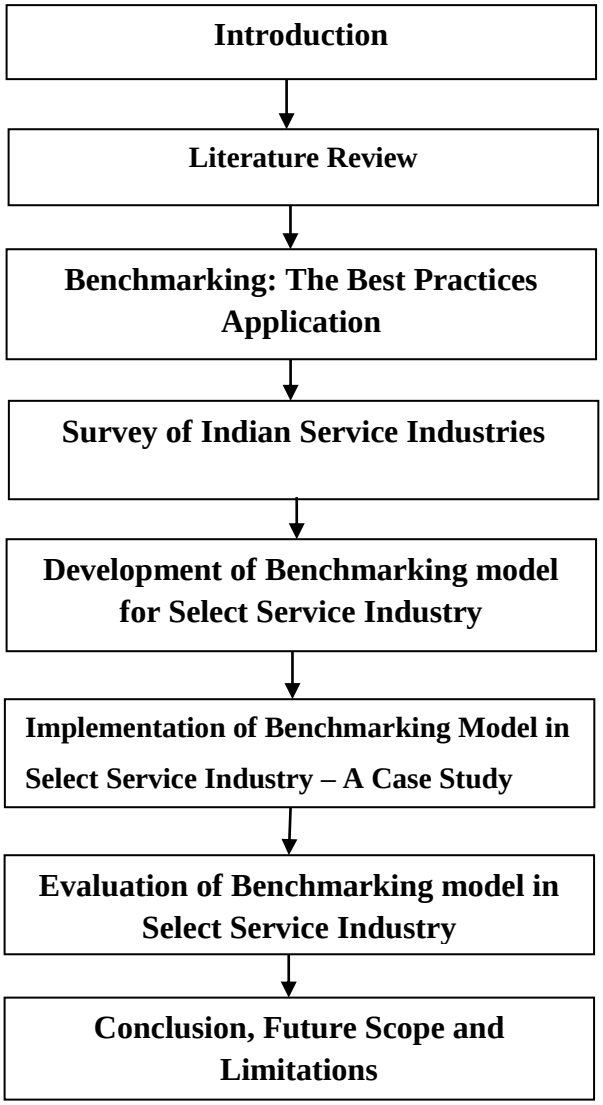


Figure 1.2 Chapter wise Organization of Proposed Thesis

# Chapter II LITERATURE REVIEW

***Chapter Objective***

*This chapter presents literature review in the field of benchmarking specifically with the purpose of identifications of factors. The systematic literature review has been done with analysis of research papers in the field of benchmarking. Literature on MADM approaches, benchmarking models and their applications are also discussed with Indian scenario.*

## 2.1 INTRODUCTION

Benchmarking practice was first applied in 1970's, used to relate key parameters and make sure for improved processes to enhance industrial performance. Benchmarking is the study of best practices with affection of effective results, employee's capabilities and advanced performances (Goold and Collis, 2005; Menor and Roth, 2007). Dattakumar and Jagadeesh (2003) suggested about companies to move their focus on benchmarking for supplementary functional which is an adaptable tool in the industrial tool box of quality. Wong and Wong (2008) applied service tools in the benchmarking process where requirement of benchmarking as an instrument in service sector is important.

Benchmarking as an overall quality management tool has been broadly accepted by manufacturing and service industries around the world. This chapter provides a review of literature on benchmarking with following methodology:

- Arranging the publications in an orderly manner for quick search
- Classification of literature
- Identify the quality enabled factors and found the literature gaps

## 2.2 DEVELOPMENT OF BENCHMARKING PROCESSES

Benchmarking has grown over a period of time and various developments were observed. Watson (1993); Ahmed and Rafiq (1998); Kyro P.(2003); Kumar and Chandra (2001); Moriarty and Smallman (2009); Anand and Kodali (2008), Deros et al., (2009), Mohamed S.(2012), Hong et al., (2012), Williams et al., (2012), Ebnera et al., (2015), Sweis et al.,

(2016) discussed about various generation of benchmarking with their applications in industries.

Initially, reverse type process applied in 1940's which was on initial stage just for comparison in internal organizations. It was simple and easy method for transfer with in same organizations but difficult for external purpose, so it was hard for globally scenario need (Camp, 1989).

After that competitive benchmarking was applied in 1970's by Xerox which was initial real type of benchmarking and assess relative level of the key areas through others in the similar sector. But this type of benchmarking is having restriction when applied like commenced through third parties or associations to protect privacy (Hinton et al., 2000).

Performance benchmarking is third generation benchmarking which was established in 1980's. It targets specific procedure competences and managerial approaches used by direct competitors in the area of performance improvement and main procedures to gain quick benefits. But it gives results as short term benefits which is a constraint for this type of benchmarking (Anand and Kodali, 2008).

Strategic benchmarking is fourth generation benchmarking, was developed in 1990's which is generally used for readjusting commercial strategies that become inappropriate, but it takes a long time to organize and also difficult for changing strategies in big organizations (Kumar and Chandra, 2001).

Generic benchmarking is the next generation benchmarking, part of new networking type of benchmarking which was developed before 2000 and used for comparing ideas within organization boundaries. But implementation in different areas is still a cutting edge for this type benchmarking. Deficiency of assurance, time period and possessions are identified as major problems through application of benchmarking (Longbottom, 2000).

Functional benchmarking is the next generation benchmarking and an approach that seeks information from the same functional area within a particular industry but it will take more time than other techniques thus common functions can be difficult to find with in time limit (Singh et al.,2013).

External benchmarking is the next generation benchmarking, which analyzes the external administration and known as the best in the class. It provides occasions of sharing knowledge from persons who are at the leading position. It took examples of good practices that are originated in other organizations. But this type of benchmarking can take a lot of time period and sources to confirm the comparability of data (Kyro, 2003).

## 2.3 LITERATURE ON BENCHMARKING

As the requirements of society benchmarking become more dynamic, the research methods have been originated to cover many case studies, empirical studies, conceptual framework studies and statistical modeling (Brandmeier and Rupp, 2010; Mehregan et al., 2010; Sreekumar and Mahapatra, 2011; Kourteli, 2000; Leung and Lee, 2004).

**Williams et al., (2012)** concluded that managerial direction about benchmarking reluctance concerns about soundness of practices; deficiency of assets for benchmarking; inactivity obstructing detection for new practices and detailed effects of understanding new practices. The study discussed qualitative analysis of 32 peer-reviewed sources from 2005 to 2010.

**Hong et al., (2012)** studied about the benchmarking literature context and suggested benchmarking practices at initial stage of company. The study observed the research available in benchmarking management and supply chain management from 2001 to 2010 where five research scopes of benchmarking are deliberated in relations to the strategy based benchmarking.

**Deros et al., (2011)** attempted an inclusive review with benchmarking technique and presented the way that would help investigators in the development of technique with about 450 articles of the benchmarking which were published in the last 10 years.

**Kull et al., (2010)** discussed the benchmarking in quality management as a management model for improving administrative efficiency and competitiveness. Numerous studies recommended those companies which are attaining their higher levels of effectiveness and effective application of practices related with quality management.

**Anand and Kodali (2008)** deliberated the essential organization system of benchmarking and models related to benchmarking that are developed for each type of benchmarking.

Moreover, proposed a common benchmarking model, which can be applied to all types of benchmarking and having 71 different steps. The residual steps were measured to be the best practices of benchmarking.

**Yasin (2002)** summarized that despite cumulative scope of the benchmarking events and increasing numeral directions in the field of benchmarking to a huge level without a uniting theory of benchmarking to guide its development.

**Zairi and Youssef (1996**) attempted the review of main publications of benchmarking in dual parts. The authors deliberated about the intestines of benchmarking books in terms of the feasibility and applicability of the reserve material.

The literature on benchmarking gives the different outcomes related to various studies of different area like manufacturing, service sectors etc. For finding the quality enabled factors of benchmarking, lot of review is required in different area where benchmarking is applied. Afterward all the study related to different field of benchmarking are classified in different categories, where these are coded as per different categories. The gap will be found that give review of benchmarking into different areas.

### 2.3.1 Benchmarking in Different Field

**Ramanathan et al., (2016)** discussed performance measurement in service sector by measuring quality of service. The author examined the significance of factors manipulating customer satisfaction with case study of a Chinese restaurant in Europe.

**Rendon (2015)** presented the consequences of indenture organization process by proper valuations of the US Navy using a procedure for competence in maturity model. The benchmarking of an administration's indenture management was done by maturity model.

**Klingner et al., (2015)** quantitatively evaluated the current status of productivity management of industrial and non-industrial service industries in Germany. Based on that knowledge, best practices and needs regarding tools and methods can be identified.

**Hong et al., (2012)** stated benchmarking remains an imperative tactical tool of business in stormy times. Several research dimensions for benchmarking are discussed in terms for justifiable inexpensive advantages and beyond the effective level which transfers into a general variety of chain and planned levels.

**Giannakis (2011)** discussed the capacity of benchmarking as the crucial view which understands the service by sighted the process of service for deciding the value of customer.

**Arlbjørn et al., (2011)** discussed an important message of benchmarking in supply chain management about differentiation of tasks in organization. Such diversity can be experienced over diverse associations with customers and suppliers.

**Min et al., (2011)** stated that the benchmarking process initiates with the organization of service standards over documentation of service attributes that contain service standards. Furthermore discussed about enhanced customer satisfaction is the decisive goal of benchmarking.

**Mei Chi et al., (2011)** stated that benchmarking has established an important tool for total quality management and process improvement. In this study, benchmarking knowledge-based system is applied in a medical center which aids to regulate the particular benchmarking partners for evaluation of the relative competence.

**Mellat and Adams (2011)** discussed the effect of marketable social obligation and benchmarking on administrative routine in the industry for implementation of corporate social concern in petroleum industry.

**Moser et al., (2011)** discussed a benchmarking outline for stock of network formation, attraction upon perceptions from various theories addressing diverse levels: the dyadic connection and the supply chain.

**Mellat and Adams (2011)** examined the consequence of commercial public accountability and benchmarking on administrative presentation in the petroleum sector. Approvals for executives and investigations have been drawn from educating economic situations.

**Narasimhan et al., (2010)** detailed about benchmarking in quality supervision which has occurred as the management pattern for improving administrative efficiency and affordability.

**Alfred et al., (2010)** discussed the applicable findings of benchmarking with a plan of the tool for clear analysis with extended literature review. It was found that the capability of the functioning staff, relaxed documentation and timely distribution are the most important quality features from the point of view of the small and medium enterprises.

**Perdomo et al., (2009)** stated the view about benchmarking concept of quality which has progressed from quality department and using statistical procedure for improving performance such as employee participation, environment for modification and invention.

**Scavard et al., (2009)** discussed benchmarking should be an orientation or standard for comparison in performance dimensions for specific business and quantifiable achievement.

**Koller and Salzberger (2009)** reported benchmarking as the tool which is widely used in both the manufacturing as well as the service industry. While comparing to the manufacturing sector, benchmarking in the service sector is more difficult because of intangibility of particular fields of application.

**Grigoroudis and Politis (2008)** presented the analysis which was concerned about multi criteria partiality disaggregation method for benchmarking investigation and contains of the satisfaction analysis, worries about the certification of customer preferences and the assessment of the relative position.

**Baltacioglu et al., (2007**) developed a new context which is constructed on the current evidence of service industry. The proposed theoretical model is to give service supply chains and restrained processes for the management referring that have been providing useful perceptions of the study.

**Prasad and Tata (2006)** reported that retaining suitable theory building procedure help to recover accuracy and understanding about benchmarking which are important elements of benchmarking.

**Levenburg (2006)** presented benchmarking as the procedure of associating practices and measures against those supposed to be the best. While the efforts are concentrating on manufacturing and services, the process had grown up to incorporate the collection of activities including exporting, quality goals of service systems and employee practices.

**Kumar et al., (2006)** stated that benchmarking is the process of classifying, understanding and adjusting unresolved practices from governments where in the creation to assist administrations recover its performance.

**Zwikael and Globerson (2006)** discussed about industries who expressed diverse contests though handling projects and found similar procedures might have dissimilar restrictions in same types of industries.

**Nourayi M. (2006)** stated that contract of sportsman effects their presence at sporting events like major and minor baseball associations. The study examines the matter of attending modest environment aspects and characteristics of the franchise in benchmarking.

**Yasin (2002)** summarized the despite cumulative possibility of benchmarking events and the number of administrations exploiting benchmarking at large level. Furthermore, direction is given to raise advanced procedures for benchmarking in e-commerce and supply chain management.

**Rao et al., (1999)** identified the organization's communication and appointment with its environment which mentioned as the common responsibility, especially within procedures of management. Casually responsible administrations tend to address topics such as public safety and conservation plans with benchmark model.

**Keehley et al., (**1**997)** presented benchmarking as the process of determining and associating the identified behaviors in improvement processes and attain better performance for best practices is very convenient for the Public Sectors.

## 2.4 LITERATURE OF BENCHMARKING MODELS

The purpose of review on the benchmarking process models is to describe the benchmarking models which have been applied in different sectors. Though the dominated part of dissimilar benchmarking approaches is mostly equivalent, maximum authors have personalized their procedure on their individual involvement and follows (Partovi, 1994). Many researchers have planned their individual models, which were progressive and modified as per conditions of dissimilar benchmarking circumstances.

**Boxwell (1994)** has been recommended an eight phases benchmarking model, which has been further applied by Nath and Mrinalini (1995) to benchmark research and development administrations.

**Sole and Bist (1995)** adapted Spendolini's five-step model by adding one more step and highlighted that benchmarking accepts repeated development as the goal of entire organizations.

**Anderson and Moen (1999)** have identified many dissimilar prevailing models by numerous investigators and developed a novel model of benchmarking wheel.

**Bhutta and Huq (1999)** analyzed benchmarking can be accepted in many steps, few industries have applied up to 30 steps however others used only four steps. Thus, including to Xerox radical ten-step benchmarking model (Camp, 1989), Filer et al., (1988) seven-step process model, IBM five phases process model (Eyrich, 1991).

**Landeghem and Persoons (2001)** applied contributing model to benchmark the logistical procedures which is composed of four key logistics ideas and relates the usage of best practices to the resultant performance concerning the objectives.

**Deros et al. (2006)** studied selected benchmarking contexts and have classified into academic/research-based models, expert-based models and organizational based model. The definitions for classification of model are discussed below:

### 2.4.1 Academic/Research based models

These are the models, which were developed initially by academics and researchers through their own research, knowledge and experience in benchmarking. In these models, the academic/researcher tends to look at from theoretical and conceptual aspect.

### 2.4.2 Expert based models

These models were developed from personal opinion and judgment through experience in providing consultancy to organizations embarking on a benchmarking project. These models were effectively tried and validated through implementation in the client's association and therefore the approach taken by consultant/expert tend to be more practical oriented.

### 2.4.3 Organization based models

These are the models, which were developed by organizations based on their own experience and knowledge. They tend to be exceedingly different, as each organization is different in terms of its business scope, products and process etc.

There are various models like organization based models, expert based models and research based models where different theories are applied and all of models having their individual constraint as per specific area which is discussed in below Table 2.1.

Table 2.1 Benchmarking Model Literature

| Consultant/Expert Based | Academic Based | Organizational Based |
|---|---|---|
| Vishwkarma et al., (2014), John P. Moriarty, (2011), Goncharuk and Monat (2009), Camp (2008), Graham (2005), Maire et al., (2005), Petrisch (2004), Norman Jackson (2001), Jarrar and Zairi (2001), Kumar and Chandra (2001), Maas and Flake (2001), Hinton et al., (2000), Longbottom (2000), Matters and Evans (1997), Keehley and MacBride (1997), Ehinlanwo and Zairi, (1996), Macdonald and Tanner (1996), Sole and Bist (1995), Tutcher (1994), Pulat (1994), Boxwell (1994), Watson (1993), Codling (1992), Vaziri (1992), Spendolini (1992), Balm (1992) | Gupta et al., (2014), Rosierset al., (2011), Patsioura et al., (2009), Goncharuk (2008), Anand and Kodali (2008), Smart et al., (2006), Deros et al. (2006), Camp (2006), Phillips (2004), Ungan (2004), Anderson and McAdam (2004), Dattakumar and Jagadeesh (2003), Freytag and Hollensen (2001), Drew's model (2002), Longbottom (2000), Dervitsiotis (2000), Anderson and Moen (1999), Fong et al. (1998), Andersen and Pettersen (1996), Yasin and Zimmerer (1995), Lema and Price (1995) | Singh et al., (2015), Hui Chen et al., (2011), Inskip et al., (2011), Weldy and Gillis, (2010), George and Rangaraj (2008), Yadav et al., (2008), Tiku et al., (2007), Watson (2007), John Kenny (2006), Bryan Phillips (2003), Rigby (2003), Kidwell et al., (2002), Jarrar and Zairi (2001), Simpson and Kondouli (2000), Fridley et al., (1997), Xerox(1996), JShirley Daniels (1996), Sweeney (1994), Leibfried and McNair (1992), Bemowski (1991) |

## 2.5 BENCHMARKING IN INDIAN INDUSTRIES

Benchmarking is an increasing management requirement for executing expressive positive changes in an industry and has proved to be an effective tool for achieving business objectives. Benchmarking has been done in the historical view from the name of best practices and competitive analysis. It is extensively practiced across USA and has been quickly mounting in Europe, Australia and Asia. In India, although Benchmarking has been widely talked about, only few firms have successfully implemented it.

**Garg and Chauhan (2015)** discussed the effort for identifying and discovering the factors which may distress the ERP application in retail sector of India. Furthermore the authors examined the factors and their impression on the effective application of ERP by structured equation modeling (SEM) approach. A theoretical model was formed that clarifies the factors which may distress the achievement of ERP implementation.

**Bhanot and Singh (2014)** developed the customer centric competitiveness for Indian Railways which is an important government organization of India. Moreover by using suitable criteria the performance indicators have been found for container services and private sectors selection policy in Indian Railway container business.

**Choudhury K., (2014)** analyzed service quality attributes of electricity utility in India by structural equation modeling and improve overall efficiency of electricity utility system.

**Panwar et al., (2013)** discussed the existence of complete analysis for the application of benchmarking perceptions in Indian automobile industries.

**Routroy et al., (2012)** proposed a benchmarking model regarding supplier development aimed at gear manufacturing industry in Indian scenario and found numerous numbers of critical success factors during implementation.

**Vishwakarma et al., (2012)** implemented stochastic frontier analysis in municipal solid waste management for the evaluation of efficiency in the Indian utilities system.

**Gourishankar et al., (2012)** explored benchmarking model for educational development of the Indian states with the help of DEA approach for improving their education standards.

**Soni and Kodali (2010)** applied internal benchmarking in the area of supply chains to enhance the performance across various dimensions in Indian industries.

**Jyoti et al., (2010)** give modeling for the success factors in Indian research and developed an organizational model which helps to improve their standards in research activities.

**Anand and Kodali (2009)** utilized benchmarking for evaluating the lean manufacturing employment in Indian industries and established the gaps of benchmarking models applied in Indian manufacturing industries.

**Narayan et al., (2008)** explained the scales of measurement for benchmarking of service quality in Indian tourism industry, where various significant factors for tourism industries have been found.

**George and Rangaraj (2008)** developed a benchmarking model for different Indian Railway zones to improve their standards and reliability towards passengers.

**Jain et al., (2008)** discussed the circulation of benchmarking perceptions in manufacturing industry in India and suggested the appropriate benchmarking for Indian manufacturing system.

**Singh et al., (2007)** identified approach for competitiveness in Indian automobile sector where incensement of competitiveness may be achieved. Benchmarking in supply chain management in Indian industries are applied by various researchers and identified the key factors for performance improvement (Simatupang and Sridharan 2004; Jothimani and Sarmah 2014).

**Kumar and Chandra (2001)** adopted a manufacturing industry perspective, claiming that benchmarking can be considered as a form of reverse engineering, where the performance goals from other successful organizations are assumed to be achievable and applicable to others.

**Jain and Yadav (2006)** presented benchmarking as an effective tool for identifying development occasions and process to improve business effectiveness. The study discussed procedures of two industries for identifying a number of upgrading events and system for the industries.

## 2.6 APPLICATION OF MADM IN BENCHMARKING

Benchmarking evaluation has been targeted by many researchers for evaluation of the service quality.

**Singh (2016)** explained measurement of modest service quality for service of Indian airlines by analytic hierarchy process (AHP). Further author has discussed about deep literature related to service quality in benchmarking system.

**Sharma et al., (2016)** discussed about reverse logistics which has an excessive consideration towards supply chain for quality enhancement. Fuzzy values have been used for criteria and attributes to select the best product retrieval alternative. The combined weights of criteria are assessed by using diverse scopes of dual weights by application of SIR method to attain the final status of the attributes.

**Singh et al., (2015)** suggested a benchmark model for industries using Fuzzy TOPSIS approach which helps to improve internal assessment at department level.

**Mishra (2014)** applied graph theoretic approach for world class maintenance system and analysis with Structural modelling in a modest manner where he used benchmarking model for finding the solution of problem.

**Moghimi and Anvari (2014)** applied a combined fuzzy MCDM method to appraise the financial performance for Iranian cement industries and found best support system to evaluate the financial performance.

**Singh and Kumar (2013)** described hybrid procedure using AHP and TOPSIS for computing utilization of computerized manufacturing technology where hybrid methodology used for prioritization of manufacturing components.

**Kabir and Ahsan (2012)** had provided basis for benchmarking online transaction performance using FAHP and TOPSIS. These techniques present solution for identifying online dependent factors and ranking for usage in benchmarking model.

**Uysal and Tosun (2012)** established a concluded provision founded on Fuzzy TOPSIS for the selection of computerized maintenance administration system which permits the maintenance practitioners to compare their genuine competences.

**Khanna et al., (2011)** used TOPSIS approach for identification for critical success factors of Total Quality Management and ranking of critical success factors in Indian manufacturing sectors

**Sarkis (2011)** offered a grey based analysis approach for performance assessment by using simple methodology which gives easy mechanism for performance improvement.

**Tuzmen and Sipahi (2011)** discussed a multi-criteria factor evaluation model for gas station site selection from a case study.

**Kannan et al., (2010)** analysed SD criteria for an Indian automobile industry using ISM approach. ISM approach helps to generate modelling structure for identified attributes of automobile sector.

**Yu and Hu (2010)** established a unified MCDM approach for the voting of organizations and discussed fuzzy method for TOPSIS method to measure the performance of multiple manufacturing plants.

**Kodali et al., (2009)** applied analytic hierarchy constant sum method for validation of world class conservation system of an association.

**Percie (2009**) showed evaluation of third party by using two phase AHP and TOPSIS method. As more service firms struggle to improve their operative performance results, service sector benchmarking transfers to novel extents of total quality management.

**Lin et al., (2008)** used AHP and TOPSIS approaches for customer driven product design process and found suitable results for implementation in benchmarking model.

**Narayan et al., (2008)** applied a second-order factor approach for measurement and provided benchmarking for service quality in tourism industry

**Talluri and Sarkis (2001)** used routine evaluation method for bus companies by fuzzy multi criteria analysis approach and also showed the best performance analysis way to the transport industries.

**Post and Spronk (1999)** discussed a performance measurement technique in a case study that combines Data Envelopment Analysis and Goal Programming to select performance benchmarks.

## 2.7 CLASSIFICATION OF LITERATURE

The earlier outcome from various studies shows that there is lot of work is done on literature review of benchmarking so it is required to classify in different category for benchmarking. The classification proposed in this chapter includes a simultaneous parallel categorization that gives growth of literature during various time periods:

Category 1 - Benchmarking: Research Papers

Category 2 - Benchmarking: Case Studies

Category 3 - Benchmarking: General Viewpoints

Category 4 - Benchmarking: Literature Reviews

One Pareto diagram of the number of publications in different categories is given in figure 2.1.

All the publications in the categories have been coded based on the chronological appearance of the article, for the convenience of the readers. Coding has been done from 2000 onwards with interval of 4 years group for every category. Publications after 2000 have been categorized on a time interval of three years.

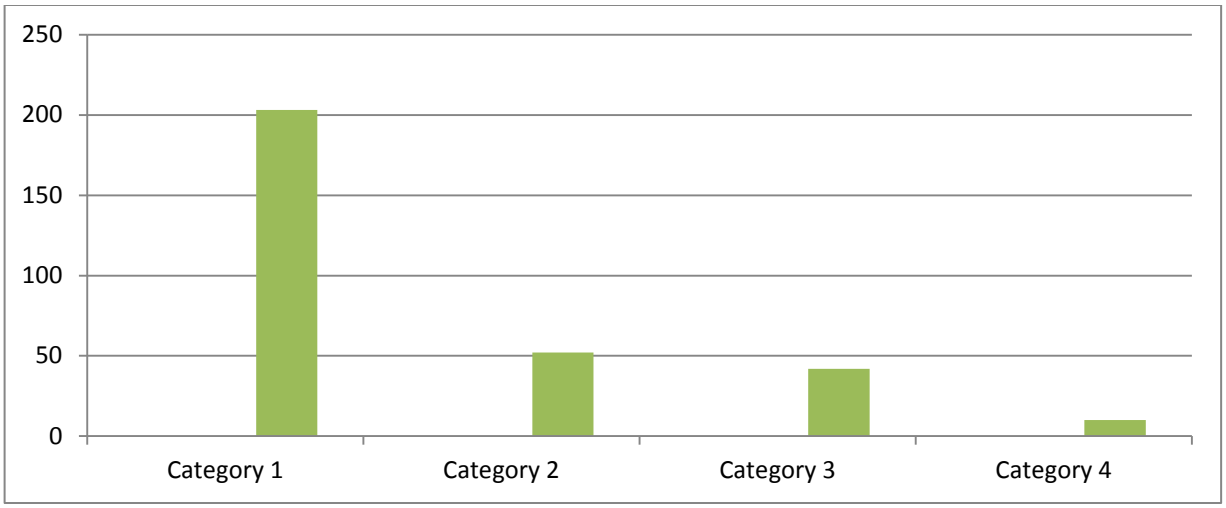


Figure 2.1 Pareto Diagram of Publications with Categories

The time periods are represented as “a”, “ b”, “c” and “d” from 2000 to 2016 into four groups i.e. shown in Table 2.2 briefly.

Table 2.2 Coding Classification of Publications

| **Time Period** | **2000-04** | **2004-08** | **2008-12** | **2012-16** |
|---|---|---|---|---|
| Category | a | b | c | d |
| 1 | 1a | 1b | 1c | 1d |
| 2 | 2a | 2b | 2c | 2d |
| 3 | 3a | 3b | 3c | 3d |
| 4 | 4a | 4b | 4c | 4d |

As an example the paper “Benchmarking environmental performance: five leading steel mills in India” by Amin and Banerjee 2010 is coded under1-C. This means that research paper was published during 2008 to 2012 and it deals with first category, “which is benchmarking research papers”. In the same way as belongs to 4-a. that means the publication is under range of year 2000-2004 and in the category of “Benchmarking: literature reviews” Correspondingly, all the publications, based on the coding pattern, are recognized in Table 2.3, by their serial number as given into the bibliographical list. Figure 2.2 is showing growth of the research papers in first category.

In this review more than 400 publications are analyzed for the purpose of providing insights the growth and development of benchmarking concept. For this, total 235 papers of benchmarking research paper, 92 of case studies, 67 Benchmarking view points and 34 literature review papers are included.

Table 2.3 Category 1, Benchmarking: Research Papers

| | |
|---|---|
| 1a | Cassell et al., Chin et al., Cock and French, Chung, Fawcett and Cooper, Fernandez et al., Fong and Cheng, Forker and Mendez, Fowler and Campbell, Fuller and Vassie, Johnston and Fitzgerald, Markou and Brignall, Kristensen and Eskildsen, Kumar and Chandra, Landeghem and Persoons, Lau and lee, Loosemore and Hisin, Chuah and McFerran, McAdam, Reenen, Robson and Prabhu, Sarkis, Seen and Cheng, Talluri and Sarkis, Thermistocleous and Ulusoy, Lambert and Pohlen, Frohlich, Berry and Dattakumar, Zeithaml, Parasuraman and Berry, M. sin, Battaglia, J. Jr and Musar, R. Fuller, Johnson, B. and Chamers, Sarkis, Simpson, M. and Kondouli, D, Zairi, M. and Whymark, Al-Mashari and Zairi, Alstete, Andriopoulos and Gotsi, Ball and Bowerman and Hawksworth, Brah and Ong and Rao, Class and Xu, Comm and Mathaisel, Dacko, Davies and Kochhar, Favret, Fuller and Tzokas, Henderson and Evans, Hinton and Holloway, Higgins and Lenard, Horton, Ho and Wong, Jarrar and Zairi, Jackson and Parks, Harrison and Stebbings, Longbottom, Kathawala and Abdou, Besterfield and Sacre, Tsourveloudis and Valavanis, Cunningham et al., Ridgway and Atkinson, Sultan and Simpson, Yasin, Tolosi |
| 1b. | Anderson and McAdam, Balzan and acchino, Bartley and Gomibuchi and Mann, Beringer and Kovacic, Bilalis and Alvizos and Tsironis and Wassenhove, Bowen and Moesen, Braadbaart, Butler and Bassiouni, El-Adly and Widjaja, Camgoz and Akdog, Carcangiu and Barba, Fanni and Mognaschi, Chen and Sok, Dawkins and Feeny, Dharmapala and Saber, Enoma and Allen, Enshassi and Mohamed, Mayer and Abed, Hurreeram, Jaques and Provey, Hunter and Lumbers, Raats and Stoeberi, Kovacic and Chan, Manning and Baines, McLeod and Childs, Missigham and Moreno, Mostafa, Officer and Panagiotou, Papaioannou et al., Rigby and Bilodeau, Robson and Mitchell, Salem, Saunders and Mann, Stewart and Waroonkun, Soltani and Lai, Tiku and Pecht |

| | |
|---|---|
| 1c. | Southard and Parente, Sweet and Rogers, Heritage and Wong, Cuthbertson and Piotrowicz, Das and Paul, Debnath and Shankar, Beringer and Wright and Malone, and Gourdin and Hartley, Huq and Abbo, Jain and Yadav, Jones and Kaluarachchi, Korosec Huiskonen, Peng Wong and Yew Bhat, Bohlke and Robinson, Burke and Ryan, Chau, Hollman, Fawcett |
| 1d. | Wallin and Allred, Fawcett and Allred, Magnan and Ogden, Gil and Berebguer, Gurumurthy and Kodali, Gonzalez and Quesada, Kwon and Stoeberi, Lyne and Hill, Madritsch, Matook and Lasch, Moffett and Gillespie, Newell, Neubauer, Price and Clark, Pitt and Tucker, Punniyamoorthy and Murali, Rawabdeh and Rutowski, Sawyer and Giannakis, Arlbjørn, Mei-Chi, Hao-Chen and Wei-Kang, Mahour Mellat, Stephanie G. Adams, Kull and Narasimhan, Lothar W., Perdomo, Gupta B., Anuar and Rosnah, Narasimhan, Afdiman and Yusuf |

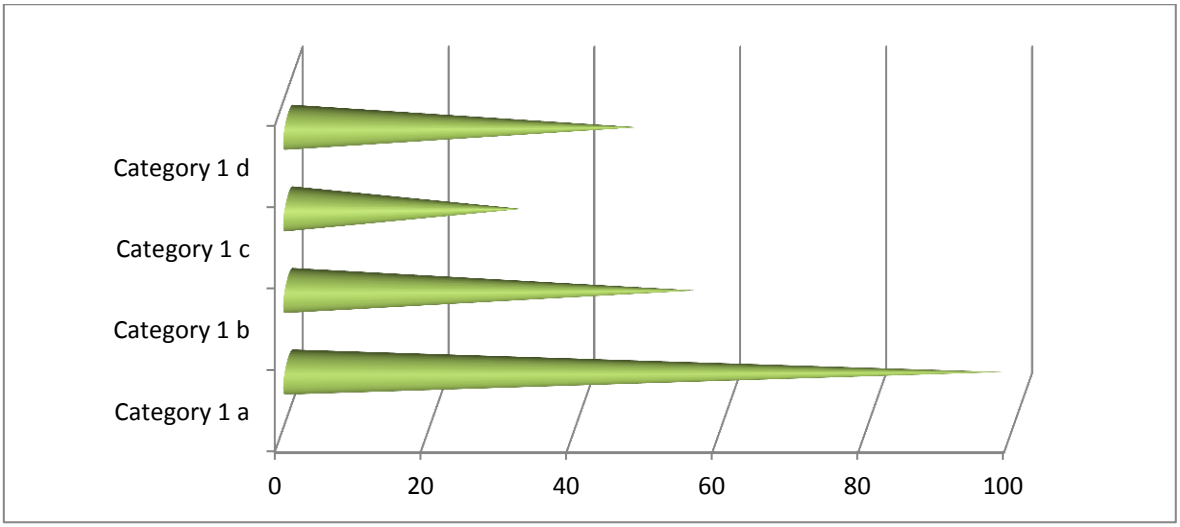


Figure 2.2 Graph showing Growth of Research Papers

The authors of case studies in benchmarking are shown in Table 2.4 with category wise and figure 2.3 shows growth of benchmarking case studies during different time period.

Table 2.4 Category 2, Benchmarking: Case Studies

| | |
|---|---|
| 2a. | Browell and Tse, Ling and Fung, Diebacker, Mann and Voss, Moeller and Breinlinger and Elser, Moreland and Jawaid, Schmid and Conen, Sommerville and Robertson, Zairi and Whymark, Zairi and Whymark. Holt and Graves, Ralston and Wright, Santos and Powell, Hargreaves and Christou, Houghton and Lee |
| 2b. | Basnet and Corner, Wisner and Tan, Boks and Stevels, McNamee and Shiels, Mirza and Green, Schvaneveldt. Axelsson and Steen, Bauer and Tanner, Coleman and Ingram, Hess and Francis, Maiga and Jakobs, Marr, Tavana, Austin, Friesner and Neufelder and Raisor and Khayum, Matykiewicz and Ashton |
| 2c. | Gonzalez and Quesada and Urrutia and Gavidia, Jokioinen and Suomala, Manzini and Lazzarotti. Chim, Choy and Chow and Lee and Chan, Jafari and Akhavan and Fesharaki and Fathian. |
| 2d. | Ahren and Parida, Balague and saarti, Carpinetti and Oiko Funk, George and Rangaraj, Marwa and Zairi, McAdam and Hazlett, Miguel, Mistry, Takala and Liu, Shahalizadeh and Amirjamshidi, Zambri and Visser |

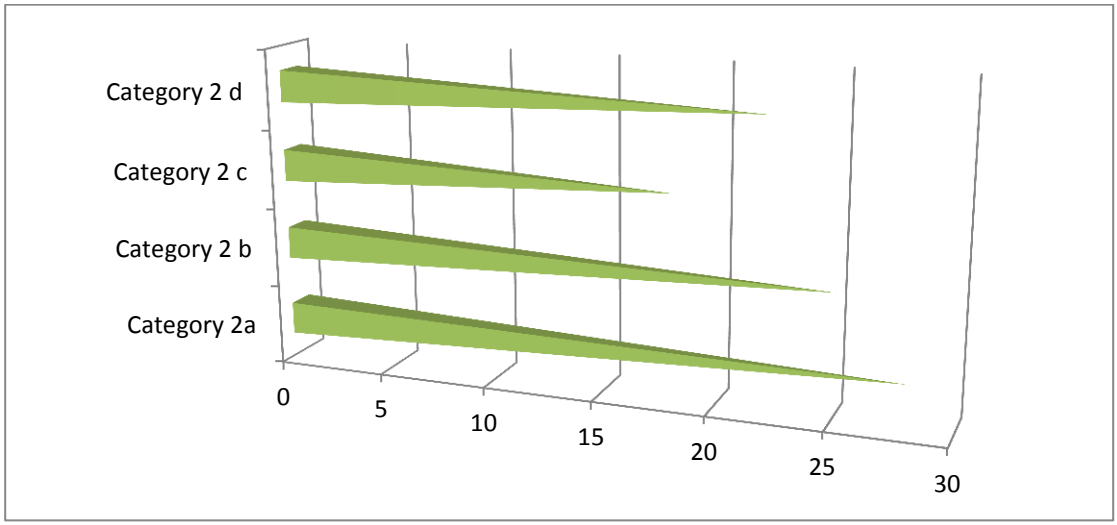


Figure 2.3 Graph showing Growth of Case Studies

The authors of publications in benchmarking general viewpoints are shown in Table 2.5 and figure 2.4 shows growth of general viewpoints in benchmarking.

Table 2.5 Category 3, Benchmarking: General Viewpoints

| | |
|---|---|
| 3a. | Palaneeswaran and Kumaraswamy, Prabhu and Appleby, Yarrow and Mitchell. Adebanjo, Barkley, Davies, Hughes and Jackson, Miciak and Desmarais |
| 3b. | Ahokas and Kaivo-Oja, Alexander, Alshawi and Irani Baldwin, Boulter, Comunale and Sexton, Flitman, Franceschini and Galetto, Pignatelli and Varetto, Magd and Curry, Matthews, Matthews and Lave |
| 3c. | Lazo and Sounderpandian, Mathaisel and Cathcart, Rohlfer, Simatupang and Sridharan, Ungan, Yasin and Wafa |
| 3d. | Graham, Houston, Price, Wait and Nolte, Wynn-Williams , Huggins and Izushi, Raymond, Kenny and Meaton, Lusty |

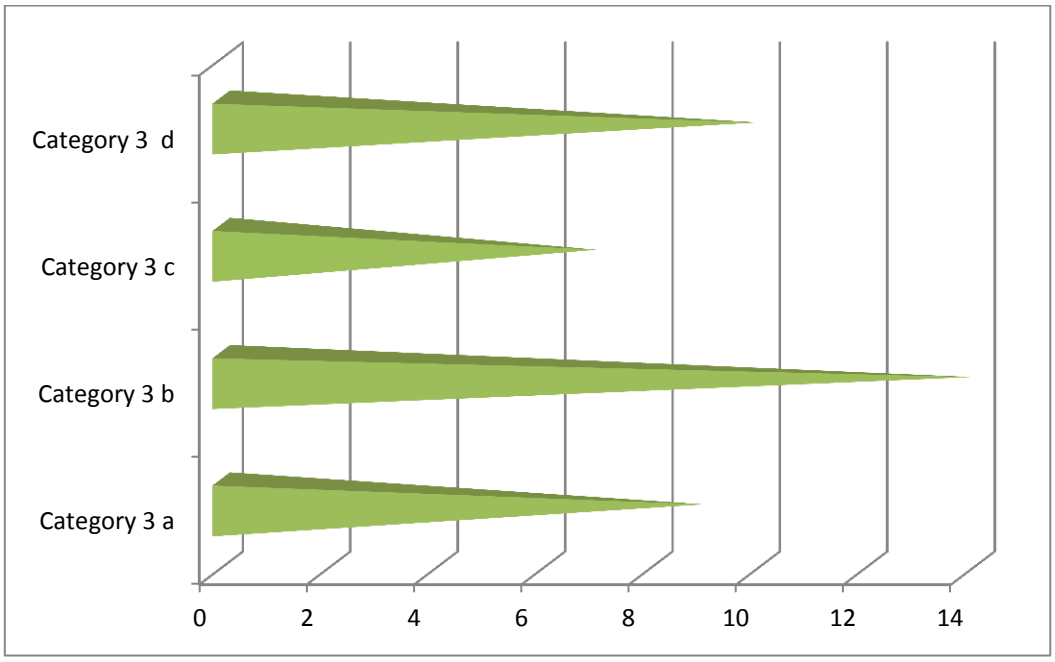


Figure 2.4 Graph showing Growth of General Viewpoints

The authors of benchmarking literature reviews are shown in Table 2.6 and figure 2.5 shows growth of literature reviews in benchmarking with time interval.

Table 2.6 Category 4, Benchmarking: Literature Reviews

| | |
|---|---|
| 4a. | Mashari and Zairi. Cagliano and Blackmon, Shi and Benet, Yasin and Khurrum, Faizul Huq, Dattakumar and Jagadeesh |
| 4b. | Tamimi and Rajan, Anderson and McAdam, Dattakumar and Jagadeesh |
| 4c. | Paul Hong, Hong, James Roh, Kihyun Park |
| 4d. | Baba and Deros, Masoomeh and Zeinalnezhad, Nizam and Rahman, Towhid and Pourrostam, John Williams, Cheryl Brown, Anita Springer,Singh et al. |

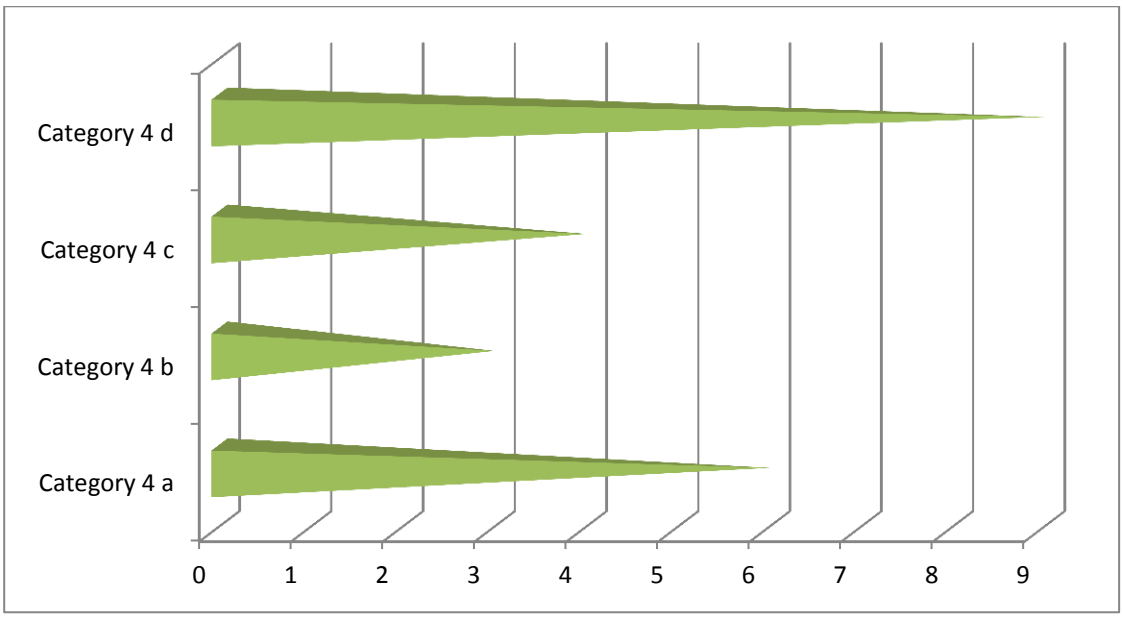


Figure 2.5 Graph showing Growth of Review Papers

For showing the chronological appearance of all publications, a graph is presented in figure 2.6. It can be seen that during 2000 until 2016, the most papers has published in the years of 2000 and 2004 (132 publications), whereas there is just minimum papers in recent years regarding literature review. There has been a decline in the chronological listing of publications number in the line graph of figure 2.6. It can be seen that under the category of "Benchmarking: general reviews", the number of publications increased from minimum in 2004 to 2008 and in the next period. However, before 2004 onwards it appears to be a drop in the number of publications.

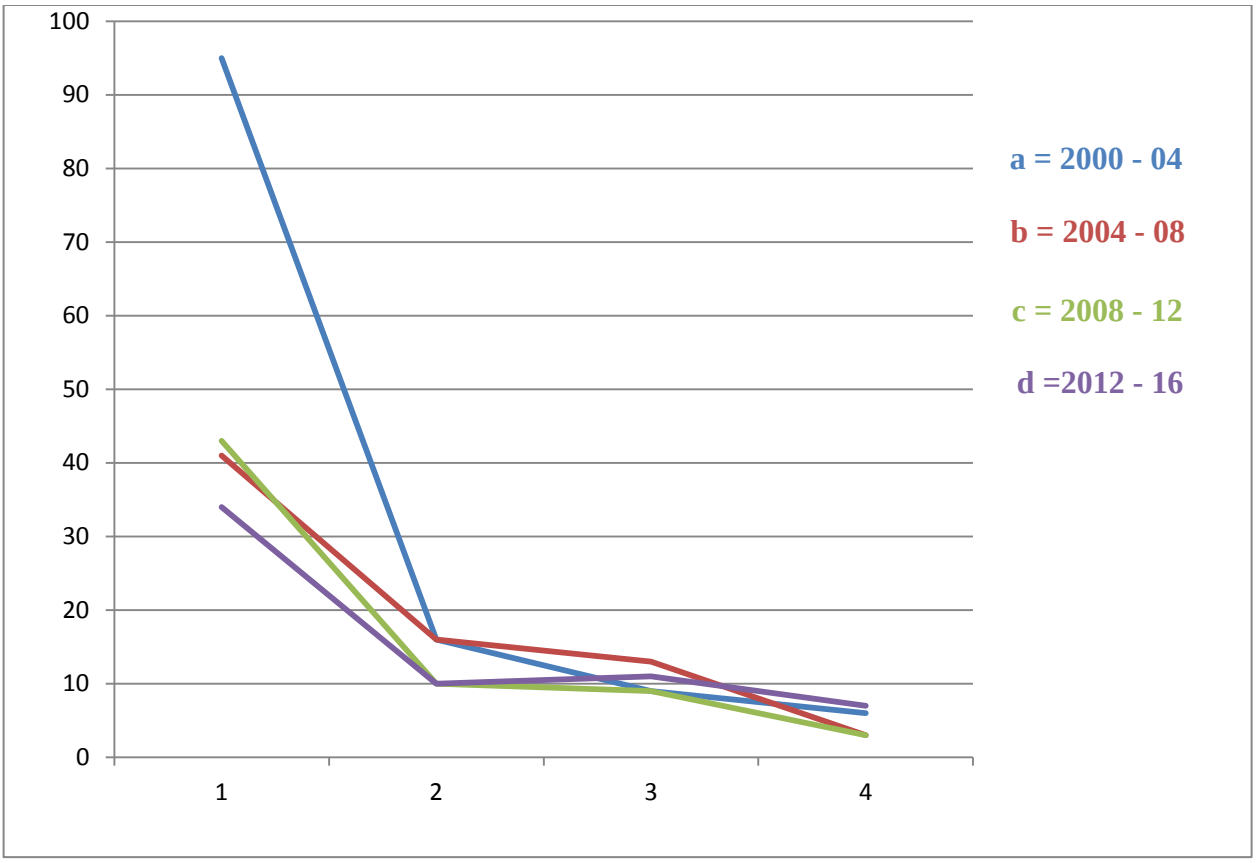


Figure 2.6 Chronological Order of Publications

## 2.8 QUALITY ENABLED FACTORS FOR BENCHMARKING

Various quality enabled factors are identified on the basis of literature, where few of them are common for individual benchmarking process those are shown in Table 2.7 and remaining are discussed later.

Table 2.7 Quality Enabled Factors

| Types of Benchmarking | Factors | Definitions | Literature |
|---|---|---|---|
| **Performance Benchmarking** | Functionality | The quality of being functional that effects performance | Cifci G.(2012), Germani M. (2012), Barbuceanu (2006) |

| | | | |
|---|---|---|---|
| | Technical | Functions, skills, profession or field refers to the skills or terminologies that are best understood by people who specialize in that field or area | Hadwich et al.,(2010), Anand. and Kodali (2009),Grigoroudis et al., (2008), Chang (2007), Yang et al.,(2005) |
| | Time behavior | The stable consistently obtain at the target level with no variations | Dominic et al.,(2011), Behkamal et al.,(2009), Olsina et al., (2009) |
| | Replace ability | The quality of being capable of exchange | Saha and Grover (2011), Behkamal et al.,(2009), Calero et al.,(2005) |
| | Cooperation | The process of working together, willingness to cooperate or get involved to others | Singh et al., (2015), Bauer (2010), Cervera A.(2004), Segers and Dochy (1996) |
| **Internal Benchmarking** | Teamwork | Cooperative effort by the members of a group or team to achieve a common goal | Germani M. (2012), Anand and Kodali (2008), Zairi and Whymark (2000) |
| | Responsiveness | The quality of being responsive, reacting quickly as a quality of group | Lau et al., (2005), Chan and Ralph (2005) |
| | Work attitudes | The attitudes towards working culture or intension of doing work | Uslu P.(2005), Shankar and Hasan (2007), Singh and Ahuja (2014) |
| | Friendliness | The attitudes towards friendly nature or behavior of helping with others | Padma et al., (2009), Yasin and Zimmerer (1995) |

| | | | |
|---|---|---|---|
| | Compensation | The defense mechanism that conceals your undesirable shortcomings by exaggerating desirable behaviors | Patsioura et al., (2009), Chia and Goh (2009), Parasuraman et al., (2005), |
| | Reliability | The ability to deliver the promised service dependably, accurately about delivery, pricing and complaint handling | Leea and Kimb (2012), Manuel and Cervera (2004) |
| **Generic Benchmarking** | Standardization | A process in which value of potential standard is fixed by measurement made with respect to a standard | Li et al., (2002), Grigoroudis et al., (2008), Singh et al., (2007), Ahn et al., (2007) |
| | Tangibles | Capable of being perceived by the senses of the mind; especially capable of being handled or touched or felt | Hadwich et al., (2010), Ladhari (2010), Grigoroudis et al., (2008), Ma et al.,(2005) |
| | Information | Data that is accurate, timely, specific and organized for a purpose presented with in a context | Yang et al., (2005), Aladwani and Palvia (2002), Li et al. (2002), Yoo and Donthu (2001) |
| | Consistency | Being in conformity with set of rules and guidelines | Hadwich et al.,(2010), Grigoroudis et al.,(2008), Jharkharia and Shankar (2007), Ahn et al., (2007) |
| | Effectiveness | The degree which objectives are achieved and extent to which targeted problems are solved | Singh et al., (2015), Panwar and Yadav (2013), Patsioura et al., (2009), Cristobal et al.,(2007), |

| | | | |
|---|---|---|---|
| | | | Waarden et al.,(2004), Li et al., (2002) |
| | Credibility | The quality of being believable or trustworthy | Hooper and Greenall (2005), Anderson and McAdam (2004) |
| **Functional Benchmarking** | Performance | The accomplishment of a given task measured against preset known standards of accuracy, completeness, cost, and speed | Grigoroudis et al., (2008), Ahn et al., (2007), Pegels et al., (2005), Li et al., (2002) |
| | Interactivity | The capability of acting on or influencing each other | Cristobal et al.,(2007), Kumar and Grewal (2007), Waarden et al., (2004) |
| | Order management | The process of taking organizing and satisfying purchase requests for products or services | Singh and Ahuja (2014), Patsioura et al., (2009), Grigoroudis et al.,(2008), Yoo and Donthu (2001) |
| | Internal quality | A procedure or system designed to promote efficiency or assure the implementation of a policy assets to avoid errors | Ladhari (2010), Hadwich et al., (2010), Sankaran et al., (2008), Chang (2007), Ma et al., (2005), Yoo and Donthu (2001) |
| **Strategic Benchmarking** | Marketing | The commercial processes involved in promoting and selling and distributing a product or service | Lim and Bae (2011), M.R.(2003), Mcmullem (1998) |
| | Reward | Scheme to support and reinforce desirable behavior that increases with | Grigoroudis et al., (2008), Ashok et al., (2006), Jun Ma |

| | | | |
|---|---|---|---|
| | | the productivity of the worker | (2005), Zairi and John (2000) |
| | Quality planning | Planning by which effective output may be achieved | Panwar and Yadav (2013), Albert and Chung (2006), Shong L.(2003) |
| | Recognition | Identification of performing service or work | Henderson (2007), Denrell (2003), Denrell (2005) |
| | Zero defects mentality | With mentality that no defects or exact output regarding specification to requirements | Hilton and Sohal (2012), Singh and Smith (2006) |
| **External Benchmarking** | Professionalism | The level of excellence or competence that is expected of a professional group or individual | Sharma and Dyer (2009), Gulledge and Chavusholu (2008) |
| | Service level | Level at which demand for an item/ group can met from on-hand stock. Expressed as a percentage of orders satisfied | Singh et al., (2015), Awasthi et al.,(2011), Huang, (2010), Padma et al., (2010) |
| | Usability | Ease, speed and intuitiveness in operating or using a device and service | Grigoroudis et al.,(2008), Yang, Zhou and Zhou (2005), Yang et al.,(2001), Yoo and Donthu (2001) |
| | Reputation | Overall estimation of the character or quality of a group/individual held by those who know about system | Omega N.A. (2013), Katarzyna (2012),Galina S. (2011), Calero et al., (2005) |
| **Competitive** | Customer | The service offered to customer from manufacturer | Behkamal et al.,(2009), Olsina et |

| | | | |
|---|---|---|---|
| **Benchmarking** | Service | or services provider | al.,(2009), Kokaua (2005), Bilsel (2004) |
| | Credibility | The extent to which the service is believed and trusted | Alfred Radauer (2010), Abramowicz et al.,(2008), M I. Eraqi (2006) |
| | Accuracy of service | The completeness of service with in time period and specification that achieve output | Vishal Sharma (2003), Montanari (2002), Shankar R (2002) |
| | Policies | The authentication of terms and conditions for documents in any system | Amin and Banerjee (2010), Sahin (2007), Bilsel et al., (2006), Banwet (2003) |

Moreover from above table large numbers of others factors are also found which are common to all types of benchmarking applications in industries. These are as follows:

- **Market orientation:** It will be defined as the organization wide collection and distribution of market information. The role of organization's responsiveness of collected information regarding the best practices has been recognized.
- **Process Quality:** Process quality is an important factor for all phases from idea generation and analysis to concept development, presentation and testing. It is regarding maintaining quality of work during whole process.
- **Employee Involvement:** Employee involvement may be defined as involvement of employees at various stages. General interior advancement is lead to raise provision and interests for the process completely.
- **Knowledge Management:** It is about sharing of all collective knowledge into all levels of process. The knowledge should be properly endorsed in management levels.

- **Customer Involvement:** Customer involvement is about sharing customer view and demand in the regular process. By considering it benchmarking of organization gives appropriate results for completion of best practice.
- **Cross Functional Involvement:** It is about the involvement of different strategies during various processes in different types of industry also. It appears to be important in companies which rely deeply on implicit knowledge, where the categorization of evidence is difficult
- **Timeliness:** Timeliness is the degree to which an industrial process provides current and latest indication of work.
- **Trustworthy:** It means that the degree to which information in a benchmarking process is precise, reliable, and confirmed.
- **Understandability:** The characteristic of benchmarking that stand on the consumers' exertion for recognizing the rational perception and its applicability.
- **Resource Behavior:** The attribute of benchmarking that accept on the quantity of capitals used and the extent of such use in execution of its function.
- **Recoverability:** The competence to regenerate its level of performance and recover the data straightly affected in case of disappointment and on the timely effort needed for it.
- **Helpfulness:** The attribute of benchmarking that stands on the accessibility of directions for the handler on different phases and how to interconnect with it.
- **Completeness:** It means the gradation on which benchmarking offers a broad range of information which is applicable to operators' requirements.
- **Communication:** It involves the degree to which a benchmark instructs and notifies the consumers in a language that they can easily understand.
- **Adaptability:** The attribute of benchmarking that tolerate on the occasion for its adaptation to diverse quantified environments without applying other movements in case of benchmarking phases also.
- **Manageability:** The attribute of benchmarking that stand on the exertion desirable to manage and standardize its running status.

- **Level of Technology Investment:** It is the attribute which shows that how much advanced technology is needed towards achievement for objectives.
- **Post Implement Evaluation:** It means the factor which demands for making future strategies including customer's feedback and quality of product.

## 2.9 CONCLUDING REMARKS

There is lot of literature on benchmarking in the last few years, as revealed in this literature review. Considering the publications it can be said that the benchmarking technique has seen a steady growth and appears to be heading towards maturity level. A scrutiny of the publications show that benchmarking along with many interesting and diversified applications, have been covered in sufficient detail. These publications can serve a great deal towards quality improvement. Thus a good number of sources in the form of more than 400 articles, to study, discuss and debate over many aspects of benchmarking.

1. In the first Category, during period of "a" (2000-2004) there is huge number of publications in research papers which states that lot of work is done in the particular time and also required in the remaining review periods.

2. In the second category (case study), most of the work is done during first and second period that needs more work in relevant field requires now a time. There will be requirement for the study of various case studies of several field that gives better results for improvement.

3. In the third category, mainly work is done during "b" 2004 to 2008 and remaining period needs more effort in the particular field of general view points.

4. In the fourth category, very less work is done in the review field and during current years more work is needed in literature field .The more work in benchmarking gives better results in an Industry and organization.

After Reviewing all the literature related to benchmarking observed that it can be applied in all the field such as Health sectors, IT, Networking, Hotel Industries, Transports, Tourism, Banking, Food Sevices, Education, Manufacturing Industries and Public Sectors etc. These Industries applied different tools such as Servqual, Servperf, Qualitometro, Six Sigma, TQM, Analytical Processes and different Multiple Decision techniques for improving the efficiency

and growth of industries. The findings of literature review may assist leaders to anticipate potential benchmarking barriers during the past years and leading firms have realized about benchmarking to improve their efficiencies.

## 2.10 GAPS IN LITERATURE

In the literature, the performance gap was occurred during application of benchmarking in service and manufacturing sector. Because quantitative data are often gathered about a specific process and are compared from the benchmarking partner. According to Meade and Sarkies (1999), if an organization want to benchmark in manufacturing sector, then it may be difficult to choose the partner's organization. Thus, it may be impossible to know which potential partner is the best in any specific area until data has been gathered. As per discussion in earlier section, benchmarking model is generally classified into three categories which were explained by numerous authors. The following gaps are identified in below Table 2.8

Table 2.8 Gaps in Benchmarking Model

| **Categorization** | **Expert Based** | **Academic Based** | **Organization Based** |
|---|---|---|---|
| No. of Steps (Max.) | 10 | 8 | 10 |
| No. of Phases (Max.) | 4 | 5 | 4 |
| Benchmarking Partners | Mostly 03 | More than 03 | Mostly 02 |
| Subjects Involved | More than 03 | Less than 02 | More than 03 |
| Types of Model | Practical Oriented | Theoretical Oriented | Practical Oriented |
| Percentage of Model | 40% | 32% | 28% |
| Mostly Opted Process | Generic Type | Functional Type | Process Type |

With the help of gaps in benchmarking model, it will be easier for researchers to select the appropriate benchmarking and advanced benchmarking model for their research.

As per Indian context, mostly studies are related from manufacturing industries, where benchmarking was utilized in different scenario. Benchmarking was applied recently by various authors (Routroy et al., 2012; Soni and Kodali 2010; Anand and Kodali 2009; Kumar and Chandra 2001; Singh R.K 2007; Jain et al., 2008) in Indian manufacturing industries. Not so many studies were found on benchmarking of Indian service industries only few studies applied benchmarking for process improvement (Vishwakarma et al., 2012; Jyoti et al., 2010; Gourishankar et al., 2012; George and Rangaraj, 2008; Narayan et al., 2008 and Singh et al., 2015). Thus, there is massive gap among benchmarking in manufacturing and service in Indian industries. The most of industries in Indian scenario, are adopting a relatively traditional approach with a focus on gladly quantifiable activities and similar comparator organizations. As discussed above, the benchmarking process is applied in different areas throughout the world but in India, benchmarking is normally used in manufacturing industries (Jain et al., 2008). While in service industries benchmarking is rarely used for Indian industries, hence there is huge gap of benchmarking implementation in Indian scenario. Benchmarking found growth over a period of time and various developments were observed. A review of literature brings out the following gaps in the context of benchmarking in service industries:

- Insufficient studies are available for benchmarking applications in Indian scenario.
- Insufficient benchmarking system models are available definitely for the service industries.
- Limited literature is available which explores the different stages of the benchmarking system for service in detail.
- Very few literatures are available which explores the barriers in different phases of the benchmarking system for service in detail.
- Few studies are available for comparison of the benchmarking models applied in service industries.

- In literature, identification of parameters such as key activities, department involved in performing these activities and utilizations of these activities in different phases of benchmarking system has not been carried out.
- During the review not so many methodologies found, which can be effectively utilized for improvement of benchmarking process in different phases of service industries especially in Indian context.

# CHAPTER III

# BENCHMARKING: THE BEST PRACTICES APPLICATION

***Chapter Objective***

*This chapter gives the details about benchmarking in manufacturing and service industries which explains the refined concept of benchmarking. From the conclusion of previous chapter benchmarking phases applied in different industries are considered for identification of quality enabled factors. The detailed contribution of manufacturing and service industries can be measured by identification of gaps in manufacturing and service industries*.

---

## 3.1 APPLICATIONS OF BENCHMARKING IN MANUFACTURING

Manufacturing is the group of activities and processes used in making tangible products, also called as production. Resources such as labour, money, materials, and energy are converted into outputs. Manufacturing can be defined as the use of tools and labour to make things for utilization in the market. The term may be referred to a range of human activity, from handiwork to high technology but normally applied to industrial production in which raw materials are transformed into finished goods on a large scale.

In manufacturing input materials are used to produce products during the process of transformation. As for the process of manufacturing itself, there are few services involved in producing the goods. For example, the car manufacturing, for such particular field, the manufacturer only produces cars with slight services included. In other words, it is the industry which produces pure product. The whole process of manufacturing cars is concerned about the transformation of the materials and a slight service. Manufacturers produce cars and then sell the cars to the customers. There is low customer contact during the whole process of manufacturing and selling of cars. The output, mainly the car can be evaluated easily by its appearance and inside parts because it is tangible. Consequently, the quality of the car is evident and can be judged relative objectively. As far as the service in the car industry is concerned, it is obvious that such manufacturing industry hold a little bit services, such as bring the cars which can be transported to the market and sell them. Various critical actions and decisions are considered to improve manufacturing performances after

identification of key factors. These are research and development, commitment, outsourcing degree, and time compression during production. These factors not only lead to superior manufacturing and also form the main of a manufacturing strategy

Numbers of researchers have applied benchmarking in manufacturing sector during the last few years. Some of them are as follows:

**Anuar and Mohd (2011)** discussed the present level of best manufacturing performance in Malaysian ISO 9000 specialized small and medium enterprises. The industries should be able to measure their achievements and recognize the relevant areas that will definitely move their performance.

**Bindu Gupta (2011)** examined the strategy and culture of 32 Indian organizations belong to 7 industries segments and find the linkages between the organization's strategy and culture of the organization to find the suitable strategy for different segments of industries.

**Amin and Banerjee (2010)** deliberated the benchmarking environmental presentation of leading steel mills in India, where universal presentations of the ISO14001 certification process with smallest environmental performance standard were taken.

**Jain et al., (2008)** inspected the circulation of benchmarking ideas amongst Indian manufacturing corporations after liberalization of Indian economy which benefits the managers to appreciate the inhibitors of effective benchmarking.

**Yusuff (2004)** applied benchmarking model in manufacturing sector for the electric and electronic firms in Malaysia where imperative factors were found for effective application and incessant of quality development.

**Esmail and Saggu (1996)** expressed about international competition and progressive manufacturing technology which have intensely improved the essential for initiatives to competitively value products such as defect rates, response time and delivery commitments.

**Hill (1994)** stated that literature of manufacturing strategy had observed product quality as one of the major competitive priorities for attaining a sustainable competitive advantage.

More literature is shown in below Table 3.1, where benchmarking in manufacturing is applied by different authors.

Table 3.1 Benchmarking in Manufacturing Sector

| |
|---|
| Sharma and Kumar (2015), Moor and Verheyden (2015), Routroy and Pradhan (2014), Gebaue et al., (2011), Golam and Hasinb (2012), Kuula and Putkiranta (2012), Hong et al., (2012), Nassar (2012), Giacone and Manco (2012), Merli and Renzi (2011), Bindu Gupta (2011), Cappelli et al., (2011), Anuar and Mohd. (2011), Lim et al., (2011), Amin and Banerjee (2010), Johnson et al., (2010), Sousa et al., (2006), Peças and Henriques, (2006), McFadden and Gowen (2007), Baird et al.,(2007), Valentine and Gray (2001). Ribeiro and Cabral (2006), Jain et al., (2008), Basler et al., (2007), Harrison and Reeve (2007), Conti T. (2007), Elaine and Rodrigues (2006), Camp R.C. (2006), Ribeiro and Cabral (2006), Pecas and Henriques (2006), Chen (2005), Kumar and Madu (2005), Lau et al., (2005), Laburu et al., (2005), Leachman et al., (2005), Yusuff (2004), Phillips (2003), Carpinetti and Melo (2002), Ahmed A.M. (2002), Andersen et al., (2001), Zaire and Whymark (2000), Taylor G.D (2000), Choudhury and Sampler (1997) |

As shown above numerous authors have applied benchmarking techniques in manufacturing sector to improve overall efficiency of manufacturing industries. This shows that benchmarking is an important tool for manufacturing sector to improve its effectiveness.

## 3.2 APPLICATION OF BENCHMARKING IN SERVICE

Service industry is the group of companies that primarily earn revenue through providing intangible products and services. Service industry is involved in retail, transport, food services, as well as other service dominated businesses also called tertiary sector of industry. In recent years the service sector has come to be viewed as a dynamic component of the economy, characterized by the large consumption of new technologies and human capital. For example, the observable growth in Internet and Web-based services and high-technology environmental services indicates that knowledge-intensive services are taking on a more active economic role. Traditionally, services were described narrowly as discrete products. However, as the nature of services has become more complex largely because of technological advancement. The intangible nature of service products makes distinguishing between product and process difficult. For this reason, industries in the service sector have

traditionally been viewed as static, technology consuming, non- innovative companies that provide nontechnical products. Generally, service may be classified into four types which are as follows:

### 3.2.1 Distributive Service

This type of service is dependent on distribution of service items where customers can take direct benefits such as transportation and storage, communication, wholesale trade retail trade (except eating and drinking places).

### 3.2.2 Producer Service

This type of service is directly beneficial associated with the consumer and share their revenue to the customers also like as banking, credit and other financial services, insurance, real estate, engineering, architectural services, accounting, miscellaneous business services and legal services.

### 3.2.3 Social Service

This type of service is made on behalf of society and relevant to social needs. In social service generally marginal profit can be obtained like as postal service, medical, health services, hospitals, education, welfare and religious services, non-profit organizations and miscellaneous professionals.

### 3.2.4 Personal Service

This type of service is purely personal type service which is dependent on customer's choice. It's completely based on commercial activities of the service providers like as domestic.
Various researchers have performed their work on benchmarking in service industries few of them are as follows:

**Trento et al., (2016)** discussed the inspected opportunities to transform benchmarking theories near strategic level. The service prices are discussed on the basis of additional value for the customer. Furthermore they related customer satisfaction with revenue reception and found that combination may help to clarify the presence of dissimilar prices for comparable products and services.

**Klingner et al., (2015)** quantitatively evaluated the current status of productivity management of industrial and non-industrial service industries in Germany. Based on that knowledge, best practices and needs regarding tools and methods can be identified.

**Wong and Cheung (2014)** developed benchmarking model in banking sector and concluded about satisfied and dedicated employees covers more service in banking sector as per evaluation to other employees.

**Panwar et al., (2013)** discussed the implementation of benchmarking perceptions in automobile industries and authenticate their model with obtained quantitative consequences which helps for emerging competiveness between them.

**Boonitt and Pongpanarat (2011)** applied Q-sort method to measure development procedure for the consistency and prudence difficulties produced by prejudice of management in service. Though, several dimensions are included in performance management which is having imperfect statistics of succeeding scales.

**Boonitt and Pongpanarat (2011)** applied MADM technique in scale growth procedure to address the reliability and difficulties to measure supply chain management processes by benchmark model.

**Giannakis (2011)** presented the assessment of capacity administration as the key to understand the service, through seeing the process of service as the capacity transfer for providing the value of customer.

**Hallgren and Olhager (2009)** concluded that benchmark quality functional deployment can improve industrial knowledge, efficiency and excellence to reduce costs in product development.

**Baltacioglu et al., (2007)** developed a new framework for the service, which is built on the usual information resulting from the earlier models in the healthcare industry.

**Narayan et al., (2008)** discussed the scales of dimension in benchmarking of service quality in travel industry and originate that customer satisfaction had an important impact on the benchmarking in service industries.

Numbers of authors have applied benchmarking in service industries as shown in Table 3.2 which shows lot of research required in service sectors towards benchmarking.

Table 3.2 Benchmarking in Service Sector

| Service Industry | Authors |
|---|---|
| Hotel / Tourism | Yasin and Small (2011), Grigoroudis and Moustakis (2009), Sharma and Dyer (2009), Holmes K. (2007), Alstete J.W. (2008), Talwar (2008), Alavi and Koubida (2007), Kyriakidou and Gore (2005), Croy and Hogh (2002), Sharma and Yasin (2000) |
| Insurance | Srivastava and Ray (2013), Giorgio and Lovaglio, (2010), Rajendran and Sai (2009), Min and Srinivasan, (2009), Northcott and Llewellyn (2005), Booth et al., (2005), Welsh and Kokaua (2005), Jacobsen et al., (2003), Pfrijnder and Sharma (2003) |
| Banking | Kabir and Ahsan (2012), Ho and Wu (2006), Simpson and Evans (2005), Yavas and Yasin, (2001), Bahia and Nantel (2000) |
| Education | Gupta et al., (2013), Chen et al., (2007), Gapp and Fisher (2006), Sahney et al., (2004), Carmona and Gronland (2003), Amin and Amin (2003) |
| Air Lines | Souza et al., (2011), Hooper and Greenall (2005), Dobbie and Hooper (2001), Straker et al., (2009), Sarkis (2000), Pitt et al., (2001), Wal and Teck (2000) |
| Automobile | Klingner (2015), Laisi et al., (2012), Phillip Marksberry (2012), Fujimoto and Park (2012), Rothenberg et al., (2012), Gebauer et al., (2011), Trappey et al., (2010), Kannan V. (2010), Alan McKinnon, (2009), Zhi et al., (2008), Zhu et al., (2007), Ehinlanwo and Zairi (1996), Bouman and Van der Wiele (1992), Müller and Reuss (1994) |

### 3.2.5 Models of Service Quality

- **SERVQUAL**

One of the most popular method was developed in 1988 to measure service quality across various surroundings and involves calculation of the differences between consumer. The method is based on the calculation of the differences between expectations and perceptions

on a number of pre-specified criteria. Respondents are asked to identify the level of service expected from a service. The respondents then are asked to use the service and answer the same questions again to provide their perceived level of service. Service level evaluation is obtained by subtracting the expectation rating

- **SERVPERF**

The model investigates the relationships between service quality, consumer satisfaction and purchase intentions.

It is performance-based model theorizes that it is consumer satisfaction not service quality that influence purchase intentions. Most approaches to service performance measurement lack demonstrable control systems that regulate quality through measurement of standard performance.

- **Service Quality Gaps Model**

**Gap1: Customer expectation-management gap**

This gap addresses the difference between consumer's expectations and management's perceptions of service quality.

**Gap2: Management perception-service quality specifications gap**

This gap addresses the difference between management's perceptions of consumer's expectations and service quality specifications, i.e. improper service-quality standards.

**Gap3: Service quality specification-service delivery gap**

This gap addresses the difference between service quality specifications and service actually delivered, i.e. the service performance gap

**Gap 4: Service delivery-external communication gap**

It addresses the difference between service delivery & communications to consumers about service delivery, i.e. whether promises match delivery

**Gap 5: Expected service-perceived service gap**

This gap addresses the difference between consumer's expectation and perceived service. This gap depends on size and direction of the four gaps associated with the delivery of

service quality on the marketer's side. It enables the management to identify systematically service quality gaps between a numbers of variables affecting the quality of the offering.

- **Direct Investigation Approach**

It involves disguising an inspector as a customer and allowing them to actually experience the service level of an organization under evaluation where an inspector fills out a multi-point report card, detailing the quality of service provided by the organization. The grade is based on the overall service quality provided and ranges from 0 to 100. The grade card indicates by low scores where the store or sales people were deficient, while the overall grade indicates how the store ranks among its competitors.

- **Effective Market Share Method**

Through literature, It was noted that a large gap existed in making the measurement of customer service effective. Effective means that resources spent in obtaining customer service data provide valuable information to managers who can then make adjustments to operating procedures and increase market share. For example: customer satisfaction includes image, quality, convenience, price, selection, etc.

- **Retail Service Quality and Perceived Value Model**

This model highlights that in addition to product quality and price perceptions, functional service quality and technical service quality perceptions both are directly influence value perceptions. Perceptions directly influence consumers' willingness to buy. Functional service quality perceptions also influence technical service quality perceptions, which in turn influence product quality perceptions and neither of the two directly influence value perceptions.

- **Service Performance Experiment Design**

These models have two fundamental components such as threshold and incremental values. Customers would likely to perceive these values that are manifested by fact or degree. Thresholds are those that should exist and as a matter of fact, whether or not they do. Incremental values are those that could exist and are expressed as a matter of degree to which they do. These are dynamic, open ended opportunities for added value and continuous

improvement to which a service provider can creatively add through the expression of mutually satisfying relationships with their customers.

## 3.3 BENCHMARKING PROCESS STEPS

Benchmarking is done in four phases and these four phases are divided into ten process steps to obtain good results. The four phases of benchmarking process are:

### 3.3.1 Planning

Recognizing whatever to be benchmarked to identify comparative candidates and planning for the next steps. The objective of this stage is to prepare a plan for selecting factors for comparing, method of data collection and identifying the competitors for benchmarking. The following steps will be adopted during this phase.

- **Identification of What is to Be Benchmarked**

Industry can be a service, process and any practice. This may be completed with the assistance of the organizer and consultant of benchmarking system. The organizer would present and analyses the types of benchmarking available with discussion of the company management their advantages and difficulties. It may cover areas such as: manufacturing, innovation and product development, logistics, environment, health and safety, finance and marketing, other service industries.

- **Form Benchmarking Team in the Organization**

A benchmarking team will be formed which is responsible to bring out the benchmarking process. A team leader would be appointed, as well as employees who could expressively contribute the exercise followed by other employees' contribution. The organizer could provide the efficient team leader as well as the employees who can contribute in the process.

- **Identification of Organization Which Would Be Benchmarked**

This can be other operating units within the company, competitors and unrelated organization. However, the selected organization should be a leader or best in class of the area being benchmarked. It may similarly be a collection of industries in the similar region or in the same country. This will depend on availability of such information locally and

globally. Admittance of the organizer to such data even on-line and access to this type of data is provided for payment.

- **Determine the Indicators and Data Collection Method**

In this section number of performance factors should be adopted which include· leadership, policy and strategy, resource management, business processes, customer satisfaction, etc. The authors have identified key characteristics of performance measures:

- ❖ Requirements of direct relations with the company strategy
- ❖ Financial and Non financial measures
- ❖ Variation between locations
- ❖ Need to be simple usages of the resources and easy to use
- ❖ Providing rapid responses to employees

- **Collection of Data**

The measurements must be chosen to provide a significant comparison. Collection involves personal meetings and location visits of companies being benchmarked. The number of visits may be performed by the benchmarking team with the help of the organizer. Documents containing the questions may be asked collectively with the worth of benchmarking. Employees should fill data with proper concentration and intention. Wrong answers will guide to incorrect results and unfair value of the benchmarking exercise for the company.

### 3.3.2 Analysis

The objective of this phase is towards the usage of data gathered and defines the goals necessary to gain or sustain dominance to incorporate these goals into corporation's formal planning processes.

- **Determine Existing Performance Levels**

  This includes identifying gaps between organization and benchmarking partners which involves the data analysis and the detailed comparison between industrial data and the reference organization. The comparison may be each of the performance factors chosen and the current performance level of the company obtainable in the weighted scale. The performance level may be best in class as well as medium and average, if reference data is recovered from a data base.

- **Determine Performance Levels for Future**

Estimate the predictable improvements of benchmarking partners so that improvement program will not turn out to be outdated. This step required expert advice depending on the factors chosen. After taking into description of the factors a report could be generated that on the future values of the performance factors.

### 3.3.3 Integration

In this phase communication of benchmarking findings and again acceptance with establishment of practical goals are studied.

- **Communicate the Benchmark Findings**

In this step benchmarking findings should be communicated to senior management and employees for necessary improvements by discussing the methodology, findings and strategy for improvements. A detailed presentations in the form of long workshop should be made to all workforce concerned in each process, so that the findings can be easily accepted and everyone participates in process improvements.

- **Development of the Strategy**

After consensus on results and strategy, the team presents final recommendations on how the organization must change their processes towards achieving goal. Action plans for each objective should be developed to gain the essential support within the organization and regarding the limitation of financial budget.

### 3.3.4 Action

Development of action plans and implementation of specific actions with monitoring progress and recalibrate benchmark. Throughout this phase the strategies and achievement of plans established through the benchmarking process which are implemented and occasionally assessed with reports of company's development for attaining them.

- **Implementation of Precise Actions and Monitoring Process**

This includes collection of data on new levels of performance by problem solving team to examine the problems. Afterwards, if goals are met then adjustments for the improvement process are required.

- **Recalibrate the Benchmarks**

In this step, mostly recent performance data are used which come from the above processes. On the basis of these data benchmarks must be re-evaluated and reorganized for their applications.

## 3.4 CHARACTERISTICS OF BENCHMARKING WITH THEIR APPLICATIONS

Besides, the application of benchmarking in manufacturing and service industries the phases are completely depend on each process steps of benchmarking model. In each steps of benchmarking process, convinced decisions have been recognized as in the first step of planning, where decision on identifying the strategic objective for the business and planning of selection for benchmarking partner also. In second step, several strategic decisions like selection of team members, leading team members, visiting members, role of each member and proper training to members has to be completed. Though in third step, collection of data where identification of data, decision on collection methods with role of benchmarking team is considered. In fourth step, analyzing of data where comparison among suitable partners with selection of performance gaps and their possible causes are considered. In the next step improvement, the selection of performance variables with critical success factors and development of action plan for critical success factors with their implementation plan are considered. Therefore every step, necessitate decision makers to make effective judgments. However, a number of multi-attribute decision making (MADM) techniques are available in literature for making good judgments but study gives a different method to bond with the decision making problems for service quality environment. The selection of benchmarking and team can be done on characteristics of benchmarking processes. The Table 3.3 shows characteristics of benchmarking with their limitations for proper selection of benchmarking.

Table 3.3 Benchmarking Characteristics

| Type | Description | Most Appropriate | Limitations |
|---|---|---|---|
| **Strategic Benchmarking** | Where industries required improving its complete performance by examining the permanent strategies and overall methods that must be enabled high-performers to be succeed. It includes high level aspects like as main competencies, evolving new products and services for trade by changes in the external environment. | Re aligning commercial tactics that have become unsuitable | Variations of resulting from this type of benchmarking may be problematic to implement and yield a long time to organize. |
| **Performance or Competitive Benchmarking** | Industries considered their situation in relation to routine characteristics of main products and services. . | Evaluating comparative level in crucial areas or in assessment with others for the same sectors and concluded ways of last gaps in the performance | This type of investigation is frequently undertaken through trade relations and third parties to protect discretion. |
| **Process Benchmarking** | It emphases on educating critical processes and processes. This type of benchmarking always involves | Achieve developments in main procedures to attain quick | This type of benchmarking regularly outcomes in short term benefits |

| | | | |
|---|---|---|---|
| | producing procedure maps to ease contrast. | assistances. This type are sought from organizations that perform similar work or deliver similar services | |
| **Functional Benchmarking** | Businesses look to benchmark with partners drawn from different business sectors to find ways of improving similar functions This category of benchmarking can lead to innovation and affected improvements | Improving activities or services for which counterparts do not exist | The main activities will change that effect business process |
| **Internal Benchmarking** | It Involves benchmarking trades or operations after within the similar organisation like as business units in different countries. | Numerous business elements inside organization demonstrated good practices and administration need to feast this expertise speedily, through the society. | It might be comparatively informal to transfer crossways the same association and may be deficient finest in class performance is addition likely to be found over external benchmarking. |

| | | | |
|---|---|---|---|
| **External Benchmarking** | It includes examining outside organisations that are recognized as the best in class. It provides occasions of knowledge from persons who are at the foremost control. | Where examples of good practices is found in other administrations and absence of best practices within internal corporate units | It can yield up important time and resource to confirm the comparability of data. |

## 3.5 DIMENSIONS OF MANUFACTURING AND SERVICE

The below table shows the dimensions which occurs in manufacturing and service organization. Based on these dimensions gaps between both sectors can be identified easily.

Table 3.4 Dimensions of Industries

| Dimensions | Manufacturing | Service |
|---|---|---|
| **Organizational system**<br>Training and education<br><br>Recruitment and selection | Task-oriented skills, teamwork, Interpersonal relations, teamwork quality values, Training and education<br>Hard topics: Accounting, communication skills, engineering, statistics , etc | Interpersonal relations, teamwork employee behavior and customer service<br><br>Soft topics: communication skills interpersonal relations and quality values, teamwork |
| Employee empowerment | Supporting infrastructure such as required resource and technical assistance, increasing autonomy and responsibility; emphasis on shop floor workers | Providing power, information, rewards and knowledge protection of employees in times of their unforeseen behavior during customer service, emphasis on customer contact etc |

| | | |
|---|---|---|
| Employment involvement | Quality control circles, problem hit squads, quality improvement teams, suggestion schemes, brainstorming, Gordon technique, etc | Better emphasis on employee involvement in service organizations as they run the service operation, market the services and are equated with service by the customers |
| **Technical system**<br>Design quality management | Quality function deployment, house of quality, Taguchi's design of experiments, failure mode act analysis, poke-yoke, etc | Error prevention and zero fault strategy; gap analysis; critical incident technique |
| Process management | Statistical process control, statistical quality control, just-in- time production, cellular manufacturing, six sigma quality, 5 S approach, seven old and new tools of quality, etc | Systematization, standardization, simplification and streamlining of the service delivery processes; Computerization; networking of operations; etc. |
| Information system | Data related to cost and financial accounting, sales, marketing, purchasing, etc | Data related to customer satisfaction, service quality and employee satisfaction |
| Culture | Though the importance of culture is acknowledged even in the manufacturing literature, the emphasis has been more on<br>Technology | Seamlessness in service delivery, moments of truth, critical incident and recovery |

| | | |
|---|---|---|
| Tangibles | Building, Machine and Equipment's; signs, symbols, advertisement boards, pamphlets, employee appearance and other artifacts in the organization, etc | Ambient conditions such as temperature, ventilation, noise, odor, etc. physical layout of premises and other furnishings |
| Social responsibility | Environmental management, ISO14000, etc | Corporate citizenship to lead as a corporate citizen by promoting ethical conduct in everything the organization does |
| **Goals**<br>Customer focus | Though customer satisfaction and employee satisfaction are acknowledged as vital elements. The focus is on product quality, elimination of defects, conformance to specifications, requirements, reliability, durability, etc. | Customer delight and loyalty, favorable purchase intentions, repeat business, etc. customers are treated as productive human resources, substitutes for leadership and as organizational consultants |
| Employee Satisfaction | Continuous improvement | As well as big quality contributions and achievements, better behavior, work values, integrities, etc. are obtained. |

On the basis of literature outcomes and various case studies, following gaps are identified between both manufacturing and service sectors.

### 3.5.1 Focus on Performance

Goods are produced while services are performed. Because services are more tangible and customized than most of the products, service operations tend to be more complex than goods production.

### 3.5.2 Focus on Process and Outcome

Manufacturing procedures emphasis on the outcome of the production process but the products of service procedures are combinations of goods and services.

### 3.5.3 Focus on Service Characteristics

Intangibility is the main characteristic of service that cannot be touched, recognized or felt and cannot be wrapped but manufacturing process can be recognized easily. The consumer taste of service quality is extremely subjective because of the tangible nature of services while in manufacturing the taste become broad.

### 3.5.4 Focus on Customer Service Link

Service operations often acknowledge the customer as part of the service communications itself while manufacturing typically depend on as a part of process link of production system.

### 3.5.5 Working Conditions

In service sector hotel, restaurant, transport and communications sectors stance out usually less favourable work conditions than other service industries. Working conditions in manufacturing sectors are generally tend to be tough for all circumstances.

### 3.5.6 Inventory

Service firms' generally not holding inventories as well as they create a service when consumer requires it. Manufacturers create goods for stock, with inventory levels associated to predictions of market demand. Some manufacturers sustain least stock levels, relying on the precision of demand forecasts and their invention capacity to meet demand on the basis of just in time as the part of supply chain. Inventory also signifies a cost for the manufacturing organization.

### 3.5.7 Location

Service firms do not require a physical production site. The persons producing and conveying the service can be positioned anyplace. Global organizations such as any industries related to communication networks for admittance to the most suitable service need to locate their positioning throughout the world. Manufacturers must have a physical location for their production and stock holding operations

### 3.5.8 Intangibility

It is not tangible like the physical goods. It cannot be realized physically, but it can be felt. Non-inventor capability as opposed to physical goods services is not inventorial, because a

service is produced and consumed simultaneously. In this sense a service doesn't exist, however the result of service last for some time.

### 3.5.9 Customer Involvement

Besides the quality aspects, the inventor ability of services also means that the customer may be directly involved in operations, where the production and consumption takes place simultaneously. Therefore the service and the service provider both are directly contacted with the customers.

### 3.5.10 Operation Management

The responsibility of the operation managers in manufacturing is absolutely diverse from the operation managers in service provision. On the consecutively of the business, operations management in manufacturing is more product oriented, however operations management in service provision is more persons oriented.

### 3.5.11 Employee Recruitment

Service firm recruits people with precise knowledge and skills in the service disciplines that offers to consumer. Service delivery is work intensive and cannot be easily automated, although knowledge management systems allow a gradation of knowledge distribution.

### 3.5.12 Employment Consistency

The proportion of workers not feel protected in their jobs as higher job security in the hotel and medical sector than in manufacturing, although the proportion is lower than in agriculture type sectors. At the other end of scale workers in economic intermediation seem to have certainly the most satisfactory working conditions which is thoroughly monitored by workers in public direction and in business activities.

Table 3.5 Traditional Comparison of Manufacturing and Services System

| S. No. | Characteristics | Manufacturing | Service |
|---|---|---|---|
| 1 | Customer contact | Low | High |
| 2 | Uniformity of input | High | Low |
| 3 | Labour content | Low | High |
| 4 | Uniformity of output | High | Low |

| | | | |
|---|---|---|---|
| 5 | Output | Tangible | Intangible |
| 6 | Measurement of productivity | Easy | Difficult |
| 7 | Inventory | Much | Little |
| 8 | Opportunity to correct problems | High | Low |
| 9 | Evaluation | Easier | Difficult |
| 10 | Research/innovation | In-house | Out-sourced |
| 11 | Technology orientation | Push Technology | Pull Technology |
| 12 | Human element | Less Important | Very Important |

Manufacturing operations converts input like materials, labour and capital into some tangible outputs. The objectives of each process is to change the shape or physical characteristics of the raw-materials or inputs Service operations non-manufacturing or service operations also transform a set of inputs into a set of outputs, but the outputs are not tangible.

The above Table 3.5 shows those factors, which can be utilized in determining the economic conditions of the society where as the close linkages between the manufacturing and service sector show the need of designing policy measurements. The policy measures can include improved technology, structure financing, proper infrastructure, managing manpower etc. The growing and competitive manufacturing with service sector has become the prime mover of modern economy. Manufacturing accelerates the effective use of primary products and drives service sector by inducing multiplier effects through numerous linkages. Service with Manufacturing is essential for maintaining a balanced growth of the country. It can create large employment opportunities. As a result, the race for competitiveness in both industries among nations has gathered momentum supported by a strong foundation for innovation, advanced technology and high end process development programs. Fast reductions in the manufacturing cost with service cost have become one of the core aspects for increasing competitiveness in global market sector. In a developing country like India, manufacturing activities help in providing better infrastructure and service provides employment for those who belongs to rural and agricultural background. Therefore, manufacturing needs to occupy a strong relationship with service sector.

# CHAPTER IV

# SURVEY OF INDIAN SERVICE INDUSTRIES

***Chapter Objective***

*This chapter highlights the methodology of survey for Indian service industries. Key parameters such as basic activities of each phase and department involved in performing these activities are considered. Data collection method and analysis of data are also discussed. A Hypothesis test with ANOVA method is applied for proper validation of survey data*.

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## 4.1 INTRODUCTION

Knowing the applicability of benchmarking in Indian industries and the performances of benchmarking in Indian service industries this chapter highlights the methodology used in collection and analysis of data. Identification of parameters associated with the benchmarking system and applications of these parameters in various departments are also considered. Then, quality enabled factors identified from previous chapter are discussed in detail and validated by the questionnaire based survey. The main objective of survey is to measure the benchmarking system in Indian service industries. This part also tests a hypothesis model with ANOVA in order to accept or reject a statement in form of Null and alternative hypothesis.

## 4.2 METHODOLOGY

A tentative survey research methodology has developed for benchmarking in service industries. The research is distributed as per following procedure:

- An extensive analysis of prevailing literature intended at the decisive dimensions of service quality, strategy and attributes of benchmarking has been performed.

- In direction to explore the service quality, a survey has been performed with proper designed questionnaire which are sent by mail or direct interview in industries. More than 100 attributes have been identified on the basis of literature.

### 4.2.1 Questionnaire Based Survey

A questionnaire survey has been done on the basis of questions asked to respondents. The questionnaire has a wide range of research objectives and involved many questions but to remain within the scope of this study only questions related to evaluation of attributes were used The questionnaire is designed as per expert's opinion and literature outcome on the five point likert scale. Respondents are asked to give point on the likert scale, where 1 stands for very little and 5 for very high. Few close-ended questions related to the process used have also included in the questionnaire. The appendix no.1 shows the list of questions contained in questionnaire survey.

### 4.2.2 Target Industries

Major industries from Indian service sector are selected for the administration of questionnaire. Most of them are from automobile service; hotel industry; banking: aviation and insurance sectors. Out of these, maximum numbers are from automobile industries. In India there is huge scope of automobile industries, all of the major industries have established their plants in India therefore the use of automobile vehicles generate the need of their maintenance and services also. A hundred of automobile industries are selected for survey, rest of all are from all the remaining sectors.

### 4.2.3 Survey Administration

The Indian experience of mailed surveys using random sample from an industrial database has not been encouraging. Therefore, for a high response rate, convenience randomized sampling has been used in this survey. Survey is conducted in Indian service industries, where the mostly respondents are executives or above supervisors level. The participants have been asked questions by mail, telephonic and direct interview. The population included service industries like automobiles, aviation, communications, insurances and hotels of India. Questionnaires were sent to Indian service industries, along with a covering letter, self-

addressed and a stamped envelope, to these industries. The sample has been selected from the directory of ISO 9000/14000 and QS 9000 certified companies in India.

### 4.2.4 Survey Response

In total, questionnaires were sent to 324 companies and 69 completed questionnaires were received. Ten surveys were not filled completely, so they were discarded for the further analysis. This gives a response rate of 21.29%, which is not too low for such type of surveys (Malhotra and Grover, 1998). Out of the 69 respondents, 10% had less than 100 employees; 28% in the range of 101–500; 30% in the range of 501–1000; 20% in the range of 1001-3000 and 12% with more than 3000 employees. In terms of turnover (Indian Rupee) 20% of them had less than 10 crores; 37% in the range of 10–50; 20% in the range of 50–100; 10% in the range of 100-500 and 13% are the above 500 crores. In most of the cases, the addressee filled the questionnaire self but in some cases; senior members of the companies also filled the questionnaires on behalf of addressee.

### 4.2.5 Non-Response Bias

The assessment aimed at non-response bias is to evaluate the modification between the primary and the late respondents of survey on certain variables of attention. Consequently, associating those responses which were acknowledged without a warning, afterward one notice against the responses then which were acknowledged after distribution two or additional notices can deliver a proposal of non-response bias. The consequences from t-tests suggest that early replies do not knowingly vary from late replies which includes that there is a great degree of internal reliability in replies of the questionnaire.

### 4.2.6 Reliability Analysis

Reliability Analysis has been performed after validation of survey. The easiest way to analysis reliability is to test the same group of people in two times. If the survey item is reliable then the score of each respondent will remain same at different points. This problem can be overcome using the alternate method in which two similar questionnaires are devised and compared. This method randomly splits the questionnaire items into two groups. A score for each subject is then calculated based on each half of the scale. If a scale is reliable then it is expected a respondent’s score is the same on one half of the scale as the other and two

halves should correlate perfectly.. The problem is that there are number of ways in which a set of data can be split into two and the results might be way in which the data are split. To defeat this problem, Cronbach suggested splitting the data in conceivable way and computing the correlation coefficient for each split. The average of these values is known as Cronbach's alpha, which is the generally used method for reliability. By using Predictive Analytics Software (PASW 18), reliability analysis has been conducted. Data collection has been used for collecting all of the data to accumulate pragmatic material, Predictive Analytics Software (PASW) statistics 18 software is used for finding the relevant scores.

Cronbach's coefficient has been intended to form the reliability and internal stability of the replies. It is found 0.83 for standing of attributes in general. This checks the reliability of the survey and internal consistency of the survey. Cronbach's coefficient, which has the value of large than 0.5, has to be considered as sufficient value for investigative effort (Nually, 1978). It entails that a high grade of internal consistency includes in the responses to the questionnaire, where more than hundred respondents have been taken on convenience sampling method from national capital region of India.

## 4.3 DATA COLLECTION

The main survey instrument has been administered for selected respondents through direct contact and email. The respondents from service industries who are having more than five years of experience within quality environment are considered. The strength of data was based on the standards that the survey instrument was completely occupied. Considering more than hundred numbers of attributes along with high responses for each attribute produces in decent amount of data which requires further analysis with validation of data for checking data reliability. Many softwares are available in the market for data analysis. Here PASW 18 software (SPSS) is found suitable for further data analysis. Data has been entered in the PASW 18 physically and exposed for further data analysis as discussed below.

### 4.3.1 Validation of Data

This chapter has reviewed the factors pertaining benchmarking with a view of study in current state of research. Based on literature review more than hundred representative factors

have been identified for further analysis. Since the identified factors are measured sufficient to represent current scenario of benchmarking in service industries thus there is requirement to validate these factors for developing a benchmarking model. The quality benchmark model needs to be developed for consideration of the collective impact of constituent subsystems and integrating them for applying towards quantification of service quality.

### 4.3.2 Factorial Validity

Factorial validity presents that whether the factor arrangement of the survey tool makes intuitive sense. The factorial analysis has been conducted by using PASW 18 software. Even as factor analysis has been conducted satisfactorily, the results obtained from them are not creating instinctive sense. Grouping of these items on factor loading give direction for disappointing results. After penetrating for the underlying theory, it can be said that factor analysis may not lead to satisfactory result due to following two reasons (De Bruin, 2004).

- The relationships among items remain nonlinear, which entertains the hypothesis of linearity and regularity fundamental factor investigation. The problem through non-linearity is replicated in important univariate skewness (difficulty factors) and similar deliveries incline in the form of clusters irrespective of their content (McDonald, 1999).
- The intervals among the scale points of substances are probable to be fewer, larger and less identical that of scales. Bandalos (2002) discussed the intermissions between scales points with objects called as coarse categorizations.

In this study, Many items are one sided on the scale of 1 to 5 and many of items scored heavily for 3, 4 and 5 none for 1 and 2. Equally convinced items are tilted towards low score. Since such the relations between items are non-linear. The result of this analysis consequently made automatically by referring literature review and consulting experts of the subject.

## 4.4 ONE WAY ANOVA

Analysis of Variance (ANOVA) is a hypothesis-testing technique used to test the equality of two or more population means by examining the variances of samples that are taken. It allows determining whether the differences between the samples are simple due to random

error (sampling error) or whether there are systematic treatment effects that cause the mean in one group to differ from the mean in another.

ANOVA is based on comparing the variances between the data samples to variation within each particular sample. Sample between variation is much larger than the within variation, the means of different samples will not be equal. Sample between and within variations are approximately the same size and then there is no significant difference between sample means. The procedure of ANOVA is as follows:

(i) Obtain the mean of each sample i.e., obtain X1, X2, X3, ..., $X_k$ when there are k samples.

(ii) Work out the mean of the sample means as follows:

$$\overline{\overline{X}} = (\overline{X_1} + \overline{X_2} + \overline{X_3} + \overline{X_4} \_ \_ \_ \_ + \overline{X}) / \text{ No. of samples (K)}$$

(iii) Take the deviations of the sample means from the mean of the sample means and calculate the square of such deviations which may be multiplied by the number of items in the corresponding sample and then obtain their total. This is known as the sum of squares for variance between the samples (or SS between). Symbolically, this can be written:

$$\text{SS between} = \quad n_1 (\overline{X_1} - \overline{\overline{X}}) + n_2 (\overline{X_2} - \overline{\overline{X}})$$

(iv) Divide the result of the previous step by the degrees of freedom between the samples to obtain Variance or Mean Square (MS) between samples. Symbolically, this can be written:

$$\text{MS} = SS \text{ between} / (\mathcal{K}\text{-}1)$$

(v) Obtain the deviations of the values of sample items for all the samples from corresponding means of the samples and calculate the squares of such deviations and then obtain their total. This total is known as the sum of squares for variance within samples (or SS within). Symbolically this can be written:

$$\text{SS within} = \quad \Sigma (X_{1i} - \overline{X_1})^2 + \Sigma (X_{2i} - \overline{X_2})^2$$

(vi) Divide the result of above step by the degrees of freedom within samples to obtain the variance, mean square (MS) within samples. Symbolically, this can be written as within

$$\text{MS within} = SS \text{ between} / (\mathcal{K}\text{-}1)$$

n = Total number of items in all the samples i.e., n1 + n2 + … + nk

k = Number of samples

**DOF**: -- The degrees of freedom for total variances are equal to the number of items in all samples minus one i.e., (n – 1). The degrees of freedom for between and within must add up to the degrees of freedom for total variance i.e., (n – 1) = (k – 1) + (n – k). This fact explains the additive property of the ANOVA technique.

Finally, F-ratio may be worked out as under:

$$F = \text{MS Between/ MS within}$$

This ratio is used to judge whether the difference among several sample means is significant or is just a matter of sampling fluctuations.

For this purpose as seen in the Table 4.2, giving the values of F for given degrees of freedom at different levels of significance. If worked out value of F, as stated above, is less than the table value of significant, the difference is taken as insignificant.

In case the calculated value of F happens to be either equal or more than its table value, the difference is considered as significant (which means the samples could not have come from the same universe) and accordingly the conclusion may be drawn. The higher calculated value of F is above the table value and the more definite with sure one can be about conclusions. Here for finding the F ratio PASW 18 software is used by taking some important critical success factors shown in below Table 4.3, where all the values are taken from PASW 18 software.

## 4.5 HYPOTHESIS TEST

Hypothesis testing using statistical techniques to support predictions have done for the study. This is done at statistical significant level, in which hypothesis is either accepted or rejected. The two hypothesis complicated in hypothesis testing which are the null and alternate hypothesis where H0 represents the null (false) and H1 shows the research hypothesis is true.

Following hypothesis have been developed based on the attributes of the study

**H0:** There is no correlation between customer satisfaction and tangible attributes in automobile car service sector.

**H1**: There is a correlation between customer satisfaction and tangible attributes in automobile car service sector.

**H0:** There is no correlation between customer satisfaction and reliability in automobile car service sector.

**H2**: There is a correlation between customer satisfaction and reliability in automobile car service sector.

**H0:** There is no correlation between customer satisfaction and assurance in automobile car service sector.

**H3**: There is a correlation between customer satisfaction and assurance in automobile car service sector.

**H0:** There is no correlation between customer satisfaction and responsiveness in automobile car service sector**.**

**H4:** There is a correlation between customer satisfaction and responsiveness in automobile car service sector**.**

**H0:** There is no correlation between customer satisfaction and empathy in automobile car service sector.

**H5**: There is a correlation between customer satisfaction and empathy in automobile car service sector.

[**Note:** H0 is Null Hypothesis and H1-H5 are alternative Hypothesis]

The hypothesis test authorizes all the service quality attributes that are completely associated with customer satisfaction. Empathy allows the maximum positive correlation with customer satisfaction and assurance authorizes the maximum positive correlation with customer satisfaction. Tangibility discloses the slightest positive correlation with customer satisfaction. A huge positive affiliation between customer satisfaction and responsiveness has been demonstrated in the hypotheses test. The perceptions have been tested within and between the groups using the statistical tool one way ANOVA. The 'F' value of top management commitment.

Table 4.1 Important Critical Success Factors Ranking

| Symbol | Factors | SD | Rank |
|---|---|---|---|
| CF1 | Responsiveness | 4.52 | 1 |
| CF2 | Reliability | 4.00 | 2 |
| CF3 | Assurance | 3.42 | 3 |
| CF4 | Customer Satisfaction | 3.06 | 4 |
| CF5 | Tangibles | 2.50 | 5 |
| CF6 | Empathy | 2.28 | 6 |

Table 4.2 Insight for Critical Success Factors of Benchmarking

| Critical Factors | N=115 | Sum of Squares | Degree of Freedom | Mean Squares | F-ratio | Significance |
|---|---|---|---|---|---|---|
| CF1 (Items 1- 20) | BG =1<br>WG=114<br>Total=115 | 162.6104<br>4786.8410<br>4929.8640 | 1 | 51.3052<br>17.2706 | 5.0823 | 0.2380 |
| CF2 (Items 21- 40) | BG =1<br>WG=114<br>Total=115 | 41.0375<br>2003.1233 | 1 | 13.1235<br>7.6523 | 2.0220 | 0.4856 |
| CF3 (Items 41- 60) | BG =1<br>WG=114<br>Total=115 | 15.4120<br>1081.5535<br>2523.6561 | 1 | 7.0012<br>10.8331 | 2.6152 | 0.4258 |
| CF4 (Items 61- 80) | BG =1<br>WG=114<br>Total=115 | 18.0359<br>2090.8625<br>2706.896 | 1 | 9.4010<br>8.4473 | 6.8562 | 0.2161 |
| CF5 (Items 81- 100) | BG =1<br>WG=114<br>Total=115 | 19.0627<br>1238.7443<br>1357.6960 | 1 | 9.2861<br>5.3825 | 2.6520 | 0.0011 |
| CF6 (Items 101- 115) | BG =1<br>WG=114<br>Total=115 | 86.2659<br>1253.1741<br>1359.4650 | 1 | 36.1024<br>6.3675 | 4.5628 | 0.8061 |

Figure 4.1 Graph showing Differences between Significance and F Ratio Values

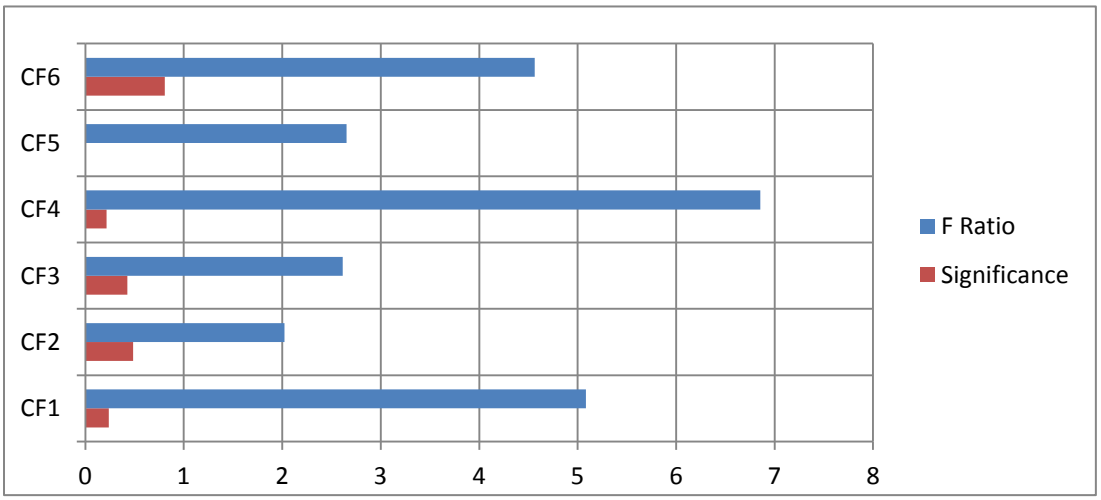

Table 4.3 Probable Regression Results of Critical Factors Prompting Benchmarking

| Variables | SD | Rank | Multiple Regression | Regression Square | F-Ratio | Significance |
|---|---|---|---|---|---|---|
| Responsiveness | 4.52 | 1 | 0.78552 | 0.39987 | 3.1011 | 0.0310 |
| Reliability | 4.00 | 2 | 0.72780 | 0.52969 | 1.3102 | 0.0210 |
| Assurance | 3.42 | 3 | 0.70024 | 0.49034 | 3.4856 | 0.0251 |
| Customer Satisfaction | 3.06 | 4 | 0.67097 | 0.25026 | 3.3351 | 0.0125 |
| Tangibles | 2.50 | 5 | 0.45110 | 0.21091 | 1.0091 | 0.0147 |
| Empathy | 2.28 | 6 | 0.57551 | 0.35762 | 3.2005 | 0.0014 |

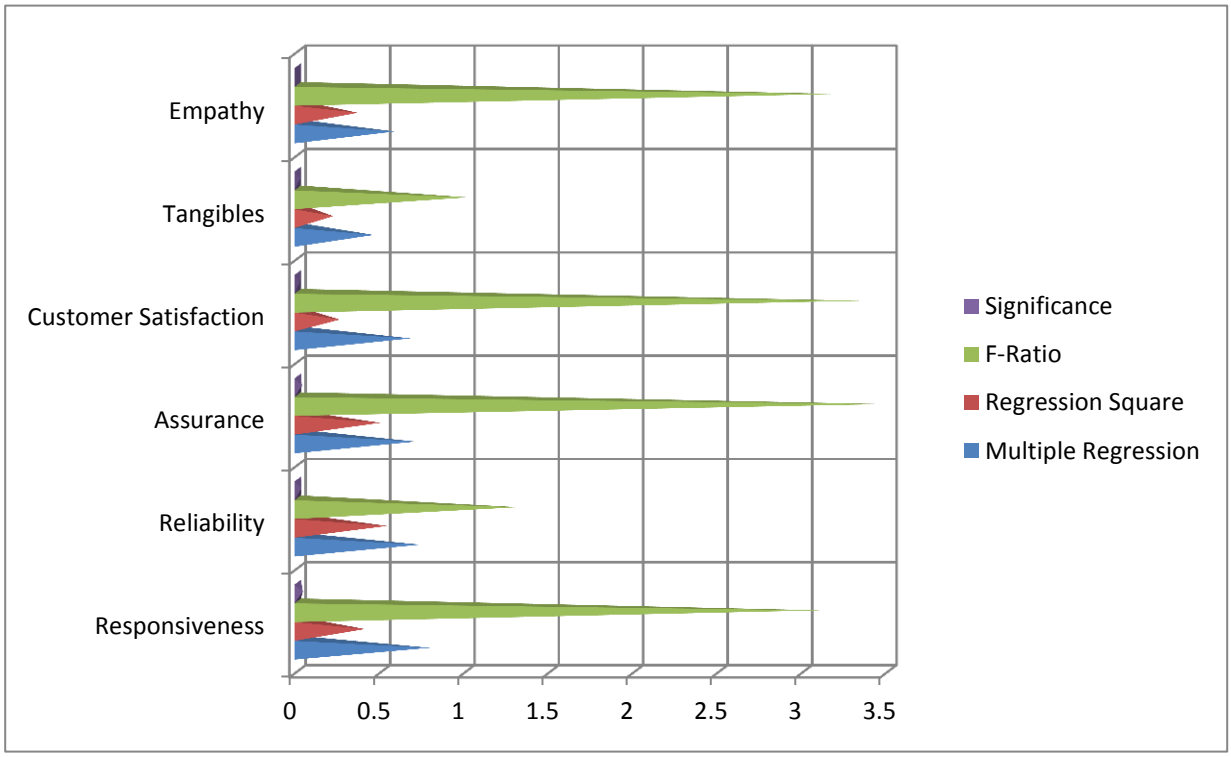


Figure 4.2 Graph showing Differences between Important Critical Factors

Results of ANOVA prompt to accept the alternate hypothesis in all stating that quality systems of the firms have been improved due to benchmarking implementation. The performance of service industries has shown improvement in terms of flexibility, increased involvement, customer satisfaction and reliability. Similarly, the manufacturing performances also have shown improvement in terms of reduced cycle time, reduced manpower and improved quality of finished product. Improvement in information sharing was seen through improved accuracy, effectiveness and frequency of data sharing.

The mean value of responses scoring is 3 and 4 i.e. high category, which indicates that responses are high for Indian service industries except in case of different service issues. ANOVA test is performed to show the significance of these means. Test results (F-ratio at 5% significance approx.) show that these high means are systematic and there is acceptance of factors in Indian industries in case of service issues as values of F ratios are more than significance.

Therefore five alternate hypothesis (H1, H2, H3, H4, H5) are accepted and Null hypothesis (H0) concerned these Hypothesis are rejected.

The F ratios indicate the significance of mean value which are more than significance as shown in Table 4.3. Thus the mean value of low responses is high and this prompts that there is less interest in benchmarking for Indian industries. The applicability of benchmarking in service industry is highly appreciated in terms of level, benefits and importance. But the degree of difficulties and challenges are also high. The variations of values can also be seen in figure 4.1 and figure 4.2 for their comparison. The results are similar as encountered in the literature given by various authors in respect of developing nations. The results can be seen from the literature in respect of various sections; for an example critical success factors find out during literature are showing importance related to each other.

## 4.6 CONCLUDING REMARKS

The observations of customers have recognized within the groups using the one way ANOVA. Various critical success factors are identified on the basis of literature outcome. A sample test has been conducted on the basis of these critical success factors which show there is non-linearity in test output. Thus, further analysis may be included with the help of PSAW

software for checking of reliability of survey. The F ratio gives significant value as all of these values are positive in nature. The F value of Responsiveness (CF1) and Empathy (CF6) significantly differ from the other critical success factors as there is large difference between outcome values. The CF1 comprises of sub items out of which sub item Reliability, should be given significance. Like these CSFs, all CSFs have obtained some values which are shown in Table 4.2 and Table 4.3.

While in hypothesis, H1and H2 is incompletely rejected with affection to CF1 and CF6. However there is no significant difference of insight found among critical factors CF2, CF3, CF4, CF5 and CF7 between the above groups. Hence the H1 & H2 are accepted with regard to these critical factors. As seen from Table 4.2, there is no significant difference found among the groups II & III in their perceptions. Hence the hypothesis H3 is accepted. Table 4.3 shows that there is substantial difference of perception between customer and service provider with favor to all critical factors are considered. All the CSFs were statistically significant at 0.05 level. It concludes that critical factors are the significant factors in determining the operative implementation of benchmarking.

The hypothesis test confirms that all the service quality attributes are positively correlated with customer satisfaction. Empathy displays the highest positive correlation with customer satisfaction and Assurance demonstrate the second highest positive correlation with customer satisfaction. Tangibility reveals the least positive correlation with customer satisfaction. A large positive relationship between customer satisfaction and customer loyalty has been established in the hypotheses test. Numerous studies have expressed the objectives and adorned the requirement of empirically inspect the relationship among the practical competencies and industrial recital of a firm. The empirical findings are helpful for managers to focus on the determinants which are basis of competitive gain.

# CHAPTER V

# DEVELOPMENT OF BENCHMARKING MODEL FOR SELECT SERVICE INDUSTRY

***Chapter Objective***

*This chapter shows appropriate demonstrating attitude for selection of benchmarking model in Indian service industries. Critical success factors have been analyzed and modelled by using the Interpretive Structural Modelling (ISM) approach for each phase of the benchmarking system for Indian service industries. Furthermore, application of Fuzzy Graph theory (FGTA) has also been used to help in investigation of important attributes and development of benchmarking model.*

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## 5.1 INTRODUCTION

The service sector has emerged as the highest mounting sector compared to other sectors. By increasing influence of service industry, more firms are concerned about service and its management. Unlike tangible products, service is a deliverance scheme, where designing and controlling process is extremely crucial. Service benchmarking is made more difficult than benchmarking in manufacturing because it appears those things, which are important to a customer and can differ significantly from one service industry to another (Narayan et al., 2008). There is need of benchmarking model for industries which will eliminate the executive's confusion for improving the success factors of service quality. Thus, the overall efficiency of Indian service industries will be enhanced by increasing competitiveness. The aim of this chapter is to evaluate benchmarking quality enabled factors using Interpretive Structural Modelling (ISM) technique and Graph Theory Approach. Both methodologies facilitate to recognize the mutual influences among the quality enabled factors and identifying the decisive factors in an arranged manner for each phase of the benchmarking system for Indian service industries. This chapter illustrates the suitable modelling work for selection of benchmarking model and interactions among the identified quality enabled factors for Indian service industries.

ISM approach identifies the crucial quality enabled factors in an orderly manner and helps to understand the mutual influences among these quality enabled factors. Seventeen quality enabled factors are identified where two attributes are in cluster 1, seven in cluster 2, two in cluster 3 and six in cluster 4. Hence it is obvious that a supplier having more attributes in cluster two will be selected. This is pronounced as the practicing of the seventh benchmarking attributes in strong driving power and strong dependence cluster of MIC-MAC analysis. The same is also verified in ranking of attributes through ISM technique. With the ISM based model, an Impact Matrix Cross Reference Multiplication Applied to a Classification (MICMAC) analysis is also carried out. This analysis shows that there are no identified autonomous barriers. The absence of autonomous barriers in this study indicates that all identified barriers have a significant role in the implementation of benchmarking providers. Thus, ISM based model and MICMAC analysis may be considered significant assistance from this research work. Moreover, the quality enabled factors have been classified into four categories i.e. autonomous QEFs; dependent QEFs; linkage QEFs and independent QEFs by using the MICMAC analysis.

Fuzzy Graph theory (FGTA) methodology has also been used to help in investigation of important attributes for benchmarking. This is done by establishing the interdependencies of 05 attributes as dimensions and its 12 criterion pertaining to benchmarking in service industries. To convert the linguistic data for critical success factors into crisp score the 11 point scale has been used. A digraph showing the interactions among the identified attributes is developed. The digraph is then used to develop the matrix in order to quantify the proposed GTA model. Afterwards overall numerical index has been computed by using Graph Theoretic Approach (GTA), which helps to compare different alternatives of benchmarking for industries' existence.

## 5.2 DEVELOPMENT OF ISM METHODOLOGY

Interpretive structural modeling (ISM) is a well-proven and widely accepted methodology for identifying the interrelationships among the variables (Jharkharia & Shankar, 2005). It is process that helps to develop a model of complex relationships between the numerous factors involved in a multifaceted situation for analyzing the influence of one factor over the other

(Qureshi et al., 2007). More and Babu (2011) developed a hierarchical relationship model of supply chain stimuli the disruptions, problems and changes by using the ISM application to reduce weakness of stimuli. Faisal et al.,(2007) have identified barriers to risk management in supply chains for small and medium-sized enterprises and to derive the mutual relationships among them using ISM technique. Saxena and Seth (2012) used ISM to analyze the relational among the variables of industrial supply chain. Diabet et al., (2011) analyzed the interaction among some of the major barriers by ISM approach that may obstruct the implementation of third-party logistics in industries. Routroy et al., (2012) proposed a benchmarking model of supplier development through ISM approach with identification of critical success factors for Indian scenario. Singh et al., (2003) have utilized this technique for the implementation of knowledge management in engineering industries. Beside this, Raj et al., (2008) conducted a case study and applied ISM approach for modelling the enablers of flexible manufacturing system. Attri et al., (2015) applied ISM methodology in improving decision making process among executives working in different functional areas while Qureshi et al., (2007) developed a model for the logistics outsourcing relationship variables to enhance shipper's productivity and competitiveness in logistical supply chain using ISM based approach. ISM is an interactive learning process in which a set of different directly or indirectly related elements/measures are structured into a comprehensive systematic model. ISM methodology helps to impose order and direction on the complexity of relationships among elements of a system (Sage, 1977). Kumar et al., (2013) have used ISM approach for developing the relationship among the enablers of e-applications in agri-food supply chain. Joshi and Kant (2012) have applied ISM approach for understanding the dynamics between the various supply chain collaboration enablers. Toktaş-Palut et al., (2014) have utilized ISM approach for the pragmatic analysis of the influence of barriers and benefits of e-procurement on its implemented decision. Nath et al. (2013) have displayed the enablers of consumer implementation of green products using the ISM approach. Cagno et al., (2014) have established an interpretive model of professional safety performance for small and medium sized enterprises. Govindan et al., (2014) have analyzed third party converse logistics provider using the interpretive structural modelling approach. It is obvious that ISM is a qualitative tool used by a number of researchers in various environments from the literature (Goyal and Grover 2012; Pandey et al., 2005; Thakkar et al., 2007; Singh and Garg 2007; Raj

et al., 2009, Mudgal et al., 2010; Sahney et al., 2008; Chidambaranathan et al., 2009; Kannan et al.,2010; Jyoti and Deshmukh 2010; Singh et al.,2015). The various steps involved in the ISM technique are:

- Identification of elements, which are relevant to the problem or issues, this could be done by survey or any group problem solving technique.
- Establishing a contextual relationship between elements with respect to pairs of elements that will be examined.
- Developing a structural self-interaction matrix (SSIM) of elements, this indicates pair-wise relationship between elements of the system.
- Developing a reachability matrix from the SSIM, and checking the matrix for transitivity. Transitivity of the contextual relation is a basic assumption in ISM which states that if element A is related to B and B is related to C, then A is necessarily related to C.
- Partitioning of reachability matrix into different levels.
- Based on the relationships given above in the reachability matrix draw a directed graph (digraph), and remove transitive links.
- Convert the resultant digraph into an ISM, by replacing element nodes with statements.
- Review the ISM model to check for conceptual inconsistency and make the necessary modifications as required. The flow diagram of ISM methodology can be seen in figure 5.1.

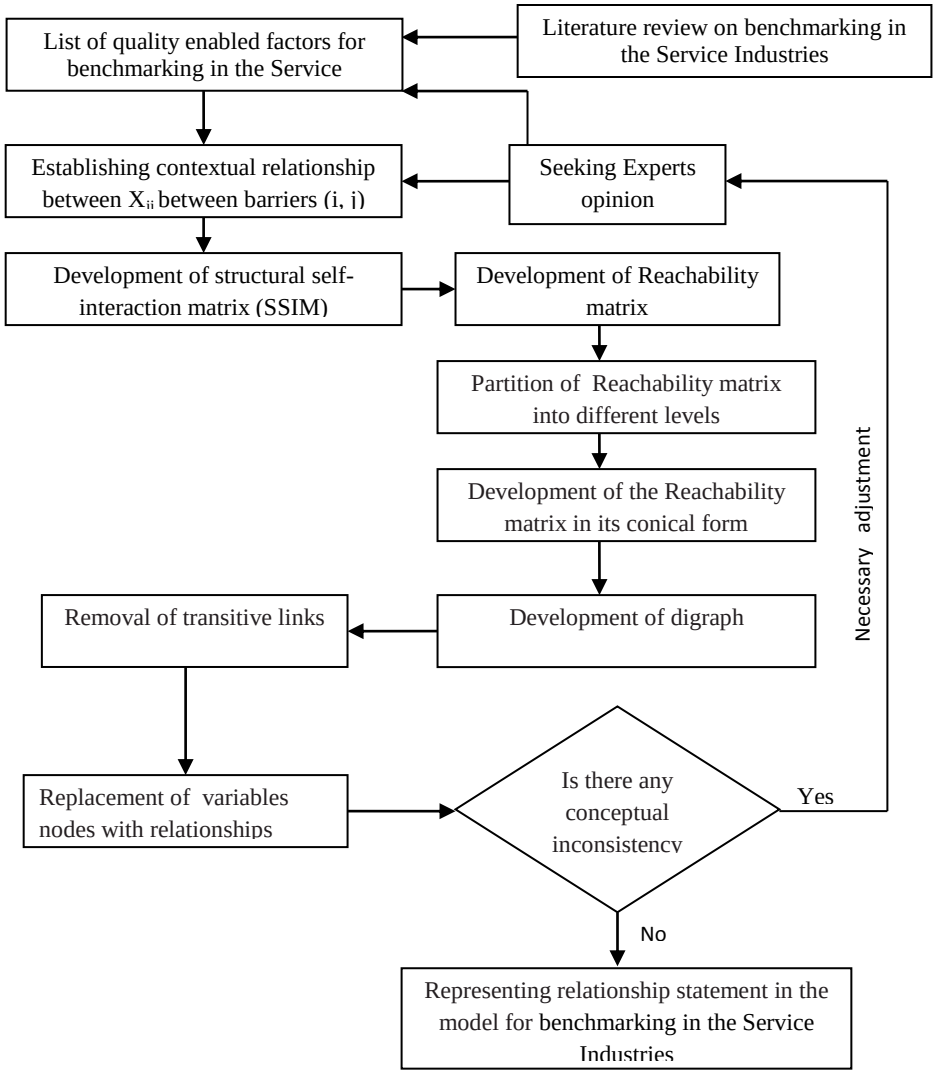


Figure 5.1 Flow diagram of ISM Model

## 5.3 FACTORS AFFECTING THE SERVICE INDUSTRIES

Through the literature review and interactions with experts, a large number of critical success factors are identified in service industries. Out of which some important factors are shown in Table 5.1, as follows:

Table 5.1 Factors with their Notations

| S. No. | Factors | Notation | Definitions |
|---|---|---|---|
| 1 | Assurance | F1 | The knowledge and courtesy of employees and their ability to convey trust and confidence |
| 2 | Empathy | F2 | The provision of caring individualized attention to customers. |
| 3 | Reliability | F3 | The ability to perform the promised service dependably and accurately |
| 4 | Responsiveness | F4 | The willingness to help customers and to provide prompt service |
| 5 | Tangibles | F5 | The appearance of physical facilities, equipment, personnel and communication materials |
| 6 | Strategic planning | F6 | Mainly involves the assessment of capabilities of the organization to meet requirements of benchmark. |
| 7 | Coordination | F7 | The subsequent linkage that occurs attitude towards quality among employees, customers and environment in any industry. |
| 8 | Knowing the Customer | F8 | It means making an effort to understand the customer's individual needs, providing individualized attention, recognizing the customer when they arrive and so on |
| 9 | Employees relations | F9 | How much emphasis does the company place on the worker’s attitude, morale, problems and effect of the system . |
| 10 | Professionalism | F10 | The combination of skill, expertise and innovation of the employees. |
| 11 | Flexibility | F11 | This covers design flexibility, volume flexibility, process operation flexibility with service. |
| 12 | Capacity utilization | F12 | It is the extent where the idle time of system is reduced. Does system facilitate greater utilization with process planning? |
| 13 | Throughput | F13 | This is an indicator of the lead time, cycle time and dispatch time of the system that will effect delivery time. |

| | | | |
|---|---|---|---|
| 14 | Process management | F14 | It is defined as the behavioural and systematic principles that are important in managing the process rather than the outcomes. |
| 15 | Awareness | F15 | The well understanding of service results in higher quality, productivity, lower costs, faster delivery, safer workplace and higher employee spirits. |
| 16 | Communication | F16 | Transfer of information between personnel and employees, the degree of interaction level of two-way communication. |
| 17 | Leadership | F17 | It establishes the unity and purpose for the internal environment of the organization and developing a vision of the future and strategies for achieving that vision. |

## 5.4 APPLICATION OF ISM METHODOLOGY FOR INDIAN SERVICE INDUSTRIES

ISM methodology suggests the application of the expert opinions based up on various management techniques in developing the contextual affiliation between the variables. Thus, identifying the contextual relationship among the quality enabled factors, four experts are selected. Experts are from the industry and academia with well conversant to benchmarking quality practices and having an experience of over 5 years. The various steps which tend to development of ISM model are discussed below.

### 5.4.1 Establishing Contextual Relationship Between Factors

The following four symbols have been used to denote the direction of the relationship between two factors (i and j): which is step one.

- V is used for the relation from factors i to factors j (i.e. if factors i influences or reaches to factors j).
- A is used for the relation from factors j to factors i (if factors j reaches to factors i).
- X is used for both direction relations (i.e. if factors i and j reach to each other).
- O is used for no relation between two factors (i.e. if factors i and j are unrelated).

### 5.4.2 Development of Structural Self-Interaction Matrix (SSIM)

The SSIM has been developed on the basis of the contextual relationship between factors. SSIM has been finalized and it is presented in Table 5.2.The following statement explains the use of symbols in SSIM:

- Symbol V is assigned to cell (1, 10) because factors 1 influence to factor 10.
- Symbol A is assigned to cell (4, 10) because factors 10 influence the factor 4.
- Symbol X is assigned to cell (2, 10) because factors 2 and 10 influence each other.
- Symbol O is assigned to cell (7, 10) because factors 7 and 10 are unrelated.

  With the help of these symbols V, A, X, and O in SSIM Table 5.2 is prepared.

Table 5.2 Structural Self-Interactive Matrix (SSIM)

| | F 17 | F 16 | F 15 | F 14 | F 13 | F 12 | F 11 | F 10 | F9 | F8 | F7 | F6 | F5 | F4 | F3 | F2 | F1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F1 | V | V | V | V | V | V | O | V | V | V | V | V | V | V | V | O | |
| F2 | O | O | V | V | O | V | O | V | V | O | O | O | O | O | O | | |
| F3 | V | V | O | V | V | V | O | V | V | O | V | V | V | V | | | |
| F4 | A | A | O | A | O | A | O | V | A | A | V | O | A | | | | |
| F5 | A | A | O | O | O | A | O | O | V | V | V | V | | | | | |
| F6 | A | V | V | V | O | V | O | V | V | V | V | | | | | | |
| F7 | A | A | O | O | V | A | O | V | A | V | | | | | | | |
| F8 | A | V | O | O | V | A | O | V | A | | | | | | | | |
| F9 | A | A | O | O | V | A | O | V | | | | | | | | | |
| F10 | A | O | A | O | O | A | A | | | | | | | | | | |
| F11 | O | O | O | O | O | O | | | | | | | | | | | |
| F12 | A | V | V | V | V | | | | | | | | | | | | |
| F13 | A | O | O | O | | | | | | | | | | | | | |
| F14 | A | O | A | | | | | | | | | | | | | | |
| F15 | O | O | | | | | | | | | | | | | | | |
| F16 | A | | | | | | | | | | | | | | | | |
| F17 | | | | | | | | | | | | | | | | | |

### 5.4.3 Development of Reachability Matrix

The next step is to develop the reachability matrix from SSIM. This transformation has been done with the following rules and shown in Table 5.3. For example, If the cell (i, j) is assigned with symbol V in the SSIM, then, this cell (i, j) entry becomes 1 and the cell (j, i) entry becomes 0 in the initial reachability matrix. Same as, If the cell (i, j) is assigned with symbol A in the SSIM, then, this cell (i, j) entry becomes 0 and the cell (j, i) entry becomes 1 in the initial reachability matrix. Now If the cell (i, j) is assigned with symbol X in the SSIM, then, this cell (i, j) entry becomes 1 and the cell (j, i) entry also becomes 1 in the initial reachability matrix. If the cell (i, j) is assigned with symbol O in the SSIM, then, this cell (i, j) entry becomes 0 and the cell (j, i) entry also becomes 0 in the initial reachability matrix.

Table 5.3 Initial Reachability Matrix

| Factors | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | F9 | F10 | F11 | F12 | F13 | F14 | F15 | F16 | F17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| F3 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| F4 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F5 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F6 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| F7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| F8 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| F9 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| F10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| F12 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| F14 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| F15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| F16 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| F17 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |

The final reachability matrix is obtained by incorporating the transitivity as enumerated in next step of the ISM methodology. This is shown in Table 5.4 where the driving power and dependence of each quality enabled factor are also shown. The driving power of a particular factor is the total number of factors (including self) and the dependence is the total number of factors which may help to achieve it. The various iterations are shown as per order wise:

Table 5.4 Final Reachability Matrix

| Factors | F 1 | F 2 | F 3 | F 4 | F 5 | F 6 | F 7 | F 8 | F 9 | F 10 | F 11 | F 12 | F 13 | F 14 | F 15 | F 16 | F 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F2 | 0 | 1 | 0 | 1* | 1* | 0 | 1* | 1* | 1 | 1 | 0 | 1 | 1* | 1 | 1 | 1* | 1* |
| F3 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1* | 1 | 1 | 0 | 1 | 1 | 1 | 1* | 1 | 1 |
| F4 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F5 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1* | 0 | 1* | 1* | 1* | 1* | 1* | 0 |
| F6 | 0 | 0 | 0 | 1 | 1* | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1* | 1 | 1 | 1 | 1* |
| F7 | 0 | 0 | 0 | 1* | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1* | 0 |
| F8 | 0 | 0 | 0 | 1 | 1* | 0 | 1* | 1 | 1* | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| F9 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1* | 0 |
| F10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| F12 | 0 | 0 | 0 | 1 | 1 | 1* | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |
| F13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| F14 | 0 | 0 | 0 | 1 | 0 | 0 | 1* | 0 | 0 | 1* | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| F15 | 0 | 0 | 0 | 1* | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| F16 | 0 | 0 | 0 | 1 | 1 | 1* | 1 | 1* | 1 | 1* | 0 | 0 | 1* | 0 | 0 | 1 | 0 |
| F17 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1* | 1 | 1 |

Table 5.5 Iteration 1

| Factors | Reachability Set | Antecedent Set | Intersection Set | Level |
|---|---|---|---|---|
| F1 | F1,F3,F4,F5,F6,F7,F8,F9, F10,F12,F13,F14,F15,F16,F17 | F1 | F1 | |
| F2 | F2,F4,F5,F7,F8,F9,F10,F12, F13,F14,F15,F16,F17 | F2 | F2 | |
| F3 | F3,F4,F5,F6,F7F8,F9,F10F12, F13,F14,F15,F16,F17 | F1,F3 | F3 | |
| F4 | F4,F7,F10 | F1,F2,F3,F4,F5,F6,F7, F8,F9,F12,F14,F15,F16,F17 | F4,F7 | |
| F5 | F4,F5,F6,F7,F8,F9,F10,F12, F13,F14,F15,F16 | F1,F2,F3,F5,F6,F8,F12 F16,F17 | F5,F6,F8,F12, F16 | |
| F6 | F4,F5,F6,F7,F8,F9,F10,F12, F13,F14,F15,F16,F17 | F1,F3,F5,F6,F12,F16, F17 | F5,F6,F12,F16, F17 | |
| F7 | F4,F7,F8,F10,F13,F16 | F1,F2,F3,F4,F5,F6,F7, F8,F9,F12,F14,F16,F17 | F4,F7,F8,F16 | |
| F8 | F4,F5,F7,F8,F9,F10,F13,F16 | F1,F2,F3,F5,F6,F7,F8, F9,F12,F16,F17 | F5,F7,F8,F9, F16 | |
| F9 | F4,F7,F8,F9,F10,F13,F16 | F1,F2,F3,F5,F6,F8,F9, F12,F16,F17 | F8,F9,F16 | |
| F10 | F10 | F1,F2,F3,F4,F5,F6,F7, F8,F9,F10,F11,F12,F14,F15, F16,F17 | F10 | **I** |
| F11 | F10,F11 | F11 | F11 | |
| F12 | F4,F5,F6,F7,F8,F9,F10,F12, F13,F14,F15,F16,F17 | F1,F2,F3,F5,F6,F12, F17 | F5,F6,F12,F17, | |
| F13 | F13 | F1,F2,F3,F5,F6,F7,F8, F9,F12,F13,F16,F17 | F13 | **I** |

| | | | | |
|---|---|---|---|---|
| F14 | F4,F7,F10,F14 | F1,F2,F3,F5,F6,F12, F14,F15,F17 | F14 | |
| F15 | F4,F10,F14,F15 | F1,F2,F3,F5,F6,F12, F15,F17 | F15 | |
| F16 | F4,F5,F6,F7,F8,F9,F10,F13, F16 | F1,F2,F3,F5,F6,F7,F8, F9,F12,F16,F17 | F5,F6,F7,F8,F9, F16 | |
| F17 | F4,F5,F6,F7,F8,F9,F10,F12, F13,F14,F15,F16,F17 | F1,F2,F3,F6,F12,F17 | F6,F12,F17 | |

Table 5.6 Iteration 2

| **Factors** | **Reachability Set** | **Antecedent Set** | **Intersection Set** | **Level** |
|---|---|---|---|---|
| F1 | F1,F3,F4,F5,F6,F7,F8,F9, F12,F14,F15,F16,F17 | F1 | F1 | |
| F2 | F2,F4,F5,F7,F8,F9,F12,F14, F15,F16,F17 | F2 | F2 | |
| F3 | F3,F4,F5,F6,F7F8,F9,F12,F 14,F15,F16,F17 | F1,F3 | F3 | |
| F4 | F4,F7 | F1,F2,F3,F4,F5,F6,F7,F8 F9,F12,F14,F15,F16,F17 | F4,F7 | **II** |
| F5 | F4,F5,F6,F7,F8,F9,F12, F14,F15,F16 | F1,F2,F3,F5,F6,F8,F12 F16,F17 | F5,F6,F8,F12, F16 | |
| F6 | F4,F5,F6,F7,F8,F9,F12, F14,F15,F16,F17 | F1,F3,F5,F6,F12, F16, F17 | F5,F6,F12,F16, F17 | |
| F7 | F4,F7,F8,F16 | F1,F2,F3,F4,F5,F6,F7,F8 ,F9,F12,F14,F16,F17 | F4,F7,F8,F16 | |
| F8 | F4,F5,F7,F8,F9,F16 | F1,F2,F3,F5,F6,F7,F8,F9 F12,F16,F17 | F5,F7,F8,F9,F1 6 | |
| F9 | F4,F7,F8,F9,F16 | F1,F2,F3,F5,F8,F9,F12, F16,F17 | F8,F9,F16 | |

| | | | | |
|---|---|---|---|---|
| F11 | F11 | F11 | F11 | **II** |
| F12 | F4,F5,F6,F7,F8,F9,F12, F14,F15,F16,F17 | F1,F2,F3,F4,F5,F6,F12, F17 | F5,F6,F12,F17, | |
| F14 | F4,F7,F14 | F1,F2,F3,F5,F6,F12,F14, F15,F17 | F14 | |
| F15 | F4,F14,F15 | F1,F2,F3,F5,F6,F12,F15, F17 | F15 | |
| F16 | F4,F5,F6,F7,F8,F9,F16 | F1,F2,F3,F5,F6,F7,F8,F9 F12,F16,F17 | F5,F6,F7,F8,F9, F16 | |
| F17 | F4,F5,F6,F7,F8,F9,F12,F4, F15,F16,F17 | F1,F2,F3,F6,F12,F17 | F6,F12,F17 | |

Table 5.7 Iteration 3

| **Factors** | **Reachability Set** | **Antecedent Set** | **Intersection Set** | **Level** |
|---|---|---|---|---|
| F1 | F1,F3,F5,F6,F7,F8,F9,F12, F14,F15,F16,F17 | F1 | F1 | |
| F2 | F2,F5,F7,F8,F9,F12,F14,F1 5,F16,F17 | F2 | F2 | |
| F3 | F3,F5,F6,F7F8,F9,F12,F14, F15,F16,F17 | F1,F3 | F3 | |
| F5 | F5,F6,F7,F8,F9,F12, F14,F15,F16 | F1,F2,F3,F5,F6,F8,F12, F16,F17 | F5,F6,F8,F12, F16 | |
| F6 | F5,F6,F7,F8,F9,F12,F14, F15,F16,F17 | F1,F3,F5,F6,F12,F16, F17 | F5,F6,F12,F1 6, F17 | |
| F7 | F7,F8,F16 | F1,F2,F3,F5,F6,F7,F8,F 9F12,F14,F16,F17 | F7,F8,F16 | **III** |
| F8 | F5,F7,F8,F9,F16 | F1,F2,F3,F5,F6,F7,F8,F 9F12,F16,F17 | F5,F7,F8,F9,F 16 | |

| | | | | |
|---|---|---|---|---|
| F9 | F7,F8,F9,F16 | F1,F2,F3,F5,F8,F9,F12, F16,F17 | F8,F9,F16 | |
| F12 | F5,F6,F7,F8,F9,F12, F14,F15,F16,F17 | F1,F2,F3,F5,F6,F12,F17 | F5,F6,F12,F17, | |
| F14 | F7,F14 | F1,F2,F3,F5,F6,F12,F14, F15,F17 | F14 | |
| F15 | F14,F15 | F1,F2,F3,F5,F6,F12,F15, F17 | F15 | |
| F16 | F5,F6,F7,F8,F9,F16 | F1,F2,F3,F5,F6,F7,F8,F9,F12,F16,F17 | F5,F6,F7,F8,F9, F16 | **III** |
| F17 | F5,F6,F7,F8,F9,F12, F14,F15,F16,F17 | F1,F2,F3,F6,F12,F17 | F6,F12,F17 | |

Table 5.8 Iteration 4

| **Factors** | **Reachability Set** | **Antecedent Set** | **Intersection Set** | **Level** |
|---|---|---|---|---|
| F1 | F1,F3,F5,F6,F8,F9,F12,F14,F15, F17 | F1 | F1 | |
| F2 | F2,F5,F8,F9,F12,F14,F15, F17 | F2 | F2 | |
| F3 | F3,F5,F6,F8,F9,F12,F14,F15, F17 | F1,F3 | F3 | |
| F5 | F5,F6,F8,F9,F12,F14,F15 | F1,F2,F3,F5,F6,F8,F12,F17 | F5,F6,F8,F12 | |
| F6 | F5,F6,F8,F9,F12,F14,F15,F17 | F1,F3,F5,F6,F12,F17 | F5,F6,F12,F17 | |
| F8 | F5,F8,F9, | F1,F2,F3,F5,F6,F8,F9,F12,F17 | F5,F8,F9 | **IV** |
| F9 | F8,F9 | F1,F2,F3,F5,F8,F9,F12,F17 | F8,F9 | **IV** |
| F12 | F5,F6,F8,F9,F12,F14,F15,F17 | F1,F2,F3,F5,F6,F12,F17 | F5,F6,F12,F17 | |

| | | | | |
|---|---|---|---|---|
| F14 | F14 | F1,F2,F3,F5,F6,F12,F14, F15,F17 | F14 | **IV** |
| F15 | F14,F15 | F1,F2,F3,F5,F6,F12,F15, F17 | F15 | |
| F17 | F5,F8,F9,F12,F14,F15, F17 | F1,F2,F3,F6,F12,F17 | F6,F12,F17 | |

Table 5.9 Iteration 5

| **Factors** | **Reachability Set** | **Antecedent Set** | **Intersection Set** | **Level** |
|---|---|---|---|---|
| F1 | F1,F3,F5,F6,F12,F15,F17 | F1 | F1 | |
| F2 | F2,F5,F12,F15,F17 | F2 | F2 | |
| F3 | F3,F5,F6,F12,F15,F17 | F1,F3 | F3 | |
| F5 | F5,F6,F12,F15, | F1,F2,F3,F5,F6,F12,F17 | F5,F6,F12, | |
| F6 | F5,F6,F12,F15,F17 | F1,F3,F5,F6,F12,F17 | F5,F6,F12,F17 | |
| F12 | F5,F6,F12,F15,F17 | F1,F2,F3,F5,F6,F12,F17 | F5,F6,F12,F17, | |
| F15 | F15 | F1,F2,F3,F5,F6,F12,F15,F17 | F15 | **V** |
| F17 | F5,F12,F15,F17 | F1,F2,F3,F6,F12,F17 | F6,F12,F17 | |

Table 5.10 Iteration 6

| **Factors** | **Reachability Set** | **Antecedent Set** | **Intersection Set** | **Level** |
|---|---|---|---|---|
| F1 | F1,F3,F5,F6,F12,F17 | F1 | F1 | |
| F2 | F2,F5,F12,F17 | F2 | F2 | |
| F3 | F3,F5,F6,F12,F17 | F1,F3 | F3 | |
| F5 | F5,F6,F12 | F1,F2,F3,F5,F6,F12,F17 | F5,F6,F12, | **VI** |
| F6 | F5,F6,F12,F17 | F1,F3,F5,F6,F12,F17 | F5,F6,F12,F17 | **VI** |
| F12 | F5,F6,F12,F17 | F1,F2,F3,F5,F6,F12,F17 | F5,F6,F12,F17, | **VI** |
| F17 | F5,12,F17 | F1,F2,F3,F6,F12,F17 | F6,F12,F17 | |

Table 5.11 Iteration 7

| Factors | Reachability Set | Antecedent Set | Intersection Set | Level |
|---|---|---|---|---|
| F1 | F1,F3,F17 | F1 | F1 | |
| F2 | F2,F17 | F2 | F2 | |
| F3 | F3,F17 | F1,F3 | F3 | |
| F17 | F17 | F1,F2,F3,F17 | F17 | **VII** |

Table 5.12 Iteration 8

| Factors | Reachability Set | Antecedent Set | Intersection Set | Level |
|---|---|---|---|---|
| F1 | F1,F3 | F1 | F1 | |
| F2 | F2 | F2 | F2 | **VIII** |
| F3 | F3 | F1,F3 | F3 | **VIII** |

Table 5.13 Iteration 9

| Factors | Reachability Set | Antecedent Set | Intersection Set | Level |
|---|---|---|---|---|
| F1 | F1 | F1 | F1 | **IX** |

Similarly, the antecedent set for a top level factors (i) will consist of that factors (i) itself and all other factors which may reach it from lower levels and any factors of a strongly connected subset involving factors (i) in the top level. As a result, the intersection of the reachability set and the antecedent set will be the same as the reachability set (Farris and Sage 1975).

Once the top level factors are identified, it is removed from consideration and other top level factors of the remaining sub graph are found. This procedure is continued till all levels of the structure are identified. These identified levels help in the development of digraph and the final model. Top level factors are positioned at the top of digraph and so on. At present the 17 factors, along with their reachability set, antecedent set, intersection set and levels are presented in Tables 5.5–5.13.

### 5.4.5 Development of Conical Matrix

In the next step, a conical matrix is developed (Table 5.14) by clubbing composed factors in the same level, across rows and columns of the final reachability matrix. The drive power of a factor is derived by summing up the number of ones in the rows and its dependence power by summing up the number of ones in the columns.

Table 5.14 Conical Matrix

| Factors | F 10 | F 13 | F 4 | F 11 | F 7 | F 16 | F 8 | F 9 | F 14 | F 15 | F 5 | F 6 | F 12 | F 17 | F 2 | F 3 | F 1 | Driver Power |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F10 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| F13 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| F4 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| F11 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| F7 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| F16 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| F8 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 8 |
| F9 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| F14 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| F15 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| F5 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 12 |
| F6 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 13 |
| F12 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 13 |
| F17 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 13 |
| F2 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 13 |
| F3 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 14 |
| F1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 15 |
| Dependence Power | 16 | 13 | 14 | 1 | 13 | 11 | 12 | 10 | 9 | 8 | 9 | 7 | 7 | 6 | 1 | 2 | 1 | |

Next, drive power and dependence power ranks are calculated by giving highest ranks to the factors that have the maximum number of one in the rows and columns respectively.

### 5.4.6 Development of Digraph

Based on the conical matrix, an initial digraph including transitivity links is obtained. This is generated by nodes and lines of edges. After removing the indirect links, a final digraph is developed. In this development, the top level factors are positioned at the top of the digraph and second level factors are placed at second position and so on, until the bottom level is placed at the lowest position in the digraph.

### 5.4.7 Development of ISM Model

Next, the digraph is converted into an ISM model by replacing nodes of the elements with statements as shown in Figure 5.2.

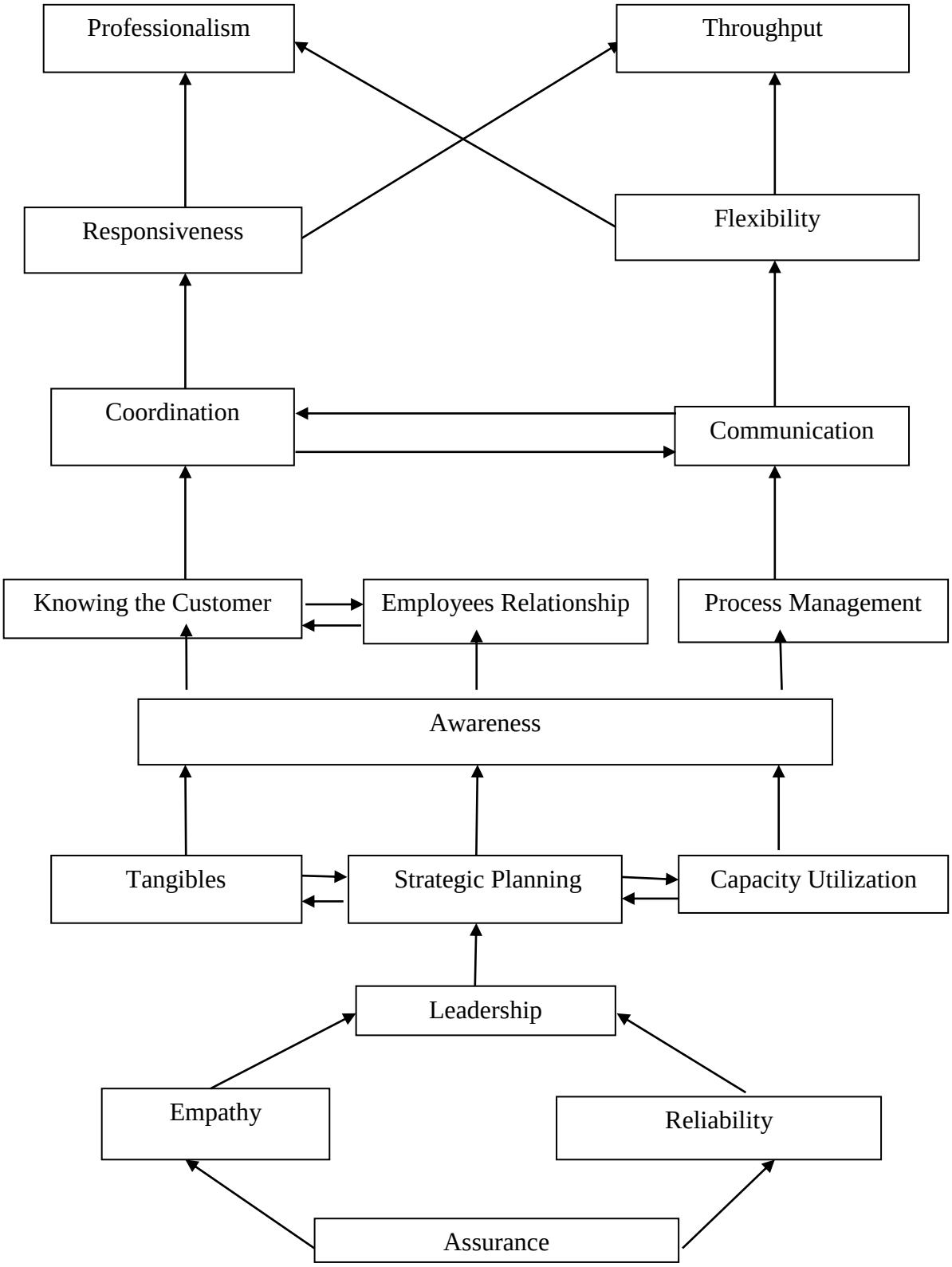


Figure 5.2 ISM Model Benchmarking attributes

## 5.5 MICMAC ANALYSIS

It is called the Matriced Impacts Croises Multiplication Appliqueeaun Classement or Cross Impact Analysis, developed by Michel Godet in 1975. The objective of the MICMAC analysis is to analyze the driver power and the dependence power of the variables. MICMAC analysis helps in the classification of factors and to identify the key factors that drive the system in various categories.

**Driving Power**

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | |
| 15 | F1 | | | | | | | | | | | | | | | | |
| 14 | | F3 | | | | | | | | | | | | | | | |
| 13 | F2 | | | | | F17 | F6, F12 | | | | | | | | | | |
| 12 | | | **IV** | | | | | | | | | **III** | | | | | |
| 11 | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | F16 | F5 | | | | | |
| 8 | | | | | | | | | | | | F8 | | | | | |
| 7 | | | | | | | | | | F9 | | | | | | | |
| 6 | | | | | | | | | | | | | F7 | | | | |
| 5 | | | | | | | | | | | | | | F4 | | | |
| 4 | | | **I** | | | | | F15 | F14 | | | **II** | | | | | |
| 3 | | | | | | | | | | | | | | | | | |
| 2 | F11 | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | F13 | | | F10 | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |

**Dependence Power**

Figure 5.3 Clusters of factors in the Service sector

The variables are classified into four clusters:

The first cluster consists of the autonomous variables that have weak driver power and weak dependence. These variables are relatively disconnected from the system, with which they have only few links, which may be strong. Second cluster consists of the dependent variables that have weak driver power but strong dependence.

Third cluster has the linkage variables that have strong driving power and also strong dependence. These variables are unstable in the fact that any action on these variables will have an effect on others and also a feedback on themselves.

Fourth cluster includes the independent variables having strong driving power but weak dependence. In this analysis the dependence power is shown on the abscissa and driving power on the ordinate. Each factor is shown on the graph against its driving and dependence power based on the final reachability matrix. Figure 5.3, is being utilized for the purpose of MICMAC analysis. This is divided into four sections and the section at the bottom left consists of autonomous factors. The bottom right section consists of dependence factors. The top right and left sections consists of linkage and independent factors respectively

It is observed that a variable with a very strong driving power called the key variables, falls into the category of independent or linkage variables. The driving power and the dependence of each of these variables are identifies the key factors on which management should focus for the service sector. The factors can be classified as follows;

- **Autonomous factors** are Flexibility and Awareness. These factors have weak drive power and weak dependence power.
- **Dependent factors** are Responsiveness, Coordination, Knowing the Customer, Employees relationship, Professional, Throughput, Process management.
    - These factors are weak drivers but strongly depend on one another.
    - The management should therefore accord high priority in tackling these factors.
    - Besides tackling these factors, management should also understand the dependence of these factors on other level factors in the ISM.
- **Linkage factors** are Tangibles and Communication.
    - They have strong driving power as well as high dependencies.
    - The regular meetings of the managers and employees on the related issues may help in overcoming these factors.
- **Independent factors** are Assurance, Empathy, Capacity Utilization, Reliability, Strategic planning, Leadership.
    - They have strong driving power and weak dependency on other factors.

- To manage these factors a comprehensive strategic plan should to be initiated to achieve success.

### 5.5.1 Evaluation of Competitiveness Index (CI)

For competitiveness index, the mean scores with their ranks have been found from the literature outcomes. Subsequent to these ranks, inverse ranks and weights for each measure are found. For conveying weights to dissimilar measures of CI, the likert scale values of five points are taken where 5 for maximum and 1 for minimum correspondingly. For each of the factors, a weight is assigned. The criteria for weight ($W_i$) is as follows:

- $W_i$ = +1 (Strong) when percentage score > 60%, (mean value > 4)
- = 0 (Neutral) when percentage score is between 40 - 60%, (mean value between 3 and 4)
- = – 1 (Weak) when percentage score < 40%, (mean value < 3).

This framework was given by Cleveland et al., (1989) is Cj = Sum [Wi Log Ki]. Chand et al., (2015) used this method for analyzing the operational risks in supply chain. Sum of entries for last column (Wi Log Ki) will give the value 2.42 overall value of CI. Theoretically, CI value may range between –6.52 to +6.52. Computation of CI for this study is illustrated with the help of a worksheet as shown in below table.

Table 5.15 Measurement of Competitiveness Index

| S. No. | Factors of Benchmarking | Mean | Rank | Inverse Rank($K_i$) | Log $k_i$ | Weights($W_i$) | Wi X log Ki |
|---|---|---|---|---|---|---|---|
| 1 | Assurance | 4.37 | 1 | 17 | 1 | +1 | 1 |
| 2 | Empathy | 4.23 | 2 | 16 | 0.95 | +1 | 0.95 |
| 3 | Reliability | 4.12 | 3 | 15 | 0.90 | +1 | 0.90 |
| 4 | Responsiveness | 4.01 | 4 | 14 | 0,85 | +1 | 0.85 |
| 5 | Tangibles | 3.84 | 5 | 13 | 0.77 | 0 | 00 |
| 6 | Strategic planning | 3.70 | 6 | 12 | 0.71 | 0 | 00 |
| 7 | Coordination | 3.53 | 7 | 11 | 0.65 | 0 | 00 |
| 8 | Knowing the | 3.39 | 8 | 10 | 0.60 | 0 | 00 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Customer | | | | | | |
| 9 | Employees relations | 3.22 | 9 | 9 | 0.48 | 0 | 00 |
| 10 | Professionalism | 3.09 | 10 | 8 | 0.39 | 0 | 00 |
| 11 | Flexibility | 2.94 | 11 | 7 | 0.28 | -1 | -0.28 |
| 12 | Capacity utilization | 2.72 | 12 | 6 | 0.27 | -1 | -0.27 |
| 13 | Throughput | 2.51 | 13 | 5 | 0.20 | -1 | -0.20 |
| 14 | Process management | 2.47 | 14 | 4 | 0.17 | -1 | -0.17 |
| 15 | Awareness | 2.35 | 15 | 3 | 0.14 | -1 | -0.14 |
| 16 | Communication | 2.29 | 16 | 2 | 0.12 | -1 | -0.12 |
| 17 | Leadership | 2.09 | 17 | 1 | 0.10 | -1 | -0.10 |

## 5.6 APPLICATION OF FUZZY GRAPH THEORY (FGTA) METHODOLOGY

Application of Fuzzy Graph theory (FGTA) methodology has been used to help in investigation of important attributes of benchmarking. This is done by establishing the interdependencies of 05 attributes as dimensions and its 12 criterion pertaining to benchmarking in service industries. To convert the linguistic data for critical success factors into crisp score the 11 point scale has been used. A digraph showing the interactions among the identified attributes is developed. The digraph is then used to develop the matrix in order to quantify the proposed GTA model. Afterwards overall numerical index has been computed by using Graph Theoretic Approach (GTA), which helps to compare different alternatives of benchmarking for industries' existence.

Graph theoretic model consists of five strategic attributes namely Tangibles; Responsiveness; Reliability; Assurance and Empathy. By utilizing these 05 attributes, benchmarking quality index has been proposed for Indian service industries. Literature survey found that the evaluation of effectiveness of benchmarking in service industries is a complex task, as it involves large numbers of tangible and intangible factors. In this context, an endeavour has been made to develop a model by using graph theoretic approach (GTA) which quantifies the

various factors and gives a single numerical index for the evaluation. The relative importance among the various factors has been quantified using 11 point fuzzy scale (Chen and Hwang, 1992).

Table 5.16 Dimensions of Service Quality

| **Dimensions** | **Criterion** | **Definitions** |
|---|---|---|
| Tangibles | Building layout | Aesthetic, being convenient of the Industry and area required |
| | Equipment | The availability of machinery used in the system achieving to rate |
| Responsiveness | Timeliness | Ability to provide operations and promised service and quality on time |
| | Completeness | The availability of all kind of services perfectness at time |
| | Willingness | Helping employees willingly and completing requirements |
| Reliability | Accuracy | It is the consistency given information regarding dimensions and service rate |
| | Expertise | Authority of staff providing reliability to be specialized |
| | Image | Creating good vision to staff and maintain it |
| | Security | Protection of every type of system data |
| Assurance | Salary/rewards | Favourable payment at time and regard with money |
| | Courtesy | Courtesy of personnel and their ability to inspire trust and confidence |
| | Compensation | To give guaranty to the employees in case of a problem |
| Empathy | Caring | Individualized service attention & understanding needs of employees |
| | Manner | The attitude of personnel in the department setting |
| | Communication | Transfer of information between personnel and employees, the degree of interaction level of two-way communication |

Modified from Ravi.S and W.Fisher (2002)

### 5. 6. 1 Graph Theoretic Approach

Graph theoretic and matrix model consists of digraph representation, matrix representation and permanent representation. It is a dominant technique to calculate single numerical index for evaluation of critical factors pertaining to a problem in any field. Grover et al., (2004, 2006) have applied Graph theory for TQM evaluation of an industry and to find the role of human factors in TQM. Various other applications of GTA have been identified by different authors in different areas, such as robot selection (Agrawal et al.,1991), failure cause analysis (Gandhi and Agrawal,1996), maintainability index for mechanical systems (Wani and Gandhi, 1999), machinability evaluation of work materials (Rao and Gandhi, 2002), capability envelop of a machining process (Huang and Yip-Hoi,2003), performance evaluation of TQM in Indian industries (Kulkarni,2005), identification and comparison of industrial robots (Rao and Padmanabhan,2006), optimization of single product flow-line for RMS (Dou et al., 2009), quality modelling and analysis of electroplating system (Kumar et al.,2011), critical factors for web service (Saha et al., 2011) and identification of factors for supply chain (Gupta & Singh,2014).The Main purpose of using Graph Theortic Approach as:

- It is a tool which is used to calculate the single numerical index for any issue.
- It also converts the intangible issues into tangible, i.e. quantifies the subjective issues.
- It helps to compare the different alternatives on the basis of the single numerical index.

The overall numerical index of the evaluation model will help the managers to compare different alternatives objectively. The proposed evaluation model based on GTA will not only minimize time and decision efforts but extend the decision maker's perception of the decision situation. This model will help to sustain the decision maker in solving structured, semi structured and unstructured problems.

### 5.6.2 Attribute Digraph

As per GTA, a digraph can be made to show the attributes and their interdependencies within the system. A graph with directed edges is known as digraph (shown in figure 2). The nodes in the evaluation digraph signify the qualitative measure of the attributes ($Di$'s) and edges show the interdependencies of the attributes ($Dij$'s). The digraph consists of a set of nodes $V = \{Vi\}$, $i = 1, 2, 3, \ldots M$ and set of directed edges $D = \{Dij\}$. A node $Vi$ represents the $i$th

qualitative attribute and the edges represent the relative importance among them. The number of nodes represents the total number of attributes considered for the evaluation of the AMT. If a node '*I*' shows the relative importance over node '*j*', then a directed edge is drawn from node '*I'* to node '*j*' (*Dij*). Similarly if node '*j*' shows relative importance over node '*i*' then a directed edge is drawn from node '*j*' to node '*i*' (i.e., *Dji*).

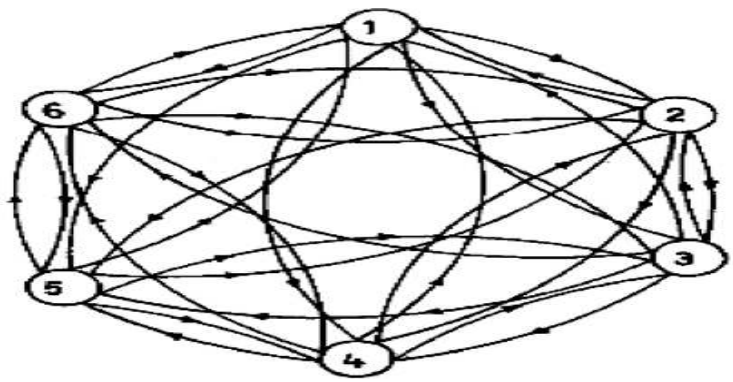


Figure 5.4 Attribute digraph

### 5.6.3 Matrix Representation of Attribute Digraph

Since the digraph representation provides visual analysis for the factors which becomes more complex to comprehend in case of large one. Moreover, for mathematical analysis its digraph should be represented in the matrix form. The matrix represents all attributes and their interrelations. Hence, the matrix called as evaluation attribute matrix (EAM) and discussed in below equation.

$$A = \begin{array}{c} Attributes \\ 1 \\ 2 \\ 3 \\ - \\ - \\ N \end{array} \begin{array}{c} \begin{array}{cccccc} 1 & 2 & 3 & - & - & N \end{array} \\ \begin{bmatrix} D_1 & a_{12} & a_{13} & - & - & a_{1N} \\ a_{21} & D_2 & a_{23} & - & - & a_{2N} \\ a_{31} & a_{32} & D_3 & - & - & a_{3N} \\ - & - & - & - & - & - \\ - & - & - & - & - & - \\ a_{N1} & a_{N2} & a_{N3} & - & - & D_N \end{bmatrix} \end{array} \qquad 1$$

Here in this matrix, '*Di*' represents the *i*th evaluation attribute represented by the node '*Vi*'. '*Dij*' represents the relative importance among the attributes and is represented by the edge

drawn from '*i*' to '*j*' in the digraph. The determinant of this matrix will give valuable information regarding the evaluation of attributes but it will contain negative terms, so some useful information will be lost. To solve this problem, researchers have used permanent function of the matrix. The only difference between determinant and permanent function is in the signs of the coefficients. Where determinant has both negative and positive signs in the terms, there only positive signs appear in the permanent function which ensures that complete objective for the evaluation of the attribute is fulfilled and no information is lost. The adjacency matrix, incidence matrix and characteristic matrix could be used but these have their own drawbacks.

### 5.6.4 Permanent Function of Attribute Matrix

The permanent function of the attribute matrix is represented as Per (A). It contains N! Terms as shown below the sigma form of the permanent function for six attributes. Where per (A), is permanent function of attribute matrix.

$$
\begin{aligned}
per\ A = \prod_{i=1}^{6} D_i &+ \sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{ji}) D_k D_l D_m D_n \\
&+ \sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{jk} a_{ki} + a_{ik} a_{kj} a_{ji}) D_l D_m D_n \\
&+ [(\sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{ji})(a_{kl} a_{lk}) D_m D_n \\
&+ \sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{jk} a_{kl} a_{li} + a_{il} a_{lk} a_{kj} a_{ji}) D_m D_n)] \\
&+ [\sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{ji})(a_{kl} a_{lm} a_{mk} + a_{km} a_{ml} a_{lk}) D_n \\
&+ \sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{jk} a_{kl} a_{lm} a_{mi} + a_{im} a_{ml} a_{lk} a_{kj} a_{ji}) D_n] \\
&+ [\sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{ji})(a_{kl} a_{lm} a_{mn} a_{nk} + a_{kn} a_{nm} a_{ml} a_{lk}) \\
&+ \sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{jk} a_{kl})(a_{lm} a_{mn} a_{nl}) \\
&+ \sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{ji})(a_{kl} a_{lk})(a_{mn} a_{nm}) \\
&+ \sum_i \sum_j \sum_k \sum_l \sum_m \sum_n (a_{ij} a_{jk} a_{lm} a_{mn} a_{ni} + a_{in} a_{nm} a_{ml} a_{lk} a_{kj} a_{ji}]
\end{aligned}
\qquad 2
$$

In these function, total ($n$ + 1) i.e. (6 + 1) groupings have been made. These groups represent the measure of attributes and the relative importance. Here, total 07 groups have been made and their importance is discussed below.

1. The first grouping represents the measures of inheritance level of implementation factors.

2. The second grouping is absent as there is no self-loop in the digraph.

3. The third grouping contains interrelationships between the sub factors (i.e., *aij aji*) and measures of four remaining factors.

4. The fourth grouping represents a set of three factors relative importance loop and measure of three factors.

5. The fifth grouping contains two sub groups. The terms of the first subgroup represent the relative importance among the two factors and the measure of two implementation factors. The second subgroup contains the relative importance among the four factors and the measure of the two implementation factors.

6. The sixth grouping contains two sub groups and the first sub grouping is set of two factor's interdependence, i.e., $a_{ij}\, a_{ji,}$ a set of three factor interdependence, i.e., $a_{kl}\, a_{lm}\, a_{mk}$ or its pair $a_{km}$ $a_{ml}\, a_{lk}$ and measure of remaining implementation factor. The second sub-grouping is a set of five implementation factors interdependence, i.e., $a_{ij}\, a_{jk}\, a_{kl}\, a_{lm}\, a_{mi}$ or its pair $a_{im}\, a_{ml}\, a_{lk}\, a_{kj}\, a_{ji}$ and measure of remaining implementation factor.

7. Similarly, seventh grouping analyses sub-grouping in terms of a set of two and four behavioural factor interdependence, 2-three behavioral factor interdependence, 3-two behavioural factor interdependence and six implementation factors interdependence.

### 5.6.5 Numerical Evaluation Index of Attribute Matrix

Numerical evaluation index as defined in the equation (2) is used for evaluation and contains all the attributes and their relative importance. The numerical value of the permanent function gives the overall numerical evaluation index. The permanent function contains only positive values, so higher the value of the inheritance level (*Di*) and the relative importance (*Dij*), higher will be the value of numerical evaluation index. To get the appropriate value of the numerical evaluation index, value of *Di* and *Dij* should be chosen judiciously through detailed discussions by the practitioners. As pointed out earlier, numerical evaluation index may mislead if the values of attributes (*Di*) and their relative importance (*Dij*) are imperfectly assumed or any important attribute has been left out.

## 5.7 FUZZY NUMBERS

Fuzzy set theory was developed by Professor Zadeh in 1965 and the origin of the study was due to the need for a flexible method that could express imprecise, ambiguous and even badly defined quantities, which can reconcile a mathematical model and human knowledge. Tsai et al. (2008) consider that the major contribution of fuzzy set theory is its capability of representing indistinguishable data. The presented numerical approximation technique systematically converts linguistic terms into fuzzy numbers. The method used here is proposed by Chen and Hwang in 1992. The linguistic intangible factors are converted into triangular fuzzy numbers. The reason of using triangular fuzzy numbers is because of their computational simplicity, useful in promoting representation and information processing in a fuzzy environment. An 11-point scale is proposed in this paper for representation of the qualitative attribute. In fuzzy situation, we do not have the complete information of the system. Table 5.17 is suggested which represents the intangible factors on a qualitative scale using fuzzy logic, corresponding to the fuzzy conversion scale and helps the users in assigning the values.

Table 5.17 Conversion of Fuzzy Numbers into Crisp Score on 11- Point Scale

| **Linguistic Terms** | **Fuzzy Numbers** | **Crisp Score** |
|---|---|---|
| Exceptionally low | M1 | 0.045 |
| Extremely low | M2 | 0.135 |
| Very low | M3 | 0.255 |
| Low | M4 | 0.335 |
| Below normal | M5 | 0.410 |
| Normal | M6 | 0.500 |
| Above normal | M7 | 0.590 |
| High | M8 | 0.665 |
| Very High | M9 | 0.745 |
| Extremely High | M10 | 0.865 |
| Exceptionally High | M11 | 0.955 |

Once a qualitative attribute is represented on a scale, the alternatives can be compared with each other in the same manner as that for quantitative attributes. The fuzzy numbers are converted into crisp score with conversion of linguistic terms into fuzzy numbers. The relative importance among the attributes can also be described on the 11-point scale and is shown in Table 5.18.

Table 5.18 Conversion of Fuzzy Numbers into Crisp Score for Relative Importance

| **Linguistic Terms** | **Fuzzy Numbers** | **Crisp Score** |
|---|---|---|
| One attribute is exceptionally less important than the other | M1 | 0.045 |
| One attribute is extremely less important less than the other | M2 | 0.135 |
| One attribute is very less important than the other | M3 | 0.255 |
| One attribute is less important than the other | M4 | 0.335 |
| One attribute is slightly less than the other | M5 | 0.410 |
| Two attribute are equally important than the other | M6 | 0.500 |
| One attribute is slightly more important than the other | M7 | 0.590 |
| One attribute is more important than the other | M8 | 0.665 |
| One attribute is much more important than the other | M9 | 0.745 |
| One attribute is extremely more important than the other | M10 | 0.865 |
| One attribute is exceptionally more important than the other | M11 | 0.955 |

By choosing the appropriate values of *Di* (diagonal values) and *Dij* (off diagonal values representing the interrelationships among the attributes) and putting them in the equation (2), numerical evaluation index can be found. With this numerical index, the different systems can be arranged in the increasing or decreasing order. The highest numerical index for a given system will be the best choice. Since, the GTA is adopted then it can incorporate more number of attributes during the modelling and matrix representation of the systems. It becomes easier to upgrade such systems with modifications in the attribute constraints represented in matrix form. The GTA evaluates the single numerical index which takes into account all the qualitative measures of the attributes and their interdependencies. The various

steps of the proposed approach which would be obliged in evaluation of service industry are enlisted in a sequential manner as below:

•Identify the various attributes of service quality which affects the service industry. This step is the most prominent as wrong choice or not considering the imperative attributes may lead to delusion.

•A survey has been done in Indian service industries to find the relative importance among the attributes on 11 point fuzzy scale which helps to establish the relative importance among the attributes on the basis of expert's opinion.

•The digraph has been developed between the factors and attributes or the characteristics depending upon their interdependencies.

•The variable permanent function matrix has been computed on the basis of digraph.

•Using the logical values of the evaluation measures their interdependencies and the permanent functions has been identified for the system.

•Evaluation of the permanent function at the macro level. This permanent has been obtained by analyzing, retrieving and processing the evaluation data of the service quality system without losing any information as per the combinatorial practices of graph theory.

The alternatives chosen for the service system which are Tangibles services, Responsiveness, Reliability, Assurance and Empathy are the different variants of service quality (Kang & James 2002). Respondents have been asked to indicate the importance of evaluation attributes on the 11 point scale in general and with respect to different alternatives.

Ranking so received in Table 5.19 is converted into crisp score by using Table 5.17. For example Quality attribute has got twelfth ranking which is the highest rank among the attributes, so a crisp score of 0.955 is assigned which represents exceptionally high attribute, the same way other attributes have been assigned the crisp score. This is shown in the last column of Table 5.20.

Table 5.19 List of Attributes

| Factors | Descriptions |
|---|---|
| [FLX] | Flexibility: This covers design flexibility, volume flexibility, process operation flexibility with service. |
| [QUL] | Quality: This is an indicator of the quality of the product. Will it conform to the required specifications and tolerances? |
| [TNF] | Technical feasibility: Is the system capable of producing the product to the required specifications? Can it handle the large jobs precisely? |
| [MKP] | Market position: This is an indicator of the competition faced, the price sensitivity, the customer requirements and the product mix. |
| [CUS] | Customer feedback: This is an indicator of the industry towards quality and reliability feedback, which will help to improve quality outcome. |
| [DLT] | Delivery Time: Is time between order placed and goods to deliver at the customer end that will improve customer relations. |
| [TPT] | Throughput: This is an indicator of the lead time, cycle time and dispatch time of the system that will effect delivery time. |
| [STP] | Strategic Planning: Mainly involves the assessment of capabilities of the organization to meet requirements of benchmark. |
| [IFO] | Information: How efficiently information and statistics regarding the state of production &requirements are processed and supplied to the management? |
| [CPU] | Capacity utilization: To what extent is the idle time of system reduced? Does system facilitate greater utilization with production and process planning? |
| [EMR] | Employee relations: How much emphasis does the company place on the worker's attitude, morale and problems? How will the system effect? |
| [HUF] | Human factors: How does it compare with other system in terms of safety and ergonomics, i.e. in terms of efficiency and convenience of the workers? |

Table 5.20 Descriptive Statistics and Ranking Order of Attributes

| Attributes (i) | Mean (Xi) | Sd | Ranking | Crisp Score |
|---|---|---|---|---|
| QUL | 10.4074 | 0.61198 | 12 | 0.955 |
| FLX | 8.7407 | 1.06227 | 11 | 0.865 |
| TPT | 8.5463 | 1.20268 | 10 | 0.745 |
| CPU | 7.6111 | 1.19839 | 9 | 0.665 |
| STP | 7.0185 | 1.26033 | 8 | 0.590 |
| DLT | 6.0185 | 0.82009 | 7 | 0.500 |
| MKP | 5.2037 | 1.16618 | 6 | 0.410 |
| TNF | 4.1389 | 0.81411 | 5 | 0.335 |
| CUS | 3.4722 | 0.71641 | 4 | 0.255 |
| EMR | 2.5463 | 0.71544 | 3 | 0.135 |
| HUF | 2.4074 | 0.79763 | 2 | 0.045 |
| IFO | 2.0741 | 0.85055 | 1 | 0.045 |

## 5.8 RELATIVE IMPORTANCE AMONG ATTRIBUTES

Relative importance among the attributes has been established on the basis of their ranking received. To compare the two attributes, firstly their corresponding means are subtracted. For example, to compare *flexibility (FLX)* with *quality (QUL)*, their corresponding means (8.74, 10.40) are subtracted, which gives –1.6 value and other values are shown in Table 5.21, where negative sign indicates that the first attribute is less valuable than the other.

Table 5.21 Pairwise Differences of Mean Between Two Attributes

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLX (1) | 0 | -1.6 | 4.6 | 3.5 | 5.2 | 2.7 | 0.2 | 1.7 | 6.6 | 1.1 | 6.1 | 6.3 |
| QUL (2) | 1.6 | 0 | 6.2 | 5.2 | 6.9 | 4.3 | 1.8 | 3.3 | 8.3 | 2.7 | 7.8 | 8 |
| TNF(3) | -4.6 | -6.2 | 0 | -1.0 | 0.6 | -1.8 | -4.4 | -2.8 | 2.0 | -3.4 | 1.5 | 1.7 |
| MKP (4) | -3.5 | -5.2 | 1.0 | 0 | 1.7 | -0.8 | -3.3 | -1.8 | 3.1 | -2.4 | 2.6 | 2.7 |
| CUS(5) | -5.2 | -6.9 | -0.6 | -1.7 | 0 | -2.5 | -5.0 | -3.5 | 1.3 | -4.1 | 0.9 | 1.0 |
| DLT (6) | -2.7 | -4.3 | 1.8 | 0.8 | 2.5 | 0 | -2.5 | -1 | 3.9 | -1.5 | 3.4 | 3.6 |
| TPT (7) | -0.1 | -1.8 | 4.4 | 3.3 | 5.0 | 2.5 | 0 | 1.5 | 6.4 | 0.9 | 6 | 6.1 |
| STP (8) | -1.7 | -3.3 | 2.8 | 1.8 | 3.5 | 1 | -1.5 | 0 | 4.9 | -0.5 | 4.4 | 4.6 |
| IFO (9) | -6.6 | -8.3 | -2.0 | -3.1 | -1.3 | -3.9 | -6.4 | -4.9 | 0 | -5.5 | -0.4 | -0.3 |
| CPU(10) | -1.1 | -2.7 | 3.4 | 2.4 | 4.1 | 1.5 | -0.9 | 0.5 | 5.5 | 0 | 5.0 | 5.2 |
| EMR (11) | -6.1 | -7.8 | -1.5 | -2.6 | -0.9 | -3.4 | -6 | -4.4 | 0.4 | -5.0 | 0 | 0.1 |
| HUF(12) | -6.3 | -8 | -1.7 | -2.7 | -1.0 | -3.6 | -6.1 | -4.6 | 0.3 | -5.2 | -0.1 | 0 |

Similarly, the difference of means has been calculated for each pair. Difference of means give the idea about how much one attribute is important than the other. To assign the crisp score for each comparison and to defuzzify the information, the differences of means are divided into 11 ranges on the 11 point scale as shown in Table 5.21. For example the difference of means between *flexibility (FLX)* and *quality (QUL)* is –1.6, which is assigned crisp score 0.410 as per Table 5.22.

Table 5.22 Mean Ranges on 11 Point Scale from Table 5.20 Modification

| **Linguistic Terms** | **Fuzzy Numbers** | **Mean Range** | **Crisp Score** |
|---|---|---|---|
| One attribute is exceptionally less important than other | M1 | -7.5 to -9 | 0.045 |
| One attribute is extremely less important less than other | M2 | -6 to -7.5 | 0.135 |
| One attribute is very less important than the other | M3 | -4.5 to -6 | 0.255 |
| One attribute is less important than the other | M4 | -3 to -4.5 | 0.335 |

| | | | |
|---|---|---|---|
| One attribute is slightly less important than the other | M5 | -1.5 to -3 | 0.410 |
| Two attribute are equally important than the other | M6 | -1.5 to1.5 | 0.500 |
| One attribute is slightly more important than the other | M7 | 1.5 to 3 | 0.590 |
| One attribute is more important than the other | M8 | 3 to 4.5 | 0.665 |
| One attribute is much more important than the other | M9 | 4.5 to 6 | 0.745 |
| One attribute is extremely more important than other | M10 | 6 to 7.5 | 0.865 |
| One attribute is exceptionally more important than other | M11 | 7.5 to 9 | 0.955 |

Table 5.23 Relative Importance with Crisp Score by using Table 5.21

| **Factors** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLX (1) | 0 | 0.41 | 0.665 | 0.665 | 0.745 | 0.59 | 0.5 | 0.59 | 0.865 | 0.5 | 0.865 | 0.865 |
| QUL (2) | 0.59 | 0 | 0.865 | 0.745 | 0.865 | 0.665 | 0.59 | 0.665 | 0.955 | 0.59 | 0.955 | 0.955 |
| TNF(3) | 0.335 | 0.135 | 0 | 0.5 | 0.5 | 0.41 | 0.335 | 0.41 | 0.59 | 0.335 | 0.59 | 0.59 |
| MKP (4) | 0.335 | 0.255 | 0.5 | 0 | 0.59 | 0.5 | 0.335 | 0.41 | 0.665 | 0.41 | 0.59 | 0.59 |
| CUS(5) | 0.255 | 0.135 | 0.5 | 0.41 | 0 | 0.41 | 0.255 | 0.335 | 0.5 | 0.335 | 0.5 | 0.5 |
| DLT (6) | 0.59 | 0.335 | 0.59 | 0.5 | 0.59 | 0 | 0.41 | 0.5 | 0.665 | 0.41 | 0.665 | 0.665 |
| TPT (7) | 0.5 | 0.41 | 0.665 | 0.665 | 0.745 | 0.59 | 0 | 0.59 | 0.865 | 0.5 | 0.865 | 0.865 |
| STP (8) | 0.41 | 0.335 | 0.59 | 0.59 | 0.665 | 0.5 | 0.41 | 0 | 0.745 | 0.5 | 0.665 | 0.745 |
| IFO (9) | 0.135 | 0.045 | 0.41 | 0.335 | 0.5 | 0.335 | 0.135 | 0.255 | 0 | 0.255 | 0.5 | 0.5 |
| CPU(10) | 0.5 | 0.41 | 0.665 | 0.59 | 0.665 | 0.59 | 0.5 | 0.5 | 0.745 | 0 | 0.745 | 0.745 |
| EMR(11) | 0.135 | 0.045 | 0.41 | 0.41 | 0.5 | 0.335 | 0.135 | 0.335 | 0.5 | 0.255 | 0 | 0.5 |
| HUF (12) | 0.135 | 0.045 | 0.41 | 0.41 | 0.5 | 0.335 | 0.135 | 0.335 | 0.5 | 0.255 | 0.5 | 0 |

## 5.9 EVALUATION ATTRIBUTE DIGRAPH

Towards, first step to GTA as discussed before the digraph for evaluation of attributes is made which is shown in figure 5.5

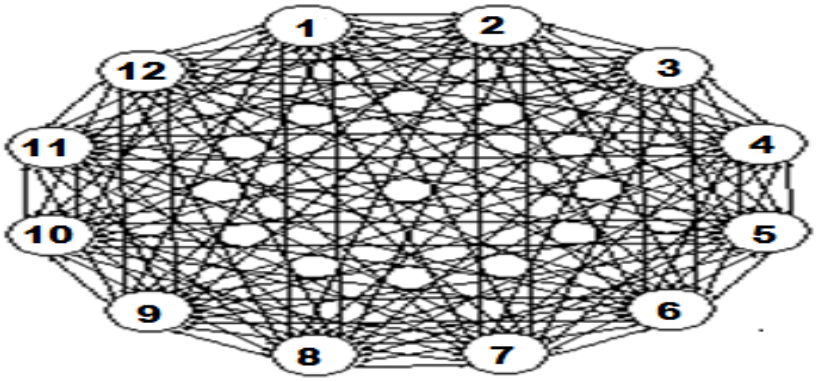


Figure 5.5 Digraph for attributes evaluation

### 5.9.1 Evaluation Attribute Matrix (EAM)

As stated in above section for mathematical evaluation, the evaluation attribute matrix system is formed from the digraph. Order of the matrix is the number of attributes responsible for evaluation of the system. The diagonal elements of this matrix are the inheritance values of the system evaluation attributes and the off diagonal elements are the relative importance among the attributes.

### 5.9.2 Calculation of Permanent Function

The evaluation permanent function or overall numerical index is represented as:

ASEPF = per (A), where A = attribute matrix

The expended form of the above equation in terms of various groupings and sub-groupings has been given in appendix and explanation of each term has also been done in appendix.

Table 5.24 Descriptive Statistics and Ranking Order of the Attributes w.r.t. Alternatives

| Factors | TS (α=0.82) | | | RSP (α=0.78) | | | RLB (α=0.76) | | | ASR (α=0.82) | | | EMY (α=0.76) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{X}$ | SD | R | $\bar{X}$ | SD | R | $\bar{X}$ | SD | R | $\bar{X}$ | SD | R | $\bar{X}$ | SD | R |
| FLX | 2.12 | 0.89 | 3 | 8.53 | 0.63 | 9 | 4.97 | 1.13 | 2 | 5.59 | 1.18 | 12 | 1.52 | 0.61 | 1 |
| QUL | 5.47 | 1.24 | 6 | 9.66 | 0.77 | 10 | 6.12 | 1.23 | 7 | 4.62 | 0.71 | 10 | 3.17 | 0.91 | 11 |
| TNF | 6.33 | 1.00 | 7 | 7.81 | 0.82 | 7 | 7.06 | 1.68 | 10 | 4.50 | 0.87 | 8 | 1.64 | 0.60 | 2 |
| MKP | 6.85 | 1.20 | 8 | 10.0 | 0.76 | 12 | 7.90 | 1.32 | 11 | 4.23 | 0.84 | 6 | 2.04 | 1.28 | 7 |
| CUS | 8.12 | 1.02 | 9 | 8.14 | 0.89 | 8 | 5.95 | 1.19 | 6 | 3.58 | 0.83 | 4 | 2.17 | 0.98 | 8 |
| DLT | 4.21 | 1.28 | 5 | 9.68 | 0.77 | 11 | 5.63 | 1.35 | 4 | 3.62 | 1.19 | 5 | 1.66 | 0.70 | 4 |
| TPT | 8.67 | 0.70 | 10 | 7.72 | 0.75 | 6 | 5.05 | 1.71 | 3 | 3.46 | 0.94 | 3 | 1.90 | 0.93 | 6 |
| STP | 8.87 | 0.71 | 11 | 5.50 | 0.90 | 3 | 5.71 | 1.48 | 5 | 2.98 | 1.00 | 2 | 1.72 | 0.99 | 5 |
| IFO | 2.80 | 0.83 | 4 | 7.40 | 0.97 | 5 | 6.87 | 1.55 | 8 | 4.70 | 0.82 | 11 | 1.65 | 1.23 | 3 |
| CPU | 10.2 | 0.85 | 12 | 4.96 | 0.88 | 2 | 6.91 | 1.26 | 9 | 4.46 | 0.94 | 7 | 2.29 | 1.57 | 10 |
| EMR | 1.52 | 0.70 | 2 | .87 | 1.05 | 1 | 4.20 | 0.91 | 1 | 2.62 | 0.71 | 1 | 4.95 | 1.47 | 12 |
| HUF | 1.26 | 0.44 | 1 | 6.81 | 0.82 | 4 | 8.07 | 1.19 | 12 | 4.59 | 1.18 | 9 | 2.23 | 1.52 | 9 |

Where TS = Tangibles Services, RSP = Responsiveness, RLB = Reliability, ASR = Assurance and EMY = Empathy are recognize from literature.

The relative importance values (*Dij*) shown in Table 5.23 have been used to calculate the permanent function of the evaluation matrix. To calculate the values of *Di*'s for different alternative systems, the respondents are further asked to rank the various attributes with respect to different alternatives (TS, RSP, RLB, ASR and EMY).

As per the information received from the survey, ranking order and descriptive statistics for TS, RSP, RLB, ASR and EMY is shown in Table 5.24. Cronbach's coefficient (α) has been calculated as 0.82, 0.78, 0.76, 0.82 and 0.76 respectively to check the reliability and internal consistency of the responses for each alternative by using SPSS. This confirms the

conformity and internal consistency of the survey. The ranking order obtained from survey has also been assigned the corresponding crisp score, where the highest ranked attribute gets the high value on Chen and Hwang's 11 point scale to defuzzify the information and shown in Table 5.25.

Table 5.25 Permanent Values for each Alternative

| S. No. | Attributes | TS | RSP | RLB | ASR | EMY |
|---|---|---|---|---|---|---|
| 1 | FLX | 0.255 | 0.745 | 0.135 | 0.955 | 0.045 |
| 2 | QUL | 0.500 | 0.865 | 0.590 | 0.865 | 0.955 |
| 3 | TNF | 0.590 | 0.590 | 0.865 | 0.665 | 0.135 |
| 4 | MKP | 0.665 | 0.955 | 0.955 | 0.500 | 0.590 |
| 5 | CUS | 0.745 | 0.665 | 0.500 | 0.335 | 0.665 |
| 6 | DLT | 0.410 | 0.955 | 0.335 | 0.410 | 0.335 |
| 7 | TPT | 0.865 | 0.500 | 0.255 | 0.255 | 0.500 |
| 8 | STP | 0.955 | 0.255 | 0.410 | 0.135 | 0.410 |
| 9 | IFO | 0.335 | 0.410 | 0.665 | 0.955 | 0.255 |
| 10 | CPU | 0.955 | 0.135 | 0.745 | 0.590 | 0.865 |
| 11 | EMR | 0.135 | 0.045 | 0.045 | 0.045 | 0.955 |
| 12 | HUF | 0.045 | 0.335 | 0.955 | 0.745 | 0.745 |
| Per | | 43755.82 | 67390.49 | 52516.97 | 48172.25 | 46542.56 |

The crisp scores of attributes, with respect to different alternatives are shown in Table 5.25 have been used as diagonal values for the purpose of calculation of permanent equation. The off diagonal values remain similar for permanent calculation of each alternative but the diagonal values will be changed according to the alternative for which permanent is being calculated. The results obtained from the calculations and weightage is shown in figure 5.6.

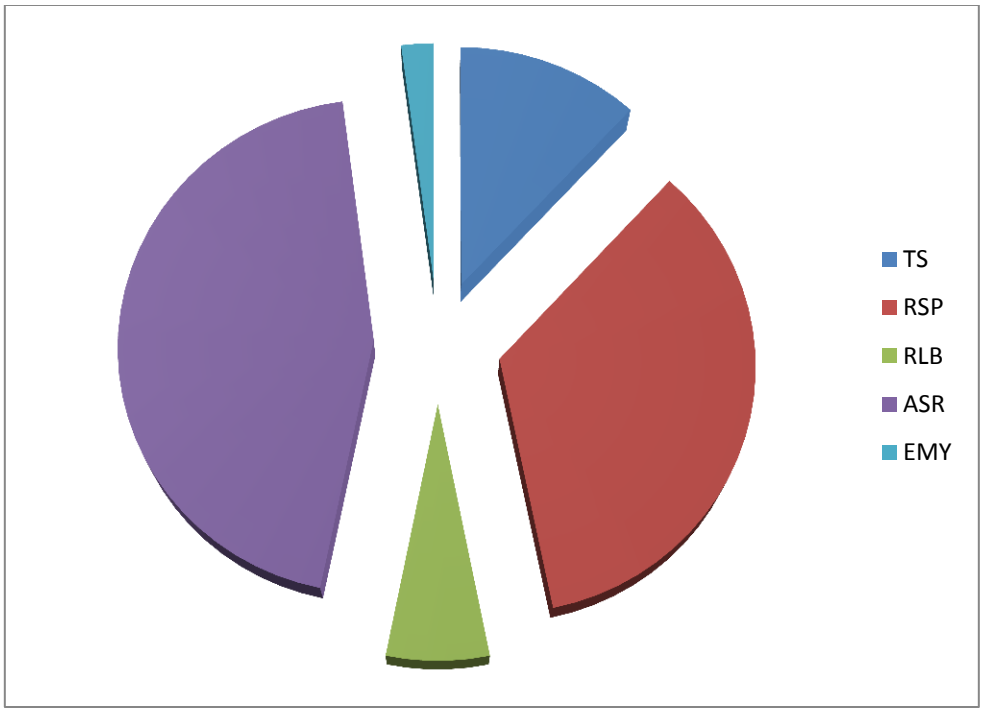


Figure 5.6 Alternatives weightage

## 5.10 RANKING OF ALTERNATIVES

The present work has compared various systems based on identified attributes using FGTA. The results of such comparisons have been depicted which indicates that the service system options as per alternatives in the decreasing order are: RSP>RLB>ASR>EMY>TS as shown in figure 5.6. In order to validate the above results, the results have been compared with the previous published analysis by the earlier research with Singh et al., (2015). In general, it does not matter that the different methods give different rankings, so long as the first choice remains the same. The methods proposed by different authors require more computations due to their complexity. The proposed method is logical and has ranked the alternatives in few steps with easy calculations. The proposed method gives the provision to quantify the intangible attributes using fuzzy scale.

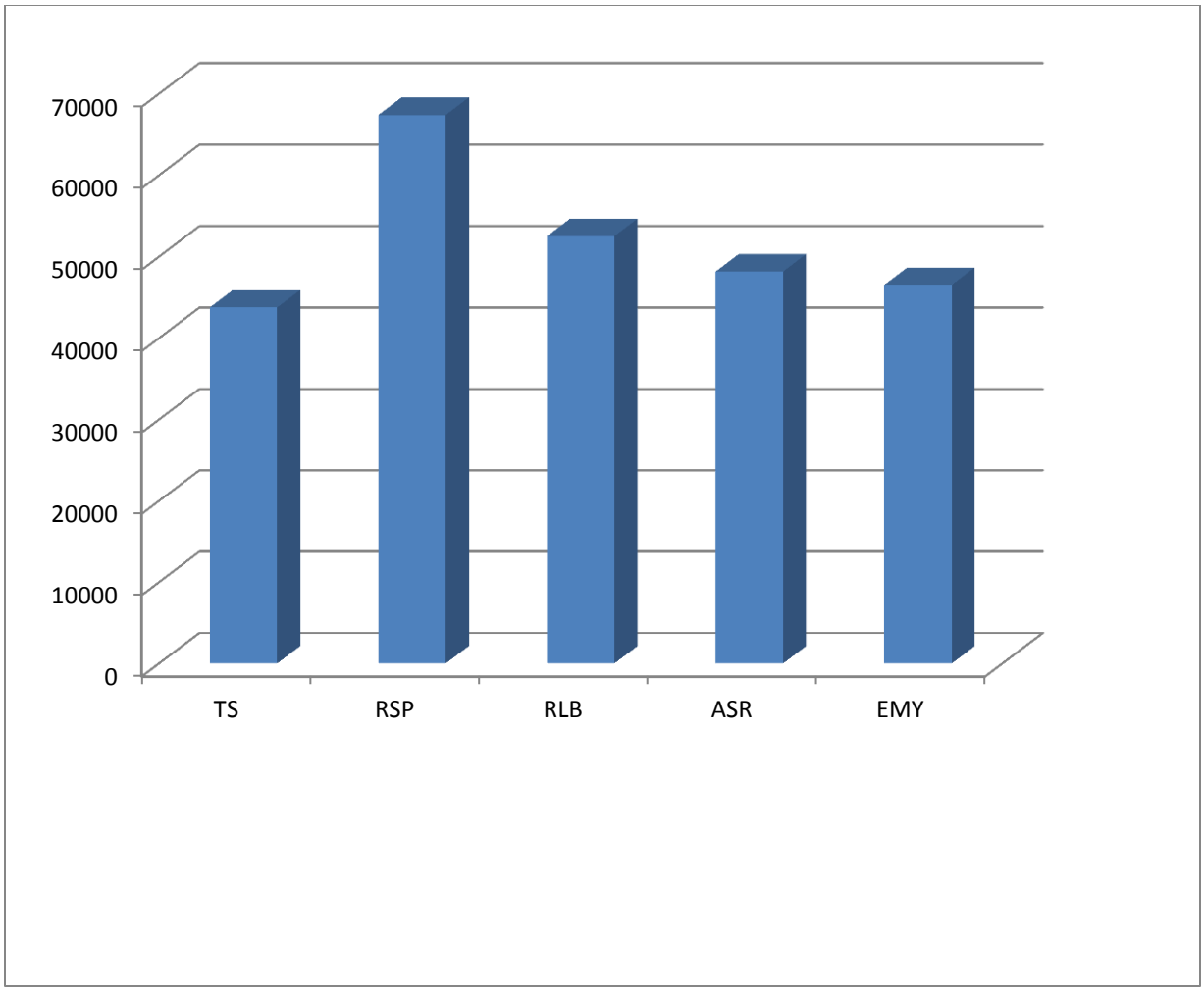


Figure 5.7 Ranking of Alternatives

## 5.11 DEVELOPMENT OF BENCHMARKING MODEL

On the basis of literature outcomes and modeling techniques, suitable attributes and alternatives have been found for development of benchmarking model which is having four main phases for implementation. The figure 5.8 proposed a benchmarking model which is further discussed in detail.

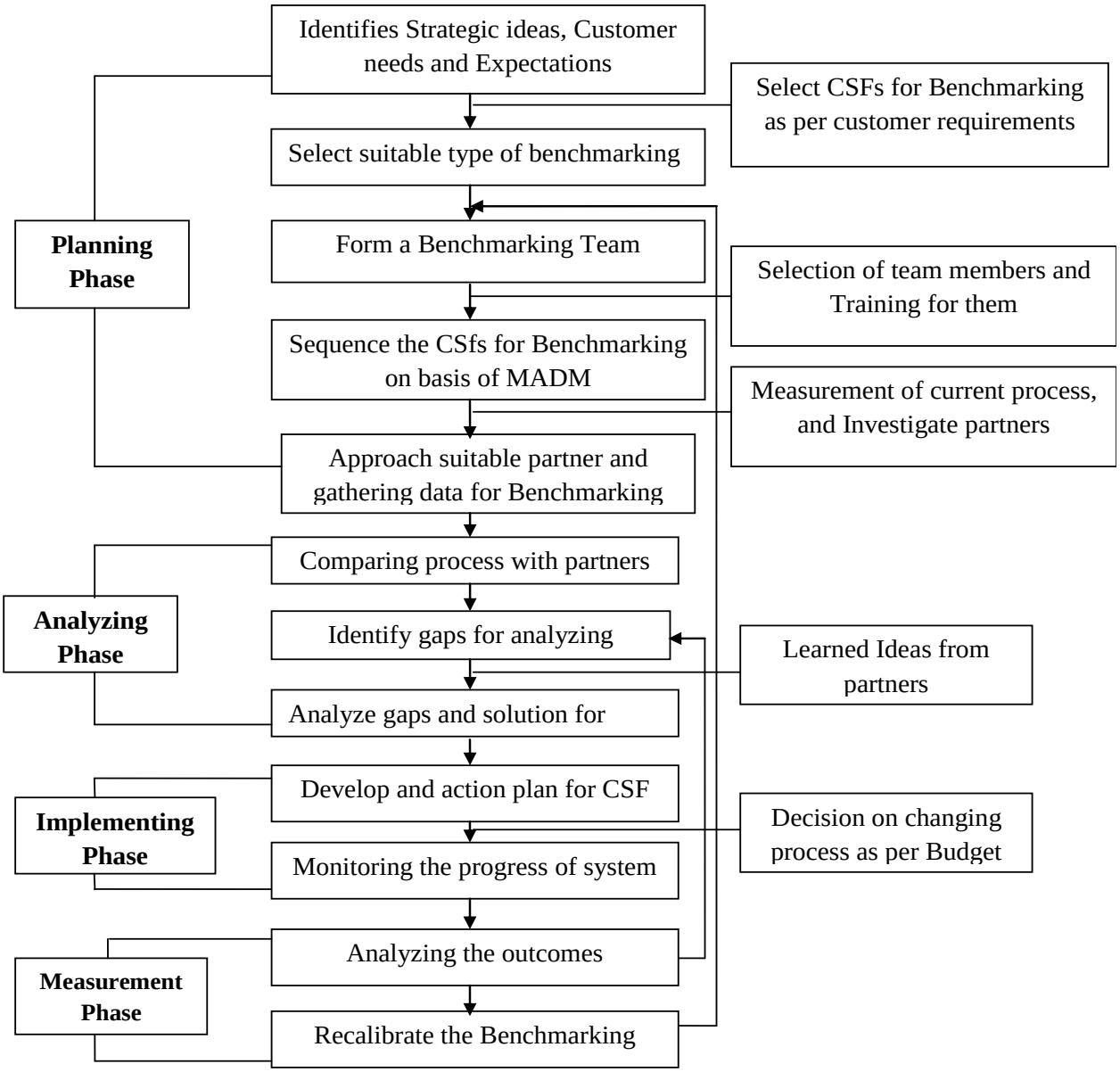


Figure 5.8 Proposed Benchmarking Model

Planning**,** Analyzing**,** Implementing and Measurement are the main phases of proposed model which are epitomized in above figure 5.8. In each steps of benchmarking process, many influenced decisions have been identified at every stage. The first phase consists of planning stage for the system where decision on identifying the strategic objective for the business and planning of selection for actual benchmarking process has to be taken. Several tactical decisions such as selection of team members, selection of leading team members, selection of visiting members, role of each member and suitable training to all relevant

members has to be completed. The training schedule of all team members has also been fixed for future plan. Addition of these, critical success factors have been found as per customer requirements for benchmarking and important factors are placed for data usage by using multi attitude decision methods. Then appropriate benchmarking partner will also been identified for the same field which helps for gathering of data in relevant service industry.

In second phase, analyzing of data has to be completed where comparison among suitable partners with selection of performance gaps and their possible causes are considered. The gaps will be found on the basis of collected data from the industry which helps for learning ideas from partner. In third phase, implementing of action plan for each critical success factor with variables has been developed. Afterwards, the all complete progress will be monitored carefully. Then decision will be taken as per budget of completing process.

The last phase is measurement phase, where outcomes are analysed and measured thoroughly for process improvement. Then recalibrating of the benchmarking process has been accomplished by the team members as per requirements.

## 5.12 CONCLUDING REMARKS

Customer satisfaction is the major target of service industries, hence the derivation of the ISM should be done by customer's view which tends to make the benchmarking process customer-oriented. Thus, selection of suitable action and relative weights should be done by the top level management of an industry. Here, critical success factors are identified as per Indian service context, with input from extensive literature reviews and discussions held with experts. An ISM methodology is proposed to develop the structural modelling and establish the relationships among the CSFs in Indian service industries. Based on the response from questionnaire survey on benchmarking, competitiveness index of the benchmarking factors for service industries has been evaluated in Table 5.15. Competitiveness index has been found as 2.42. This competitiveness index among these measurements is quite high as the maximum value can be reached up to maximum 6.52. It has been identified that industries are having more effect on success factors like Assurance, Empathy, Reliability, Responsiveness, Tangibles, Strategic planning etc., though there is requirement for improvement towards rest of success factors for performing glowing in the service industries. In the result, it is found that the "Professionalism" CSF has maximum dynamic power and

minimum dependence level among the all CSFs. Therefore, the Professionalism with addition of “Throughput” and followed by “Responsiveness” with “Flexibility” should be designed for taking the confidence of management and customer at the beginning to create a healthy environment. A benchmarking model is developed on the basis of the structural model for CSFs which is high quality equipment for enhancing the performance to feasible level in a short duration with minimum effort and resource. The findings of the proposed structural framework and benchmarking model for Indian Service industries will serve as a guideline for successful adoption in the market. Moreover, FGTA has been proposed to deal with the justification problem of service which is based on the digraph and matrix methods. The 12 attributes have been considered for the evaluation and justification of the service quality. Moreover evaluation characterization and isomorphism are used for the comparison of alternatives in service system where evaluation index has been identified. The data obtained from the survey is converted into crisp score by using an 11-point fuzzy scale to defuzzify the information.

A benchmarking model is proposed for implementation in service industries which is briefly discussed in next chapter. The proposed benchmarking model has four phases i.e. planning, analyzing, implementing and measurement that include 12 main steps. The planning phase consists of five steps with addition of 3 sub steps. Consequently, it may not be feasible to consider all CSFs at any one-time for benchmarking due to financial and non-financial constraints. The service providers should also consider the structural relationship of CSFs developed by MADM to decide which set of CSFs, be supposed to go for benchmarking in the first time and in subsequent turns for next step. A suitable type of benchmarking (i.e. internal, competitor, generic, process, functional, performance, strategic, competitive type, etc. (Singh & Grover et al., 2014) should be adopted for the selected CSFs (i.e. fourth step). The benchmarking team should identify and collect the relevant information regarding potential benchmarking partners (i.e. fifth step) and this completes theplanning phase. The analyzing phase comprises of three steps (sixth step), gap analysis (seventh step) and defining a set point for optimum gap reduction (eighth step)). The sixth step initiates with the identification of key performance indicators for each CSFs by the benchmarking team. The gap analysis for each selected CSFs should be carried out in the seventh step thus it may not be possible to bridge the entire gap in a single attempt. Therefore, a set point must be defined

for optimum gap reduction by considering the constraints for a particular attempt. It will be fixed by the benchmarking team in the eighth step. This will concludes the analyzing phase. The implementing phase consists of two steps (i.e. ninth and tenth steps). The ninth step starts with developing and implementing an action plan for each CSFs where it must be monitored for proper execution and to know their progress on a real time basis (i.e. tenth step). The last phase is the measuring phase and it consists of two steps (i.e. 11th and 12th steps). The next step starts with analyzing the outcomes and comparing with the corresponding targeted optimum reduction in the gaps fixed in the eighth step. The next attempt for optimum gap reduction is decided by the results of the above comparisons and existing internal and external environments for each selected CSFs. Finally, the benchmarking team should recalibrate the benchmark (i.e. 12th step). The proposed benchmarking approach is broad in nature and can be applied to different other industries once their structural framework of critical success factors are found.

# CHAPTER VI

# IMPLEMENTATION OF BENCHMARKING MODEL IN SELECT SERVICE INDUSTRY=A CASE STUDY

***Chapter Objective***

*This chapter explains the case study used in this research work. The main objective of this chapter is to implement the benchmark model developed in previous chapter and found suitable results for industries. The phases of benchmarking model are also defined with experts, team members and important review points are discussed. The barriers of benchmarking in implementation of model are also found for select service industry.*

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## 6.1 INTRODUCTION

Globalization has put industries into fierce competition where customers are enjoying quality of products and services with less prices. Traditional manufacturing and service methods are not sufficient for survival. Out of necessity to be competitive, industries need to adopt new methods and techniques to improve effectiveness of their systems such as: Total Quality Management, Just In Time, Flexible Manufacturing System, Service Quality Models. Although newer technologies provide excessive advantages for improvements of each operation, the complexity of the development new process makes it difficult for industries to implement these techniques. This causes a constraint for sustaining improved services to the customers when applying a benchmarking model for industries to help preserve service quality as group leaders. In India, there is extreme competition for service industries because manufacturer industries hire different service provider. Therefore, there is close competition for service which causes improvement at various levels. So the service industries want to adopt benchmarking model for achieving the best in their field and improving the performance. A benchmarking approach is a realistic approach for continuous improvements in quality and performance (Dattakumar and Jagadeesh, 2003). Benchmarking in car services enables the industries to constantly monitor and assess its performance for operating techniques against other best industries. The benchmarking process is important for

continuous improvement in an industry's service and expense levels, where some of benefits for car service industries include:

- Improvement in market position of the service provider
- Improvement in the level of customer satisfaction
- Identifies the information that will enhance throughput and lower the expenses
- Improvement in information flow between all departments
- Improvement in customer service and quality control
- Reduced overall expenses
- Improvement in team spirit and morale

Referring to the results of MADM techniques, main goal is the selection of important alternative for service industry i.e. automobile sector for case study named a leading automobile service centre in National Capital Region of India, company ABC Limited which is the authorised agency of major limited industry of Indian Cars and expanded in all major cities of National Capital Region in India.

## 6.2 APPLICATION IN AUTOMOBILE INDUSTRY

In case for improvement in tangibles, company ABC Limited has identified those good practices that can be learnt from the market leading competitor of another industry i.e. top level industry of National Capital Region of India, company XYZ Limited needs to change their machines and equipment with building layout as per their application. Since different alternatives have their different evaluation standards, so there is requirement of defining their evaluation standards before selection of improved alternatives. By entering the ratings of sub-criteria for each changing opportunities into methodology, the best practice can come out. Rearranging service capabilities with maximum percentage is the best practice that Company ABC Limited, should implement to improve its on-time delivery and also to evaluate the improved alternatives from the market leader (Company XYZ Limited) so the best practice can be implemented. In fact, this is a continuous improvement process where the company can remove its weaknesses one by one. The flow chart of proposed benchmarking model for Indian Car Service Company ABC Limited is shown in figure 6.1.

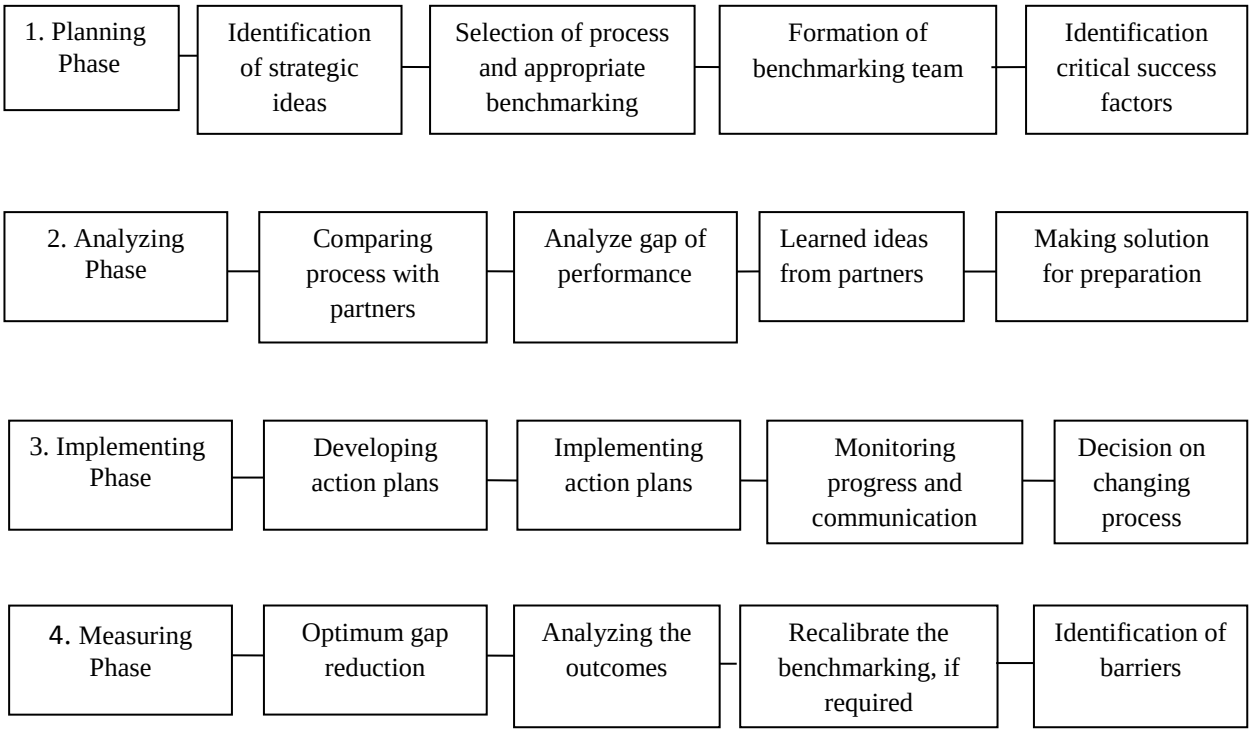


Figure 6.1 Schematic diagram of the Benchmarking process

For adoption of best practice, a benchmarking model is proposed for Indian car service company ABC Limited, based on the literature outcome from benchmarking models and modification done by the authors. The proposed benchmarking model has four phases i.e. planning, analyzing, implementing and measuring which include several steps as discussed below in brief.

The planning phase consists of four main steps with addition of some necessary terms. It may not be realistic to consider all critical success factors at any time for benchmarking due to financial and non-financial constraints. Thus keeping in view of customer expectation and desires, service provider should also consider the structural relationship of critical success factors which would be hypothetical for benchmarking in service industries. A suitable type of benchmarking should be adopted for the selected critical success factors as per industrial environment (Singh et al., 2014). Company ABC Limited, considered the structural relationship of critical success factors developed by MADM techniques to decide which set

of critical success factors is to be supposed for benchmarking in the first time and in subsequent turns for next step.

### 6.2.1 Identify What is to be Benchmarked

In this step, a suitable type of benchmarking is adopted for the selected critical success factors (i.e. fourth step). It can involve in service, process and practice. This is done with the assistance of team members on benchmarking. The types of benchmarking are discussed with the company ABC Limited and management decides the appropriate benchmarking application. A self-assessment booklet is prepared to aid in this phase. Benchmarking can cover following areas:

- Total quality of service
- Company organization and culture
- Environment, health and safety
- Finance and marketing
- Overall customer satisfaction

### 6.2.2 Development of Benchmarking Team

In this step, a benchmarking team can identify and collect the relevant information regarding potential benchmarking partners (i.e. fifth step). Spendolini (1992) has distributed benchmarking teams in to three different groups. These are

- **Intact Work Team**

This team works usually in a single place with all members of the group reporting to the same manager. In this team the manager may or may not play the role of the team leader. An intact work team is often the customer of their own investigation.

- **Cross Functional and Interdepartmental**

This team is regularly organized as task team with precise and defined sets of customers. The persons selected for this team are selected for their specific knowledge or skills, but they can also act as representatives of their respective departments and locations. The leader of this type of team is usually not the everyday manager for team members. In numerous cases, this

type of team is brought organized to work on a specific problem. Once their benchmarking investigation objective is completed then the team will dissolve.

- **Adhoc Team**

This type of team presents the flexibility in team decision. An adhoc team contains of some number of employees who can share their interests and decision on certain subject for benchmarking scheme. Generally the adhoc team describes the subject and continues to function until the project is complete.

Based on the classification, the team consists of two executives, three advisor and two supervisors with researcher. The benchmarking team is responsible to carry out the benchmarking process, since significant internal effort would be required. A team leader is appointed from the employees who could significantly contribute to the exercise. Experts from outside company are also incorporated for taking advice time to time. The following responsibilities are likely to be obliging as a team leader:

- Selection of efficient employees that can best contribute in the process.
- Selection of experts' members from outside the company for timely guidance.
- Selection of visiting members from other sources.
- Distinguish between main members and other members
- Providing relevant training to all members.
- Making coordination between all the members.

After developing the benchmarking team, the selection of benchmarking partner is to be decided on the basis of market and examination of the existing process with discussion of all the team members.

### 6.2.3 Identify Organization Want to Benchmark Against (Company, XYZ Limited)

It can be other operating units within the company, competitors or unrelated companies. However, it was a leader or "best in class" in the area being benchmarked i.e. company XYZ Limited. This will depend on accessibility of such information globally and assessment of the company data

The data can be available and access to online version at free of cost. Participating companies contribute continuously such data so that the database is updated. Few guidelines for contacting target companies for benchmarking are discussed in brief.

Company ABC Limited, requires information from company XYZ Limited, so that the entreaty can be directed and evaluated properly. This helps to simplify a timely decision regarding partnership for enhancement the effectiveness of benchmarking exchange, can be organized to respond to the following questions.

- Explanation of company, ABC Limited (outlines of business, sales, service area, etc.)
- Description of the process or function to be benchmarked
- Vision and intention of this benchmarking work
- Proposed use for the information required in this project
- Reasons the targeted company has been selected for this particular project
- Other targeted companies to be included in this benchmarking project
- Current status of the requester's internal analysis
- How the requester's process has been documented
- Key performance measurement related with this benchmarking project
- Types and nature of questionnaire development
- Chosen time frame for the project schedule
- Elective formats for information exchange
- Participants signed by a collaborative agreement such as Code of Conduct
- What are the benefits to the company XYZ Limited, for participating in the benchmarking process

### 6.2.4 Collection of Data

An enormous effort was performed to ensure that data filled by all the employees is completely reliable. The purpose was not to make the company position look enhanced than in fact, but to record an objective and composed a view that might be supported by tangible facts. Incorrect answers will direct to incorrect results and will limit the value of benchmarking exercise for the company.

Dimensions must be chosen to offer a significant comparison, collection which normally involves in individual meetings and site visits of area being benchmarked.

The visits may be performed by the benchmarking team with support of the organizer.

A written document is containing the questions to be asked mutually with explanations on how to collect the useful data which includes data collection indicators. The numbers of performance measures are selected for business excellence. Such factors include

- Policy and strategy
- People management
- Resource management
- Business processes
- Customer satisfaction
- Impact on society
- Business results

Many data have been filled and open to interpretation about local causes for differences in performance with inconsistencies of data collection. Rather than spending time on who is the best and why the measurements are not fair, the data collection was focused on those areas where precious differences in performances and fundamental processes are occurred.

### 6.2.5 Determine Current Performance Levels

This includes identifying gaps between both companies, which comes from the data investigation and the assessment between company data and the reference company. The evaluation was accessible in the presence of subjective scale, for each of the performance factors selected and could demonstrate the current performance level of the companies. The best in the class performance level as well as average and reference data was improved from a collected data base.

## 6.3 IMPLEMENTATION OF ANALYZING PHASE

The analyzing phase comprises of three main steps where measures are compared with partners and learning concepts with their competitors (seventh step). The gap analysis for each selected critical success factors will also be carried out in this stage. These gap points will be fixed by the benchmarking team. The sixth step initiates with the identification of key

performance indicators for each critical success factors by the benchmarking team. The gap analysis for each selected critical success factors should be carried out in the seventh step thus it may be possible to bridge the entire gap in a single attempt.

Therefore, a set point must be defined for optimum gap reduction by considering the constraints for a particular attempt. It will be fixed by the benchmarking team in the eighth step and helps to conclude in the analyzing phase.

This phase of the benchmarking process also includes data analysis for the companies. In order to study the relations of quantitative or qualitative data, data analysis techniques are employed. Though, in practice the pragmatic persons are frequently considered by a multiple variables. These data analysis methods provide a global study of these variables, expressive the relationships and similarities with their differences. The individuals and the variables were placed in geometric spaces and the data were transformed in order to be visualized on a plan or classify in homogeneous groups while losing minimum information.

### 6.3.1 Assignment of Questionnaire

Our first assignment is to plan a questionnaire with alliance of all the data obtained with the recognition of the first phase designated. The questionnaire of study contains three types of questions:

- **Closed ended questions with unique answer:** These types of questions are those which the respondents will select from a list of choices.
- **Closed ended questions with scale answer**: These types are the unique answer type questions but for which the choices are classified according to the likert scale.
- **Open ended questions of text type:** These questions are like as where the answer is a text. The choices which are namely possible to answers these questions are therefore qualitative or quantitative. The simple form employed for data collection and the answers to these questionnaires were the data issued of analysis realized over the first phase of the benchmarking process.

### 6.3.2 Gap Analysis

Once the team has collected all the statistics both internally and externally, the data has been grouped into relevant collection which shows how data weighted besides its benchmarking

partners. A lot of responsive and maintenance work has been performed by the team. Its responsive work amounted to about quarterly percentage of the total time spent.

This phase includes two steps which involve the analysis of all the information and data collected in the planning phase. All the people closest to the process selected for benchmarking should be deeply involved in this phase.

### 6.3.3 Finding Reasons and Inventing Improved Processes

The benchmarking team found the reasons for improved results from the benchmarked processes. This has to be completed after the information from company XYZ Limited, has been collected and analysed. Based on this analysis an improved process should be developed.

### 6.3.4 Setting of Goal

For the benchmarking team next step is to set goals for the improvement of company's existing process. These goals can be possibly stretch goals that will be resulted in a process even better than the other company to be benchmarked.

### 6.3.5 Review Points for Analyzing phase

During, analyzing phase the following review points are considered:

- The performance gaps in the company's process as associated to the benchmarked process have been identified and analyzed carefully
- The reasons for improved performance have been suggested
- The process description documents for both companies have been clearly associated
- The work processes at benchmarked company have been studied and compared with the company's processes
- The team contains proposals for developing changes in the processes
- The senior management of companies been influenced by benchmarking team
- The revised process has been tried to certify the adaptability
- The success of revised process has been documented properly for any operation

## 6.4 IMPLEMENTING PHASE

This phase is an arrangement between the three stages planning, analysis and the measurement in which two phases are prior and one is last phase for model. This phase moves onward only if the results of earlier phases have been established by the management. This phase also secures the commitment of management on the recommended action plan. Since reception of proposed process revisions by the company is essential for the success of study and significance of this phase.

The implementing phase consists of two steps (i.e. ninth and tenth steps). The ninth step starts with developing and implementing an action plan for each critical success factors, where it must be monitored for proper execution and to know their progress on a real time basis (i.e. tenth step). The main goals of process were decided with developing and implementing an action plan for each critical success factors.

### 6.4.1 Develop Action Plans

Tangible action plans have been developed and resulting in the reduction of lead times with the quality improvement, where these must be monitored for proper implementation on valid time. After agreement on findings and strategy the benchmarking team present final recommendations on goals and how the company ABC Limited, must change to achieve them. After the acceptance of improved process by all concerned action plans for every objective has been developed for required support.

The comprehensive action plan should carry the important things like a time line, individuals responsible for moving out the responsibilities, any underperformance in the achievement of tasks and the stretch targets were taken to reimburse the deficit. Individuals were responsible to be committed adequate for ensuring the tasks and assignments completed on time. Estimates are specified for the cost of implementation on the action plan.

### 6.4.2 Implement Precise Actions and Monitor Progress

Even, when all assignments are completed on plan then a responsibility of senior members to be checked cross all the process. These must be acceptable to make sure proper coordination of different activities, monitor the growth of completion of plan and effort as the obstruction in the implementation process. When the revised process is in position, an absolute report has

to be prepared and viewing the settlement of revised process compared with potentials at the time of approval for proposed modification of the process.

**.5 MEASURING PHASE**

The last phase is measurement, which consists of two sub steps. These are analyzing the outcomes and recalibrate the benchmarking process. Analyzing of outcomes is related to the analyzing phase and recalibration is attached with planning phase if required. The next step starts with analyzing the outcomes and comparing with the consistent embattled optimal concern in the gaps fixed in the eighth step.

The subsequent attempt is for optimum gap reduction to be decided by the results of above comparisons and existing internal or external environments for each selected critical success factors. Finally, the benchmarking team should recalibrate the benchmark (i.e. 12th step). The proposed benchmarking approach is broad in nature and can be applied to different industries once their structural framework of critical success factors is found.

Best practices proficient from others must be modified to company's culture, technology and human resources. Action planning or goal surroundings are appropriate for this phase. Some developments will be immediate and short term. Some of them are long term and will require considerable resources.

A method of evaluating developments over time is critical to effective revision of best practices. Those measures developed in the planning phase can now be recycled to track performance improvements on an ongoing basis.

Measurable growth takes several months after the completion of study. The time taken on the benchmarking process depends on what was being benchmarked and how efficiently the process progresses. There is regularly an amount of intersection in the processes of the benchmarking exercise and responses were ever present to enable evaluation.

**6.5.1 Recalibrate the Benchmarks**

In this step, benchmarks are re-evaluated and adopted based on the received performance data. Reserve the authority, which is willing to share information with benchmarking partner i.e. company XYZ Limited.

Work over a precise multitude and commonly settled upon scheduling with meeting arrangements. While preceding the benchmarking process to visit, the following behaviours has been encouraged

- Allocate meeting agenda in advance
- Be devoted, genuine and timely responses
- Initiate all attendees and their reason of incidence
- Use proper language that is common
- Distribute information about your own process and considered contribution of the study results
- Offer to facilitate a future mutual visit
- Close meetings and visits on agenda

### 6.5.2 Key Performance Indicator

Measurable factor of extreme importance to the organization in achieving its strategic goals, vision and values that are not properly implemented, would likely to result in a significant decrease in customer satisfaction, employee confidence and effective financial management.

A continuous and systematic process where guiding members of an organization make decision about its future, develop the necessary procedures and determine how success is to be measured. A road map is prepared for advance competitive advantage by achieving goals that define business objectives for critical success factors.

### 6.5.3 Review Points for Measurement

The review points for this phase are:

- Development of an action plan to implement the changes proposed
- Arrangement of the activities in sequencing as per the order of precedence based on the importance
- Assignments been made to the right manpower of organization
- Commitments from the team members must be secured
- Updating all directional documents for new process has been ensured

The main advantage of benchmarking is the level of improvements for the organization makes by learning from others process. A better and confirmed process can be modified, with appropriate modifications for company requirements to invest in less time for new methodologies.

## 6.6 CODE OF CONDUCT

The following strategy applies to both partners in a benchmarking meeting with its competitors industry:

### 6.6.1 Legality

Benchmarks should ensure with legal advisor if any information assembly procedure is in doubt before contacting a direct competitor.

- Making assignment of specific non-disclosure agreements that can satisfy the counsellors of both industries.
- Sensitive data need not to be filled and benchmarking partner caused to feel if they provide data to keep the process going.
- Some information obtained from a benchmarking partner should be treated as internal and pleased communications. If secret material is to be exchanged then a specific conformity should be executed to indicate content of the material that needs to be confined.
- Avoid discussions that possibly decide to suggest an attention in constraint of trade and customer allocation schemes for necessary arrangements.
- The benchmarking study should not consult any findings to another company without ensuring the data is appropriately blinded.

### 6.6.2 Exchange

Be willing to provide the same type and level of information that requested from benchmarking partner.

Information must not be communicated outside the associate companies without the prior agreement of the partner who shared that information.

### 6.6.3 Use of Information

The information found through benchmarking only for the purpose specified to the benchmarking partner.

The use of benchmarking partner's name with the data obtained and observed requires the prior permission of that partner. Avoid interactive a contact's name in an open meeting without the contact's prior permission. Table 6.1 shows a Man and Days description which gives detailed information about time consumption and team members required for the benchmarking process.

Table 6.1 Description of Man and Days

| Step | Descriptions | Team Members | Positions | Weeks Required |
|---|---|---|---|---|
| 1 | Identifies what is to be benchmarked | 4-6 | Executives | 4-5 |
| 2 | Develop the benchmarking team in the company | 5-10 | Executives and Team leader | 2-3 |
| 3 | Identifies the company want to benchmark against | 3-4 | Team leader | 5-8 |
| 4 | Determine the indicators for data collection | 1-3 | Executives and Team leader | 2-3 |
| 5 | Data Collection | 2-10 | Team Members | 8-12 |
| 6 | Determine current performance level and identifying gap | 3-5 | Executives and Team members | 4-6 |
| 7 | Determine future performance level | 1-3 | Team Members | 2-4 |
| 8 | Communicate the benchmarking findings | 3-6 | Executives and Team leader | 1-3 |
| 9 | Developing action plan based on strategy developed | 3-10 | Executives and Team leader | 2-4 |

## 6.7 BARRIERS FOR BENCHMARKING MODEL

### 6.7.1 Employee Resistance

Employee's resistance is a common barrier to implement the change that every industry experiences for quality improvement program. Employees felt that benchmarking poses them to work harder as comparison to other techniques (Mosadegh, 2005). It is also noted that professionals and educated employees poses resistance in changing as they expect sovereignty and academic freedom. To resolve these problems, management should clarify organization's quality strategies and polices with providing motivation them in order to participate in the quality planning, decision making, and processes improvement.

### 6.7.2 Refusal to Change

Beyond the resistance of employees, there is general tendency to ignore changes in the system because everyone is comfortable with existing work from point of view as consumer and developer. If they adopt changes then lot of attitude will be changed, this barrier can be considered as human resource barriers. Some studies have predicted human resource barriers such as non- participation of employees, low knowledge and experience, lack of culture and geographic homogeneity (Francois et al., 2003; Qureshi, 2012).

### 6.7.3 Improper Training

Proper training is very imperative at all levels for an industry as it has huge role for resistance of worker. A successful team requires a dedicated well trained and educated work force that fully helpful in quality improvement activities. Insufficient training to employees leads to failure of any system as they could not resist against problem solution as well as quality improvement procedure (Singh et al., 2012).

### 6.7.4 Lack of Knowledge

Lack of knowledge is the important barrier for successful implementation of any quality system. Generally it is notified that benchmarking processes are dependent on top level management, as all the indications are delivered for controlling of human barriers and resistance at different levels. This barrier is predicted such as non-participation of employees, low interest in work and less experience about system at all levels.

### 6.7.5 Lack of Top Management Assurance

Lack of top management interest may stem from a variety of reasons like lack of experience and training, resistance to change and no interest in initiating improvement programs. The top level management performs key role in quality improvement programmes such as benchmarking process for all types of industries like as manufacturing and service sectors. Thus top level management should take proper interest in developing benchmarking process.

### 6.7.6 Stance to Excellence

Excellence towards quality improvement is desirable as it gives ability for adopting good system such as benchmarking etc. Literature shows importance of stance to excellence because it helps for achieving quality system as well as continuous improvement. If, attitude towards excellence is not positive than it look system failure completely. Thus it is an imperative barrier to recognize necessitate of benchmarking in service industries.

### 6.7.7 Indecent Planning

The lack of strategic planning by the top-management has been commonly contributed to ineffective quality improvement. It seems that a large number of industries are either unable or not willing to plan efficiently for benchmarking. Therefore, attentive and comprehensive planning is needed prior to the implementation of any quality program.

### 6.7.8 Benchmarking Data Barriers

Benchmarking data have the key role when implementing it in any type of organizations. These data may include collection of data, survey from the data and analyzing of such types of data. While, in different stages the benchmarking data has their different roles. So it is required to organize these in well- known manners otherwise these can be time and money wastage for benchmarking industries. Deprived communication and scandalous training of employees will be the main reasons of failure of benchmarking data procedure.

# CHAPTER VII

# EVALUATION OF BENCHMARKING MODEL IN SELECT SERVICE INDUSTRY

***Chapter Objective***

*This chapter explains the effectiveness of benchmarking model in select service industry. A novel hybrid model which consists of ANP, TOPSIS and MOORA methods has been used for finding the effectiveness of benchmarking. Critical success factors are prioritized by using these MADM approaches in order to evaluate their impact on benchmarking model for Indian service industries. Finally with application of MOORA method the authentication of results obtained from these techniques have been verified.*

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## 7.1 INTRODUCTION

This chapter gives a measurement model for evaluating the effectiveness of benchmarking techniques in service industries where a hybrid model of ANP, TOPSIS and MOORA method is used for ranking the benchmarking techniques. The measurement model based on the selected factors should be simple in nature which can assist the executives to realize their goals. Here, ANP is used for evaluation and ranking of critical success factors of benchmarking through super decision software 2.0.8 for authentication of the relevant technique. Experts are asked to give rating of the pairwise comparison on the factors of 1 to 9 likert scale which generates un weighted matrix, weighted super matrix and limiting matrix. The priorities are obtained from these matrices which are used as weightage of normalized matrix in TOPSIS approach where evaluation of the alternatives is completed with the help of ideal solution. In this approach closest alternative to the positive ideal solution and the farthest from negative ideal solution give the relative closeness between alternatives. This relative closeness is used in decision matrix for MOORA method, where the alternatives give comparative result for ranking of benchmarking technique.

Number of researchers in literature applied various techniques as the trendy tool in the last few years. Some of the emblematic problems can be solved by simple method like MOORA

method easily. The MOORA method was firstly introduced by Brauers (2004) as a multi objective optimization technique that can be successfully applied to solve in various complex decision making problems in the manufacturing. The applications of MOORA method have been used by different researchers (Brauers and Zavadskas, 2006, 2009; Brauers et al.,2008; Kalibatas and Turskis,2008). Maniya and Bhatt (2010, 2011) made the selection of material for the optimal facility layout design using a novel type decision-making method.

Here, quality enabled factors are prioritized by using the Analytical Networking Process (ANP) approach in order to evaluate their impact on the benchmarking model for Indian service industries. For this purpose, a comprehensive ANP model is developed which consists of 36 strategic quality enabled factors namely initiation QEFs, Accuracy of service, Availability, Customer Service, Policy & Reward, Efficiency, Professionalism, Reputation, Service level, Usability, Adequacy, Interactivity, Internal quality, Order management, Performance, Consistency, Credibility, Effectiveness, Information, Standardization, Tangibles, Compensation, Friendliness Reliability, Responsiveness, Teamwork, Work attitudes, Cooperation, Functionality, Replace ability, Technical, Time behaviour, Marketing, Quality planning, Recognition, Reward and Zero defects. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is one of the most useful Multi Attribute Decision Making technique that is very simple and easy to implement where the user prefers a simpler weighting approach. On the other hand, the ANP approach provides a decision hierarchy and requires pairwise comparison between criteria. The user needs a more detailed knowledge about the criteria in the decision hierarchy to make informed decisions in using ANP model. Here the priorities obtained from ANP have been used as weightages for integration with the decision matrix. A decision matrix is formed from the obtained responses by questionnaire survey, where questions related to critical success factors have been asked. The matrix is converted into normalized and weighted matrix where finally relative closeness factors are found which give values of ranking for alternatives.

With application of MOORA method, first a decision matrix is developed with the help of relative coefficients obtained by TOPSIS method easily. Beneficial (BA) and Non Beneficial (NBA) factors are selected with the help of experts for problem solution. The final value of MOORA index is computed as highest rank alternative for service industries in India. Less computational time is required for performing mathematical calculations by the application

of this technique. With the application of MOORA method, ranking of the best alternatives and internal assessment for benchmarking model in industries are easily obtained comparative to other MADM techniques.

## 7.2 HYBRID MODEL

Number of multi-criteria decision making (MCDM) approaches are used for benchmarking such as graph theoretic approach (GTA), data envelopment analysis (DEA), grey relational analysis (GRA), compromise ranking method (VIKOR), preference selection index (PSI), analytic hierarchy process (AHP), analytic network process (ANP), MOORA, preference ranking organization method for enrichment evaluation method (PROMETHEE), technique for order preferences by similarity to ideal solution (TOPSIS), weighted euclidean distance based approach (WEDBA), etc. In all these methods, the ranking of alternatives is affected by the weights of criteria obtained.

As epitomized in figure 7.1, a hybrid model of ANP, TOPSIS and MOORA method is used for the selection of best alternatives where decisive significance with integration of these three techniques are applied. Here, critical success factors of benchmarking are used as attributes while classified benchmarking are used as alternatives for this study. The methodical procedure of benchmarking is attentive on identifying, studying, analyzing and adapting best practices after executing the obtained results from selection criteria. There are four phases in proposed model which give resultant as selection of attributes and alternatives for benchmarking. First phase starts with identification of the benchmarking technique followed by second phase, where ANP has been applied. Third phase gives the application of TOPSIS approach and fourth phase includes application of MOORA technique. This model proposed not only to increase competitiveness with the priorities of alternatives, but also shows their consistency for assessment. The detailed description of hybrid model is given in below figure.

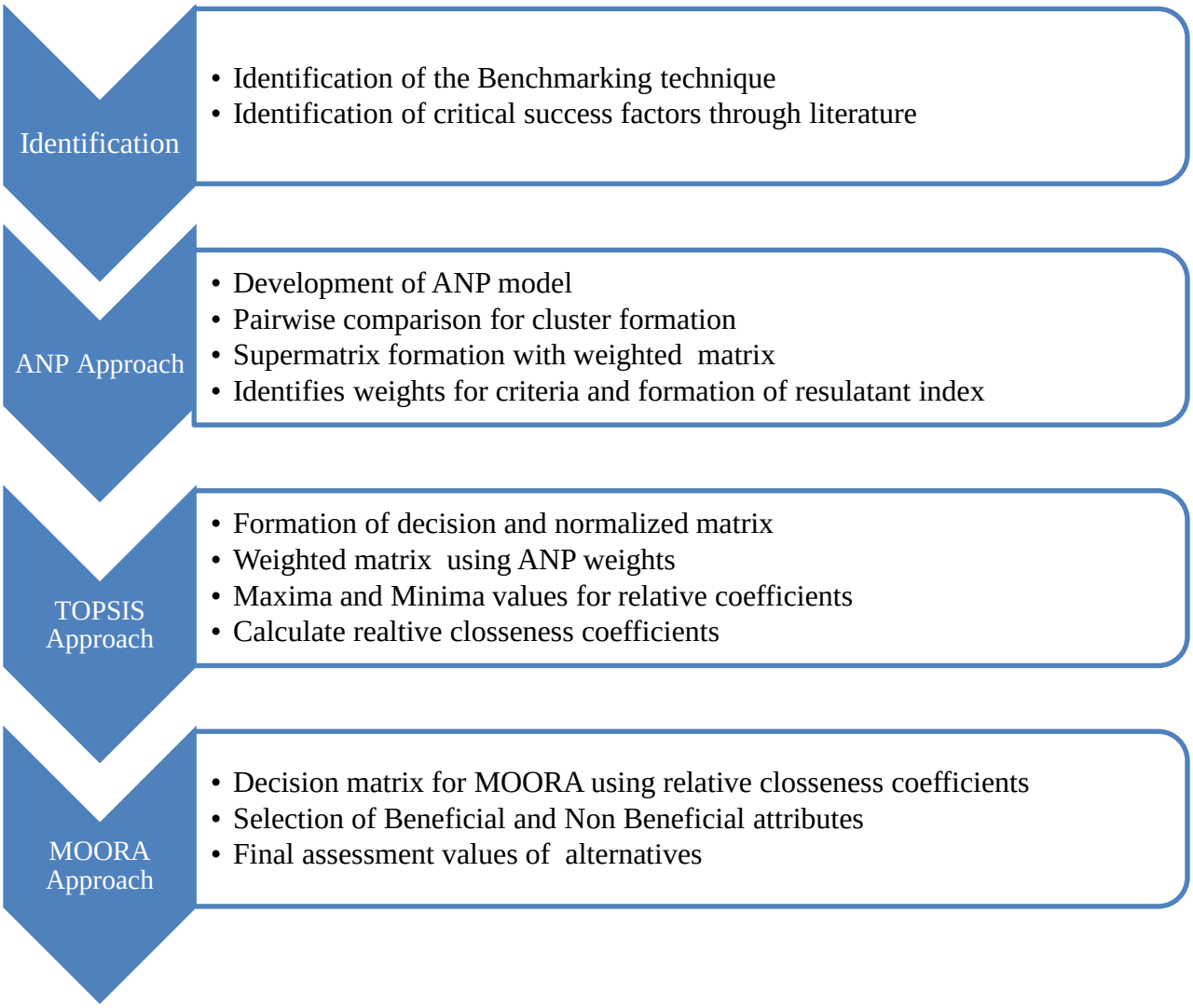


Figure 7.1 The Proposed Hybrid Model

In this model, first phase consists of two steps where identification of benchmarking technique and critical success factors have completed from literature review. In second phase, ANP is used for evaluation and ranking of CSFs for benchmarking through Super decision software 2.0.8 on trial basis, where finally weights are found as the resultant of priorities. These priorities are used for weightage of normalized matrix in TOPSIS approach where the relative closeness between alternatives is computed by various steps in third stage. These relative closeness coefficients are used in decision matrix for MOORA method where beneficial and non-beneficial attributes are selected and the final assessment values of alternatives are identified.

## 7.3 ANALYTICAL NETWORK PROCESS APPROACH

ANP is the method which provides a framework for dealing with decision making and presents strengths when working in scenarios with scarce information. It is also the general form of the AHP in the case of competitiveness measurement context. It does not require severely hierarchical structure but allows the decision levels for more complex inter-relationships. ANP simplifies the modeling process by a network of criteria and grouped all alternatives into clusters which provide an accurate modelling. According to Saaty (2005), Aggarwal and Shankar (2005), Dagdeviren and Yuksel (2007), Lee et al.,(2010), Sipahi and Timor (2010) various steps are involved in ANP:

- To identify the components and elements of the network with their relationships.
- To conduct pairwise comparisons of the elements.
- Place the resulting eigen vectors in pairwise comparison matrices with in unweighted matrix.
- Pairwise comparisons on clusters.
- To weight the blocks of the unweighted matrix by priorities of the clusters, so that weighted matrix can be formed as stochastic column.
- To develop limiting matrix where the weights remain stable until raising the weighted matrix in limiting powers.
- Obtain the element priorities as per columns of the limiting matrix. The priority of each alternative is a dimensionless value and considered as the benchmarking competitiveness index.
- A sensitivity analysis may be carried out if some alternatives give very similar results in order to express the robustness of the ranking.

For authentication of ANP procedure, Super decision software 2.0.8 has used which give exact value of dimensions. The modelling process is completed with the key clusters which are devoted to types of benchmarking such as, the strategic and competitive types. The elements inside each cluster are also identified during cluster definitions where relationship model is constructed to create the links between nodes in the same cluster. After that, the relationships between the elements are defined in a dichotomized manner and the influences

between network elements are also identified. The decision model is developed with the help of data collection and consists of several clusters where relationships between the model components are shown in figure 7.2. The model included construction of a network which identifies 7 objectives and 36 factors with main goal, are grouped into clusters. On the basis of literature on benchmarking and discussion with experts interdependences between different levels are developed.

## 7.4 APPLICATION OF ANP METHOD

Saaty (1999) presented a generalized algorithm for ANP to integrate inter dependencies and criticism for decision making also. Aggarwal et al., (2006) used ANP as an algorithm with step by step manner for solution of problem which involves following steps:

### 7.4.1 Model Construction and Problem Structuring

The main thought is to find appropriate benchmarking technique for industries on the basis of identified factors. So ANP model is developed to structure the decision problem which helps in finding the goal, clusters, elements and alternatives. The clusters and elements are computed in Figure 7.2, where the relationships of all critical success factors with alternatives are shown in a model:

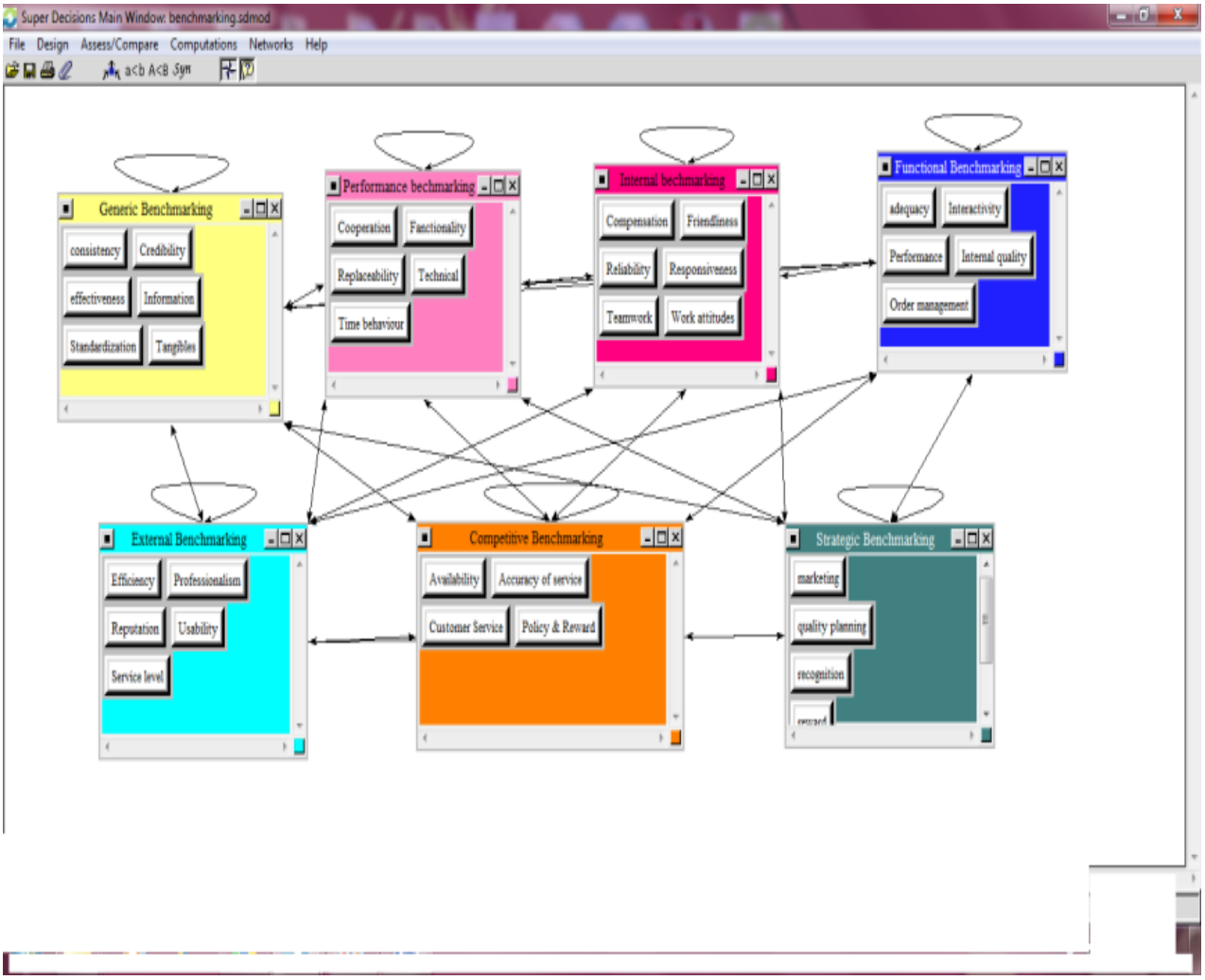


Figure 7.2 Network Illustrations for ANP Model

### 7.4.2 Pairwise Comparison

For importance a comparison is carried out between elements and clusters levels. A likert scale having a range of 1 to 9 can be used for comparing, where 1 indicates identical significance and 9 indicates awesome domination as shown in figure 7.3. A matrix is formed and relative weights of each cluster are found as an eigen vector using formula so that e cluster can be found. However, the matrices of pairwise comparison are not shown due to space limitations.

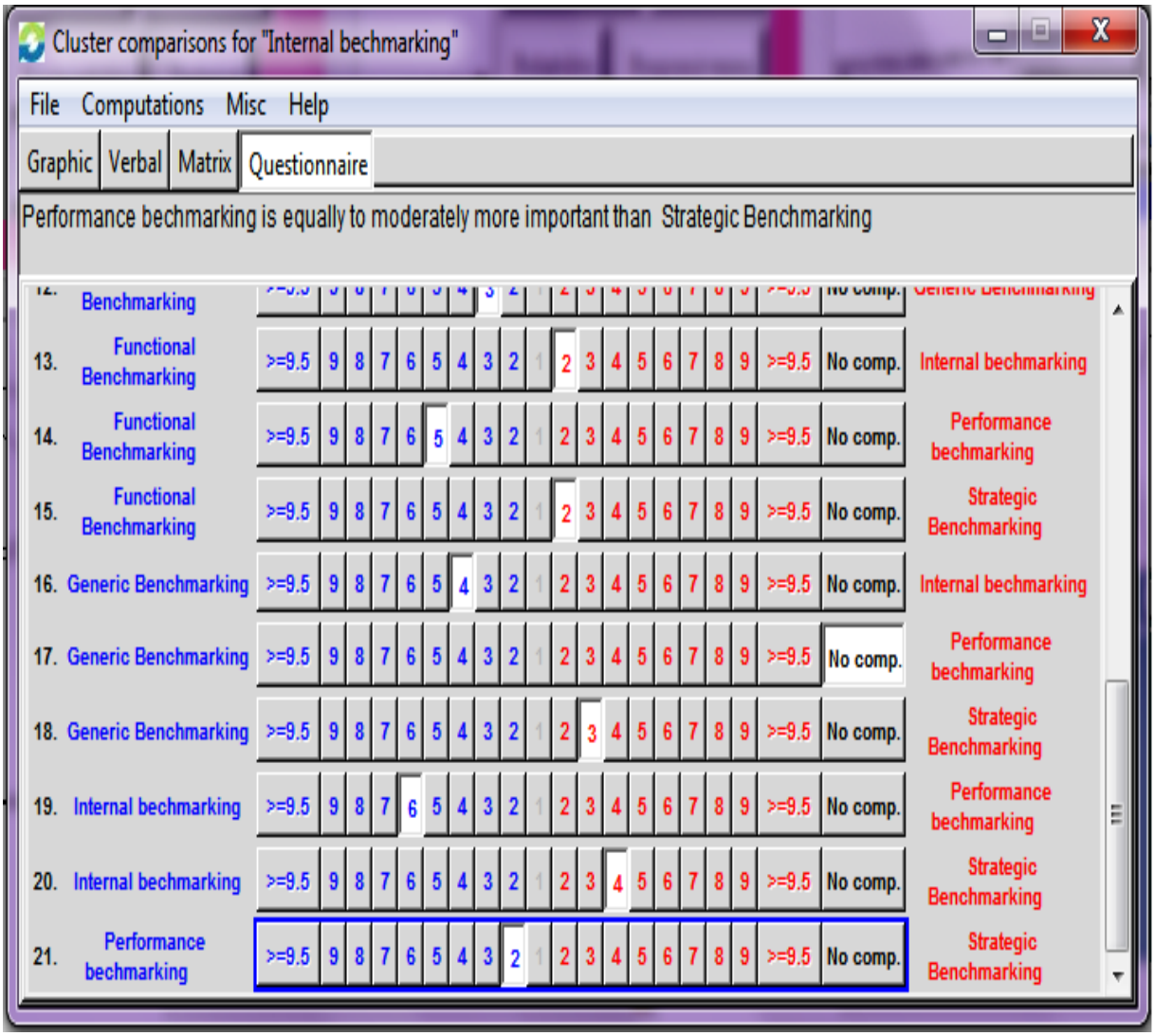


Figure 7.3 Formation of Cluster Comparison

### 7.4.3 Super Matrix Formation and Analysis

For the resolution of interdependcies, the super matrix is formed which exists between elements and found the virtual stabilized weights for each element. There are different forms that will be in this stage.

Super Decisions Main Window: benchmarking.sdmod: Cluster Matrix View

| Cluster Node Labels | Competitive Benchmarking | External Benchmarking | Functional Benchmarking | Generic Benchmarking | Internal bechmarking | Performance bechmarking |
|---|---|---|---|---|---|---|
| Competitive Benchmarking | 0.142857 | 0.142857 | 0.142857 | 0.200882 | 0.142857 | 0.142857 |
| External Benchmarking | 0.142857 | 0.142857 | 0.142857 | 0.100318 | 0.142857 | 0.142857 |
| Functional Benchmarking | 0.142857 | 0.142857 | 0.142857 | 0.209427 | 0.142857 | 0.142857 |
| Generic Benchmarking | 0.142857 | 0.142857 | 0.142857 | 0.119994 | 0.142857 | 0.142857 |
| Internal bechmarking | 0.142857 | 0.142857 | 0.142857 | 0.143070 | 0.142857 | 0.142857 |
| Performance bechmarking | 0.142857 | 0.142857 | 0.142857 | 0.118329 | 0.142857 | 0.142857 |
| Strategic Benchmarking | 0.142857 | 0.142857 | 0.142857 | 0.107980 | 0.142857 | 0.142857 |

Figure 7.4 Cluster Matrix View

### 7.4.4 Unweighted Super Matrix

In the unweighted super matrix, the entries are originated from the e vectors obtained for each column through pairwise comparisons. For this, the entries in the e vector of column the various tables are entered under individual columns. This capitulate a square matrix depending upon the relationships and exist between several elements. This matrix can't be represented in a single table and also can't be accommodated in a single page thus it is not shown while cluster matrix is moderately seen in figure 7.4.

### 7.4.5 Weighted Super Matrixes

Super Decisions Main Window: benchmarking.sdmod: Weighted Super Matrix

| Cluster Node Labels | | Competitive Benchmarking | | | | External Benchmarking | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Accuracy of service | Availability | Customer Service | Policy & Reward | Efficiency | Professional ism | Reputation | Service level |
| Competitive Benchmarking | Accuracy of service | 0.047619 | 0.000000 | 0.000000 | 0.000000 | 0.071429 | 0.035714 | 0.047619 | 0.035714 |
| | Availability | 0.000000 | 0.047619 | 0.000000 | 0.071429 | 0.071429 | 0.035714 | 0.047619 | 0.035714 |
| | Customer Service | 0.047619 | 0.047619 | 0.142857 | 0.071429 | 0.000000 | 0.035714 | 0.000000 | 0.035714 |
| | Policy & Reward | 0.047619 | 0.047619 | 0.000000 | 0.000000 | 0.000000 | 0.035714 | 0.047619 | 0.035714 |
| External Benchmarking | Efficiency | 0.000000 | 0.000000 | 0.000000 | 0.071429 | 0.035714 | 0.000000 | 0.000000 | 0.047619 |
| | Professional ism | 0.000000 | 0.071429 | 0.047619 | 0.071429 | 0.035714 | 0.000000 | 0.071429 | 0.047619 |
| | Reputation | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.035714 | 0.071429 | 0.000000 | 0.000000 |
| | Service level | 0.071429 | 0.071429 | 0.047619 | 0.000000 | 0.035714 | 0.071429 | 0.071429 | 0.047619 |

Done

Figure 7.5 Weighted Super Matrixes

In the weighted super matrix the sum of values in each column is made equal to one by multiplying weights with submatrix to create the matrix column stochastic. So it is essential to check column entries of the unweighted super matrix. If the unweigthed super matrix is not stochastic column then unweighted super matrix is converted into weighted super matrix.

The print screen view is computed in figure 7.5, where partial view of weighted super matrix is seen.

### 7.4.6 Resultant Index

Now, the limiting super matrix can be found by raising the weighted super matrix to randomly large powers and on the basis of the weighted value for each attribute obtained from the limiting super matrix, as shown in Table 7.1. Desirability index is computed for values of critical success factors i.e. epitomized in figure 7.6, as resultant index.

Table 7.1 Weights for the Criteria

| S.No. | Factors | Normalized by Cluster | Limiting |
|---|---|---|---|
| 1 | Accuracy of Service | 0.19778 | 0.02999 |
| 2 | Planning | 0.28348 | 0.04299 |
| 3 | Time Behaviour | 0.26789 | 0.04062 |
| 4 | Policy and Reward | 0.25086 | 0.03804 |
| 5 | Efficiency | 0.25468 | 0.03503 |
| 6 | Professionalism | 0.21525 | 0.0296 |
| 7 | Reputation | 0.14254 | 0.0196 |
| 8 | Service level | 0.22357 | 0.03075 |
| 9 | Compensation | 0.16397 | 0.02255 |
| 10 | Adequacy | 0.24073 | 0.03679 |
| 11 | Interactivity | 0.15095 | 0.02307 |
| 12 | Internal Quality | 0.25126 | 0.0384 |
| 13 | Order Management | 0.13418 | 0.02051 |
| 14 | Performance | 0.22288 | 0.03407 |
| 15 | Consistency | 0.24389 | 0.03312 |
| 16 | Credibility | 0.10774 | 0.01463 |

| S.No. | Factors | Normalized by Cluster | Limiting |
|---|---|---|---|
| 17 | Effectiveness | 0.13838 | 0.01879 |
| 18 | Information | 0.14493 | 0.01968 |
| 19 | Functionality | 0.15739 | 0.02137 |
| 20 | Tangibles | 0.20767 | 0.0282 |
| 21 | Usability | 0.26829 | 0.03851 |
| 22 | Friendliness | 0.16005 | 0.02297 |
| 23 | Zero defects | 0.13223 | 0.01898 |
| 24 | Responsiveness | 0.12187 | 0.01749 |
| 25 | Teamwork | 0.12229 | 0.01755 |
| 26 | Work Attitude | 0.19527 | 0.02803 |
| 27 | Cooperation | 0.21933 | 0.03072 |
| 28 | Standardization | 0.29918 | 0.0419 |
| 29 | Replace ability | 0.14265 | 0.01998 |
| 30 | Technical | 0.11441 | 0.01603 |
| 31 | Customer Service | 0.22442 | 0.03143 |
| 32 | Marketing | 0.14795 | 0.02051 |
| 33 | Availability | 0.18606 | 0.02579 |
| 34 | Recognition | 0.1812 | 0.02512 |
| 35 | Reward | 0.1803 | 0.02499 |
| 36 | Reliability Mentality | 0.30449 | 0.04221 |

The weights criteria are shown in figure 7.6, where the weightage differences of critical success factors are seen. Here, series 1 is value obtained from Limiting and series 2 is value computed from Normalized by cluster.

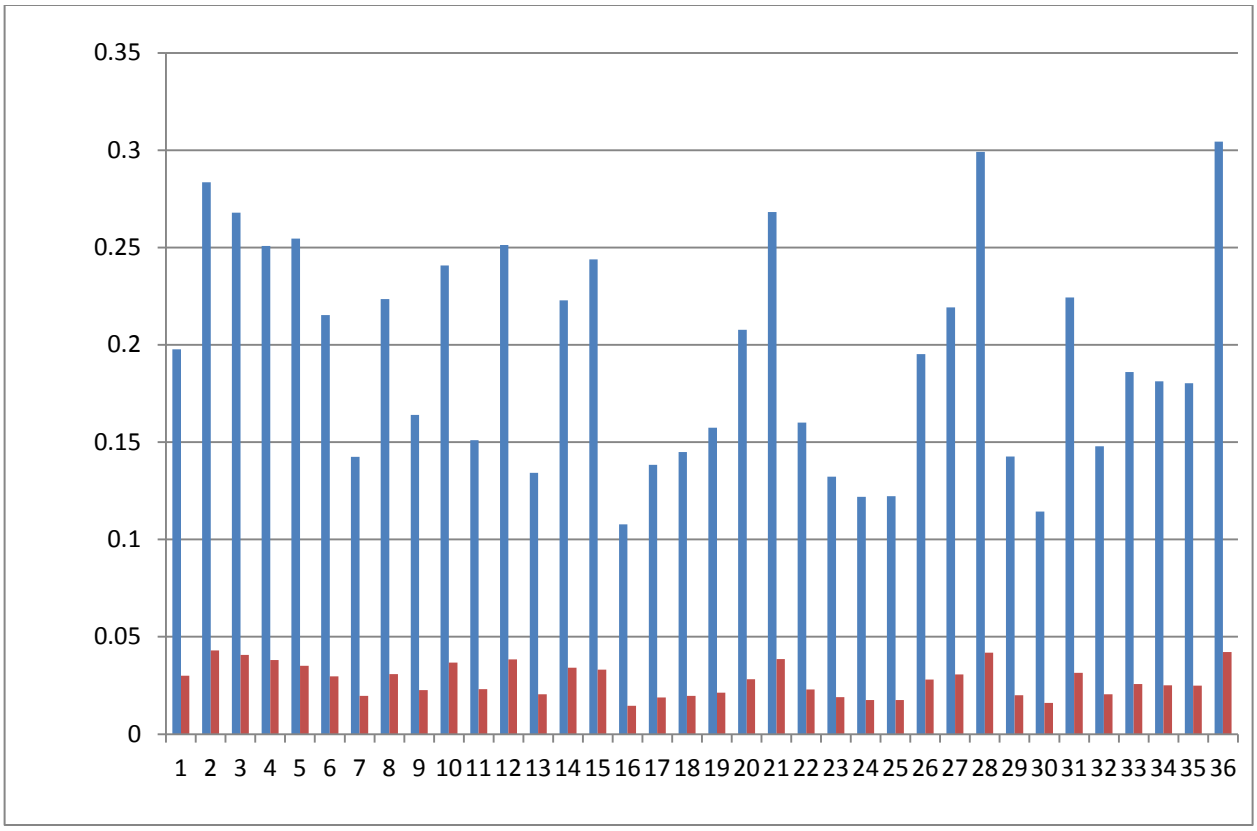


Figure 7.6 Resultant Index

## 7.5 TECHNIQUE FOR ORDER PREFERENCES BY SIMILARITY TO IDEAL SOLUTION

It was developed by Hwang & Colleagues in 1981 and widely accepted for identification of solutions from a finite set of alternatives. The alternatives evaluated by attributes are related to points in a dimensional space which has the shortest euclidean distance from the positive ideal solution (PIS) and the longest euclidean distance from the negative ideal solution (NIS) preferred as most suitable alternative (Hwang et al.,1993). In other words, the positive ideal solution is composed of all the best values attainable of criteria, whereas the negative ideal solution consists of all worst values attainable of criteria (Ertugrul and Karakasoglu, 2009).The main steps for the TOPSIS method are discussed below:

### 7.5.1 Building of Decision Matrix

The first step is to define the problem in terms of alternatives and attributes. This information is expressed in the form of decision matrix, as follows:$A_1$, $A_2$,……,$A_m$ represent the set of alternatives; $a_1$, $a_2$,……,$a_n$ represent the set of attributes; $x_{ij}$ represents the values of attributes *j* for alternative *i*. Table 7.2 shows values of decision matrix where weightages are computed from questionnaire survey and put in equation 1.

$$A = \begin{array}{c} Alternatives \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} a_1 & a_2 & \cdots & a_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} \tag{1}$$

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is one of the most useful Multi Attribute Decision Making technique that is very simple and easy to implement, which can be used when the user prefers a simpler weighting approach. On the other hand, the ANP approach provides a decision hierarchy and requires pairwise comparison among criteria. The user needs a more detailed knowledge about the criteria in the decision hierarchy to make informed decisions for this technique. Here the priorities are obtained from ANP as weightage for integration with decision matrix.

Table 7.2 A sample of Decision Matrix

| **Factors** | **A** | **B** | **C** | **D** | **E** |
|---|---|---|---|---|---|
| Sb | 32 | 32 | 16 | 52 | 41 |
| Ib | 24 | 34 | 15 | 50 | 42 |
| Eb | 50 | 33 | 14 | 48 | 42 |
| Cb | 52 | 31 | 15 | 51 | 40 |
| Gb | 54 | 30 | 15 | 53 | 42 |
| Pb | 43 | 34 | 16 | 50 | 43 |
| Fb | 46 | 29 | 12 | 45 | 40 |

Where Sb = Strategic benchmarking, Ib = Internal Benchmarking, Eb = External benchmarking, Cb = Competitive benchmarking, Gb=Generic Benchmarking, Pb = Performance Benchmarking, Fb = Functional benchmarking and A, B, C, D, E= Planning, Reliability, Standardization, Time Behaviour, Usability are important critical success factors. By using equation 2, Normalized decision matrix is computed.

### 7.5.2 Formation of Normalized Matrix

In this step, the normalized matrix is formed from the decision matrix, 'A'. Normalization is done to bring the values in a particular range and to make them dimensionless. Normalized matrix is computed in Table 7.3, where the elements of the normalization matrix have been calculated by using equation 2:

$$n_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x^2{}_{ij}} \qquad (2)$$

Where, $x_{ij}$ is the element of the decision matrix, 'A'

Table 7.3 Normalized Decision Matrix

| | **A (0.042)** | **B (0.042)** | **C (0.041)** | **D (0.040)** | **E (0.038)** |
|---|---|---|---|---|---|
| Sb | 0.1242548 | 0.143235159 | 0.14911625 | 0.145940696 | 0.142127743 |
| Ib | 0.1076078 | 0.147643423 | 0.14438119 | 0.143106627 | 0.143850567 |
| Eb | 0.1553185 | 0.145455992 | 0.13948548 | 0.140215286 | 0.143850567 |
| Gb | 0.1583944 | 0.140979347 | 0.14438119 | 0.144530608 | 0.140383779 |
| Cb | 0.1614117 | 0.138686847 | 0.14438119 | 0.14733729 | 0.143850567 |
| Pb | 0.1440365 | 0.147643423 | 0.14911625 | 0.143106627 | 0.145553 |
| Fb | 0.1489763 | 0.136355809 | 0.12913846 | 0.135762867 | 0.140383779 |

The pair wise comparison has been performed between the attributes and a relative importance matrix 'C' is formed, which is n X n matrix. This matrix has elements $c_{ij}$ representing the relative importance of the *i*th attribute over the *j*th. The symmetric terms of the matrix will be reciprocal of each other. Eigen vector method is used to calculate the weight vector, as it allows some inconsistencies arising because of human behaviour in building relative importance matrix 'C' by using equation 3.

$$Cx = \lambda x \tag{3}$$

The other approaches can also be applied to find the weights like AHP, ANP, Standard Deviation Method, Entropy Method etc. The weight vector is calculated as follows:

(1) Find $x_{max}$, eigenvector, corresponding to the maximum eigen value $\lambda_{max}$

(2) Find the sum of the elements of $x_{max}$ with utilizing equation 4 as follows:

$$\delta = \sum_{i=1}^{n} (x_i)_{\max} \tag{4}$$

Finally, the weight vector is calculated by using

$$w = \frac{(x_{\max})}{\delta} \quad such\ that \sum_{i=1}^{n} w_i = 1 \tag{5}$$

Where λ is the eigen value of C and x is the corresponding eigen vector.

### 7.5.3 Formation of Weighted Normalized Matrix

The matrix, which combines the relative weights and normalized specification of the alternatives, is weighted normalized matrix, 'E' and shown in Table 5, where weights are multiplied with normalized matrix as in equation 6.

$$E = \begin{matrix} w_1 d_1 l & \dots & w_m d_1 m \\ w_1 d_n l & \dots & w_n d_n m \end{matrix} = \begin{matrix} e_1 l & \dots & e_1 m \\ e_n l & \dots & e_n m \end{matrix} \tag{6}$$

Table 7.4 The Weighted Matrix (Computed from equation 6)

| | A | B | C | D | E |
|---|---|---|---|---|---|
| Pb | 0.0034791 | 0.004869995 | 0.00268409 | 0.003648517 | 0.002558299 |
| Ib | 0.003013 | 0.005019876 | 0.00259886 | 0.003577666 | 0.00258931 |
| Gb | 0.0043489 | 0.004945504 | 0.00251074 | 0.003505382 | 0.00258931 |
| Cb | 0.004435 | 0.004793298 | 0.00259886 | 0.003613265 | 0.002526908 |
| Sb | 0.0045195 | 0.004715353 | 0.00259886 | 0.003683432 | 0.00258931 |
| Eb | 0.004033 | 0.005019876 | 0.00268409 | 0.003577666 | 0.002619954 |
| Fb | 0.0041713 | 0.004636098 | 0.00232449 | 0.003394072 | 0.002526908 |

### 7.5.4 Ranking of Alternatives

The weighted normalized matrix 'E' is used to find the positive and negative ideal solutions as shown in Table 7.5, where formation of Ideal solution is computed. The Euclidean distance from the positive and negative ideal solution is calculated as:

The Euclidean distance from the positive ideal solution is shown in Table 6 and computed from equation 7.

$$S_i^+ = \sqrt{\sum_{j=1}^{m} (e_i^+ - e_{ij})^2}\ ;\ i = 1, 2, 3.....n \qquad (7)$$

The Euclidean distance from the negative ideal solution is shown in Table 6, where equation 8 is used.

$$S_i^- = \sqrt{\sum_{j=1}^{m} (e_{ij} - e_i^-)^2}\ ;\ i = 1, 2, 3.....n \qquad (8)$$

Table 7.5 Maximum & Minimum values (Computed from equation 7)

| | 1 | 2 | 3 | 4 | 5 | Sum of sqrt |
|---|---|---|---|---|---|---|
| $S^+$ | 0.0045195 | 0.005019876 | 0.00268409 | 0.003683432 | 0.002619954 | 0.301763284 |
| $S^-$ | 0.003013 | 0.004636098 | 0.00232449 | 0.003394072 | 0.002526908 | 0.477327861 |

Relative closeness (K*) is shown in Table 7.6, where final value of solution is computed by equation 9 as follows:

$$K^* = \frac{S_i^-}{S_i^- + S_i^+} \quad . \tag{9}$$

Table 7.6 Values of K* (Closeness Coefficients by using equation 9)

| Factors | A | B | C | D | E |
|---|---|---|---|---|---|
| Pb | 0.86188311 | 2.783934962 | 0.999993084 | 1.159041865 | -1.037277466 |
| Ib | -1.252E-05 | 0.999999013 | 1.450604764 | 0.351462545 | 1.964903712 |
| Gb | 1.14637995 | 1.316432703 | 14.44096692 | -1.667824571 | 0.99404612 |
| Cb | 1.06314078 | -2.265830886 | 1.450604764 | 1.470834613 | -1.47411E-07 |
| Sb | 0.99998121 | -2.265830886 | -0.05478027 | 0.999999147 | 1.964903712 |
| Eb | 1.91179263 | 4.842313582 | 0.999993084 | 2.358987004 | 1.00000009 |
| Fb | 1.42974145 | 4.681719813 | 6.33989E-06 | 1.16234E-06 | -1.47411E-07 |

## 7.6 MOORA APPROACH

Multi-objective optimization on the basis of ratio analysis (MOORA) is also known as multi-criteria or multi-attribute optimization. It is defined as the process of simultaneously optimizing two or more conflicting attributes subjected to some constraints (Attri and Grover 2013; Chakraborty 2011; Karande and Chakraborty 2012).This approach was introduced by Brauers (2004) and starts with a matrix consisting of performance measures for different alternatives with respect to various criteria. MOORA approach consists of basically two sections namely ratio system approach and the reference point approach. Both sections provide same result while applying this approach.

$$X = \begin{Bmatrix} X_{11}\, X_{12} \ldots\ldots X_{1n} \\ X_{21} X_{21} \ldots\ldots X_{2n} \\ \ldots\ldots\ldots\ldots\ldots \\ \ldots\ldots\ldots\ldots\ldots \\ X_{m1}\, X_{m2} \ldots\ldots X_{mn} \end{Bmatrix} \tag{10}$$

Where $x_{ij}$ is the performance measure of the $i^{th}$ alternative on the $j^{th}$ attribute, m is the number of alternatives and n is the number of the attributes. The initial data in the decision matrix is normalized. The reason behind the normalization is to make the decision matrix dimensionless and make all the elements of the decision matrix comparable.

### 7.6.1 Decision Matrix for MOORA Application

As per Karande and Chakraborty (2012), normalization can be done by comparing the performance of an alternative on a criterion to a denominator which is a representative for all the alternatives concerning that criterion.

$$X_{ij}^{*} = \frac{X_{ij}}{\sum_{i=1}^{m} X_{ij}} \tag{11}$$

Where $X_{ij}^{*}$ is a dimensionless number in the [0, 1] interval, which represents the normalized performance of the $i^{th}$ alternative on the $j^{th}$ criterion. The elements of the matrix are normalized without considering the type of the attribute i.e. beneficial attribute or non-beneficial attribute. Beneficial attributes are those attributes whose higher values are required, while for non-beneficial attributes, lower values are required.

Table 7.7 Decision Matrix for MOORA Application

| **Factors** | **A** | **B** | **C** | **D** | **E** |
|---|---|---|---|---|---|
| Pb | 0.11627 | 0.27584 | 0.05185 | 0.24806 | -0.2123 |
| Ib | -2E-06 | 0.09908 | 0.07521 | 0.07522 | 0.4021 |
| Gb | 0.15465 | 0.13043 | 0.74873 | -0.3569 | 0.20342 |
| Cb | 0.14342 | -0.2245 | 0.07521 | 0.31479 | -3E-08 |
| Sb | 0.1349 | -0.2245 | -0.0028 | 0.21402 | 0.4021 |
| Eb | 0.2579 | 0.47978 | 0.05185 | 0.50487 | 0.20464 |
| Fb | 0.19287 | 0.46387 | 3.3E-07 | 2.5E-07 | -3E-08 |
| BA/NBA | NBA | BA | BA | BA | BA |

With application of MOORA method, firstly a decision matrix is formed i.e. Relative coefficients obtained by TOPSIS method are solved by using equation 11 and computed in

Table 7.7. After that Beneficial (BA) and Non Beneficial (NBA) factors are selected for problem solution. Here, planning is non-beneficial attribute and remaining are beneficial attributes selected by the experts. Then the final value of ranking from equation 12 is obtained which is shown in Table 7.8.

### 7.6.2 Calculation Value of MOORA

For optimization based on ratio system approach of MOORA method, normalized performances are added in case of beneficial attributes (maximization) and subtracted in case of non-beneficial attributes (minimization), which can be expressed by following expression:

$$y_i^* = \sum_{j=1}^{g} x_{ij}^* - \sum_{j=g+1}^{n} x_{ij}^* \tag{12}$$

where, $y_i^*$ is the assessment value of the $i^{th}$ alternative with respect to all the criteria, g is the number of criteria to be maximized and (n - g) is the number of the criteria to be minimized. Furthermore the value of $y_i^*$ can be positive or negative depending on the total of beneficial and non-beneficial attributes in the matrix. The alternative with highest value of $y_i^*$ would be the best alternatives. An ordinal ranking of $y_i^*$ shows the final preference.

In some cases, it is often observed that some attributes are more important than the others. In order to give more importance to an attribute, it could be multiplied with its corresponding weight (significance coefficient).When these attribute weights are taken for consideration the equation becomes as follows:

$$y_i^* = \sum_{j=1}^{g} w\,ix_{ij}^* - \sum_{j=g+1}^{n} wix_{ij}^* \tag{13}$$

Where, $w_j$ is the weight of $j^{th}$ attribute, which can be determined by applying analytic hierarchy process (AHP) or ANP and any other method. The $y_i$ value can be positive or negative depending of the total of its maxima (beneficial attributes) and minima (non-beneficial attributes) in the decision matrix.

Table 7.8 Final Value of MOORA

| $Y_i$ | Ranking | Benchmarking |
|---|---|---|
| 0.2472 | **6** | Pb |
| 0.65161 | **2** | Ib |
| 0.57099 | **3** | Gb |
| 0.02208 | **7** | Cb |
| 0.25388 | **5** | Sb |
| 0.98324 | **1** | Eb |
| 0.271 | **4** | Fb |

## 7.7 RESULTS AND DISCUSSION

This chapter identifies 7 objectives and 36 critical success factors with main goal, where critical success factors namely Planning, Reliability, Standardization, Time Behaviour, Usability are found significant by ANP approach. As these critical success factors have comparatively higher weightings, thus these can be used for further analysis. These five important critical success factors are also been used with their weightages in TOPSIS approach for identifying best alternative for this study. After these methods, MOORA method is applied to simplify the calculations and ranking of alternatives with simple steps. Where 'Planning' has selected for non-beneficial attribute by expert's team while remaining attributes are selected as beneficial for selection. The outcomes of this chapter shows that External benchmarking, Internal benchmarking and Generic benchmarking are the first three ranks of benchmarking and ranking are ordered as EB>IB>GB>FB>SB>PB>CB for descending order as per result obtained from Table 7.8. So, External Benchmarking is computed as highest rank with $y_i$ index value of 0.98324 for service industries in India. Overall comparison in ranking of benchmarking is epitomized in figure 7.7. Ranking shows that service industries need to follow External benchmarking model to improve their competitiveness in Indian scenario. MCDM approaches are recommended for benchmarking

in service industries to select the best alternative from a number of alternatives. The several disparities among the ranking of alternatives are occurred due to assorted opinion given by various decision makers. Comparative large numbers of calculations, these methods are simple in calculations and easily comprehensible which can handle a large number of selection criteria. Results of this research work are converting the subjective decision into objective process which is fairly supportive for the industrial development country like India.

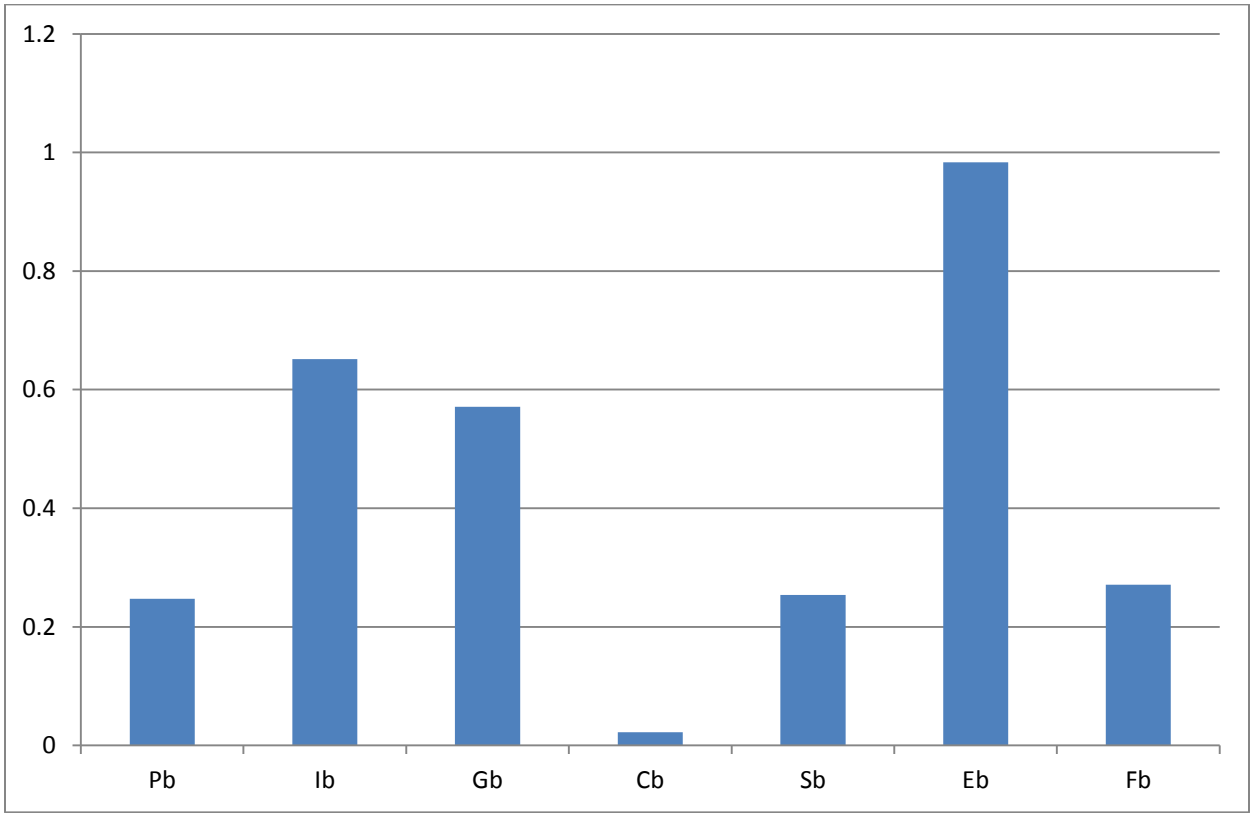


Figure 7.7 Graph showing Ranking of alternatives

## 7.8 VALIDATION OF ALTERNATIVES

In order to validate the results of alternatives, the comparison of identified attributes has been verified with previous analysis of FGTA by MOORA method. Here 05 attributes and 12 nos. of alternatives are used as per Table 7.9, where the description of alternatives is shown in brief. Five main attributes which are Tangibles, Responsiveness, Reliability, Assurance and Empathy are identified for benchmarking in service industries. For MOORA method, the

normalized decision matrix is required to solve the problem which is obtained from the decision matrix as shown in Table 7.10, where qualitative data are used from previous analysis. Applying normalized equation the normalized decision matrix is computed in Table 7.11. On the basis of ANP, important weights are found to solve the problem but only for problem which are $W_{TS}$ = 0.028,$W_{RSP}$ = 0.017, $W_{RLB}$ = 0.018, $W_{ASR}$ = 0.025, $W_{EMY}$ = 0.020 are considered. These identified weights can be used easily for the process of MOORA method. After finding normalized decision matrix these same weights can be used for consequent analysis. Then, normalized assessment values ($Y_i$) of all the considered alternatives are computed by using the equation 12, as shown in Table 7.13.

Table 7.9 List of Attributes

| Alternatives | Descriptions |
|---|---|
| [FLX] | **Flexibility:** This covers design flexibility, volume flexibility, process operation flexibility with service. |
| [QUL] | **Quality:** This is an indicator of the quality of the product. Will it conform to the required specifications and tolerances? |
| [TNF] | **Technical feasibility:** Is the system capable of producing the product to the required specifications? Can it handle the large jobs precisely? |
| [MKP] | **Market position:** This is an indicator of the competition faced, the price sensitivity, the customer requirements and the product mix. |
| [CUS] | **Customer feedback:** This is an indicator of the company's towards quality and reliability feedback will help to improve the quality outcome. |
| [DLT] | **Delivery Time:** It is the time between order placed and goods to deliver at the customer end that will improve customer relations. |
| [TPT] | **Throughput:** This is an indicator of the lead time, cycle time and dispatch time of the System that will effect delivery time. |
| [STP] | **Strategic Planning:** Mainly involves the assessment of capabilities of the organization to meet requirements of benchmark. |
| [IFO] | **Information:** How efficiently information and statistics regarding the state of |

| | |
|---|---|
| | production &requirements are processed and supplied to the management? |
| [CPU] | **Capacity utilization:** To what extent is the idle time of system reduced? Does system facilitate greater utilization with production and process planning? |
| [EMR] | **Employee relations:** How much emphasis does the company place on the worker's attitude, morale and problems? How will the system effect? |
| [HUF] | **Human factors:** How does it compare with other system in terms of safety and ergonomics, i.e., in terms of efficiency and convince of the workers? |

In Table 7.10, qualitative data are used for validation of alternative of problem solution which will be further used for normalized decision matrix.

Table 7.10 Qualitative Data of Problem

| S.No. | Alternatives | TS | RSP | RLB | ASR | EMY |
|---|---|---|---|---|---|---|
| 1 | FLX | 0.255 | 0.745 | 0.135 | 0.955 | 0.045 |
| 2 | QUL | 0.500 | 0.865 | 0.590 | 0.865 | 0.955 |
| 3 | TNF | 0.590 | 0.590 | 0.865 | 0.665 | 0.135 |
| 4 | MKP | 0.665 | 0.955 | 0.955 | 0.500 | 0.590 |
| 5 | CUS | 0.745 | 0.665 | 0.500 | 0.335 | 0.665 |
| 6 | DLT | 0.410 | 0.955 | 0.335 | 0.410 | 0.335 |
| 7 | TPT | 0.865 | 0.500 | 0.255 | 0.255 | 0.500 |
| 8 | STP | 0.955 | 0.255 | 0.410 | 0.135 | 0.410 |
| 9 | IFO | 0.335 | 0.410 | 0.665 | 0.935 | 0.255 |
| 10 | CPU | 0.955 | 0.135 | 0.745 | 0.590 | 0.865 |
| 11 | EMR | 0.135 | 0.045 | 0.045 | 0.045 | 0.955 |
| 12 | HUF | 0.045 | 0.335 | 0.955 | 0.765 | 0.745 |

Where TS: Tangibles, RSP: Responsiveness, RLB: Reliability, ASR: Assurance, EMY: Empathy are attributes.

Table 7.11 Normalized Decision Matrix of problem

| S.No. | Alternatives | TS (0.028) | RSP (0.017) | RLB (0.018) | ASR (0.025) | EMY(0.020) |
|---|---|---|---|---|---|---|
| 1 | FLX | 0.0395043 | 0.115414407 | 0.02091402 | 0.147947328 | 0.00697134 |
| 2 | QUL | 0.0774593 | 0.134004648 | 0.09140201 | 0.134004648 | 0.147947328 |
| 3 | TNF | 0.091402 | 0.091402014 | 0.13400465 | 0.103020914 | 0.02091402 |
| 4 | MKP | 0.1030209 | 0.147947328 | 0.14794733 | 0.077459334 | 0.091402014 |
| 5 | CUS | 0.1154144 | 0.103020914 | 0.07745933 | 0.051897754 | 0.103020914 |
| 6 | DLT | 0.0635167 | 0.147947328 | 0.05189775 | 0.063516654 | 0.051897754 |
| 7 | TPT | 0.1340046 | 0.077459334 | 0.03950426 | 0.03950426 | 0.077459334 |
| 8 | STP | 0.13400465 | 0.03950426 | 0.06351665 | 0.02091402 | 0.063516654 |
| 9 | IFO | 0.14794733 | 0.063516654 | 0.10302091 | 0.144848954 | 0.03950426 |
| 10 | CPU | 0.05189775 | 0.02091402 | 0.11541441 | 0.091402014 | 0.134004648 |
| 11 | EMR | 0.14794733 | 0.00697134 | 0.00697134 | 0.00697134 | 0.147947328 |
| 12 | HUF | 0.02091402 | 0.051897754 | 0.14794733 | 0.118512781 | 0.115414407 |

Table 7.12 Weighted Matrix

| S. No. | Alternatives | TS | RSP | RLB | ASR | EMY |
|---|---|---|---|---|---|---|
| 1 | FLX | 0.0011061 | 0.001962045 | 0.00037645 | 0.003698683 | 0.000139427 |
| 2 | QUL | 0.0021689 | 0.002278079 | 0.00164524 | 0.003350116 | 0.002958947 |
| 3 | TNF | 0.0025593 | 0.001553834 | 0.00241208 | 0.002575523 | 0.00041828 |
| 4 | MKP | 0.0028846 | 0.002515105 | 0.00266305 | 0.001936483 | 0.00182804 |
| 5 | CUS | 0.0032316 | 0.001751356 | 0.00139427 | 0.001297444 | 0.002060418 |
| 6 | DLT | 0.0017785 | 0.002515105 | 0.00093416 | 0.001587916 | 0.001037955 |
| 7 | TPT | 0.0037521 | 0.001316809 | 0.00071108 | 0.000987607 | 0.001549187 |
| 8 | STP | 0.0041425 | 0.000671572 | 0.0011433 | 0.000522851 | 0.001270333 |
| 9 | IFO | 0.0014531 | 0.001079783 | 0.00185438 | 0.003621224 | 0.000790085 |
| 10 | CPU | 0.0041425 | 0.000355538 | 0.00207746 | 0.00228505 | 0.002680093 |
| 11 | EMR | 0.0005856 | 0.000118513 | 0.00012548 | 0.000174284 | 0.002958947 |
| 12 | HUF | 0.0001952 | 0.000882262 | 0.00266305 | 0.00296282 | 0.002308288 |

All of the criteria are considered as beneficial and no one is non-beneficial for benchmarking view than $y_i$ is calculated by using equation 12 and above Table 7.12.The values of $y_i$ index are shown in Table 7.13.

Table 7.13 Ranking of Alternatives

| S. No | Attributes | $y_i$ | Rank |
|---|---|---|---|
| 1 | FLX | 0.007282727 | 11 |
| 2 | QUL | 0.012401239 | 1 |
| 3 | TNF | 0.009518978 | 5 |
| 4 | MKP | 0.011827266 | 2 |
| 5 | CUS | 0.009735089 | 4 |
| 6 | DLT | 0.007853602 | 9 |
| 7 | TPT | 0.008316809 | 8 |
| 8 | STP | 0.007750581 | 10 |
| 9 | IFO | 0.008798606 | 7 |
| 10 | CPU | 0.011540666 | 3 |
| 11 | EMR | 0.00396282 | 12 |
| 12 | HUF | 0.009011619 | 6 |

For analysis of MOORA method the results are obtained as per ranking while arranged descending order i.e. 2-4-10-5-3-12-9-7-6-8-1-11. So, the alternative Quality (2) is the best alternative for Benchmarking of service industries in India among all the 11 alternatives. On previous analysis by FGTA shows the results for best alternative was Quality and ascending order was 2-4-10-5-3-12-9-7-6-8-1-11 which are same as for both the cases. The last rank for both the cases is employee's relationship i.e. 11 in serial number. In general, it does not matter that the different methods give different rankings, so long as the first choice and mostly choices are remain the same. But in this case all value obtained from both techniques are remaining same. Thus MOORA technique validates positively FGTA results with proper results in both ascending and descending order.

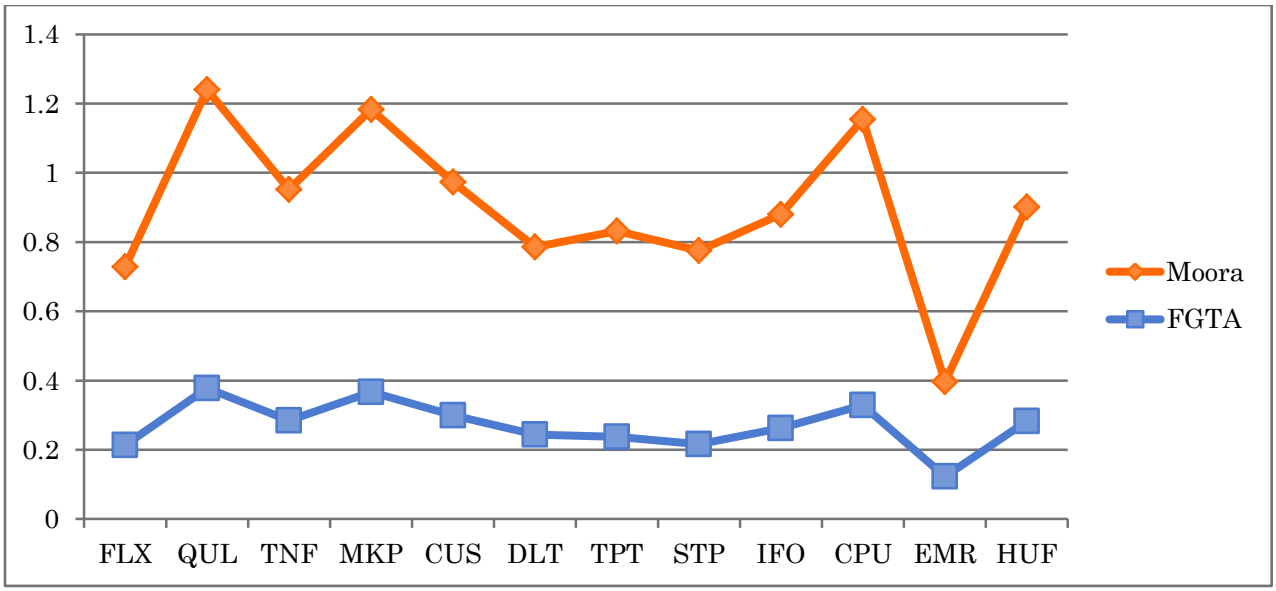


Figure 7.8 Validations of Results

MOORA approach helps to compare identified attributes which are found by using Fuzzy Graph Theory. The comparative results are shown in figure 7.8.

It indicates that as per result obtained the service system in descending order as: QUL>MKP>CPU>CUS>TNF>HUF>IFO>TPT>DLT>STP>FLX>EMR. In general, it does not matter that the different methods give different rankings, so long as the first and last choice are remain the same. But in this case all ranking obtained from both techniques are same. Thus MOORA technique validates positively results of FGTA with proper order.

## 7.9 CONCLUDING REMARKS

Usage of hybrid ANP, TOPSIS and MOORA method provides a unique model for evaluation, as these methods are systematic and reliable with capability of capturing the expert's opinions when complex MCDM problems are considered. Thus, the use of ANP weights in TOPSIS method and relative closeness of TOPSIS method in MOORA method makes the benchmarking process more balanced and realistic. The proposed method is logical and has ranked the alternative in few steps with easy calculations. In other words, it serves as a guideline to the executives in outsourcing related benchmarking decisions. Moreover, this hybrid model is containing the hierarchical structure, pairwise comparisons

and consistency examination in the evaluation process. Calculations formed by the model are faster than other mathematical techniques like DEA, AHP and Fuzzy logic based approaches.

This chapter gives an attempt to evaluate the existing prestige of benchmarking implementation and provides some thoughtful level of benchmarking activities for Indian service sector. An inspiring attention has been paid for recognizing the features professed by service industries to incorporate successful benchmarking process. The critical success factors found from literature have a framework for the industries which are significant for implementing benchmarking technique in industries. The finding of this evaluation may affect the development of benchmarking strategies and practices in developing countries like India. The industrial sectors which typically show above standard levels of benchmarking processes are Automobile service, Insurance and Hotels industries. This attempt for recognizing benchmarking techniques in service industries confirms attraction for destination managers as there is lack of knowledge for implementation of benchmarking techniques in Indian service industries. Given the strong association between benchmarking techniques and devotion, this evaluation provides a serious thought about decision selection for managers in their industries.

# CHAPTER VIII

# CONCLUSION, FUTURE SCOPE AND LIMITATIONS

***Chapter Objective***

*This chapter gives conclusion for study on the basis discussion of previous chapters. The resultant is briefly discussed to summarize the present thesis. It also reinforces the constraint of system and highlights the reward of exploring benchmarking model at subsystem level. This chapter also explores the potential of future research based on proposed approach and limitations of the study also.*

## 8.1 CONCLUSION

Service quality is a main concern which can be sighted as the development in service industries. The exponential expansion in the development of service and its embracement by the customer has put more effort in the market.

Since, in the literature various benchmarking models are developed where the existing models are not accessible for good service with presented circumstances of the service. The success of service industries imposed more factors to describe its quality environment which causes development of new benchmarking model and extend the previous models to contain the emerging factors. The purpose is to develop a benchmarking model which could represent critical success factors of quality within service environment. The esteemed literature review helps to review the benchmarking technique in manufacturing sector and service industries which help to identify the critical success factors for both industries. The pilot survey has carried out to eliminate the trivial factors. More than hundred factors are identified from the pilot survey. Based on these factors main survey has been conducted for different phases of benchmarking and quality enabled factors are prioritized by using MADM approaches in order to evaluate their impact of the benchmarking model for Indian service industries. The four phases of benchmarking model has been evaluated by using Interpretive Structural Modeling and Fuzzy Graph Theory. Quantification of critical success factors has been carried out using Graph theory and matrix methods to check the effect of factors.

Furthermore, it is observed that myopia attitudes of benchmarking and too much idealism of the concept are discouraging the practitioners. Still in many ways it is beneficiary for the industry and customers. Hence types of benchmarking have been compared on performance based by TOPSIS method. It is found that hybrid methodology consisting of ANP, TOPSIS and MOORA method are being liked by Indian practitioners for finding the effectiveness. This research is insightful for making efficient and customer oriented benchmarking system. The results obtained from these MADM approaches are cross verified by MOORA technique.

## 8.2 MAJOR CONTRIBUTIONS OF RESEARCH

The major contributions made through the present research work are as follows:

- The present research work provides a comprehensive review of literature on the benchmarking process. Moreover, it also articulates the distinctive features and limitation of each benchmarking application in industries.
- Applications of techniques used in service industries have been studied for quality improvement.
- A model for benchmarking has been suggested specifically for the service industries.
- Present work has highlighted benchmarking application in Indian service industries with a suitable case study.
- Developed countries have used benchmarking model to improve their growth in industrial sectors. The same expectation may be seen in India also. The study is exploring all those prerequisite conditions to meet benchmarks for better tomorrow.
- The key activities involved in every phase of the benchmarking model have been recognized along with the department involved in performing these key activities.
- Various quality enabled factors of different phases in benchmarking system for service industries have been identified and described in detail.
- The quality enabled factors of different stages of benchmarking have been prioritized to enumerate their impact in the service industries.

- An overview of barriers involved in different phases of benchmarking model has also been found.
- This study will enhance the thinking of benchmarking practice in acceptable manner and will motivate the industry to use the convenient components of service industries.

## 8.3 LIMITATIONS OF THE RESEARCH

Though lots of efforts have been made in this research work to analyze the quality enabled factors of benchmarking in Indian service industries but this research is not free from the limitations. The limitations of the present work are as follows:

- The developed ISM/ANP/FGTA/TOPSIS models are based on data collection method with the opinion of experts hence there is chance of biasing.
- This study consists of survey based methodology for industries which was restricted to northern region of India. While application of methodology in other regions may change the predict results of this study.
- Literature analysis has considered the research articles published in reputed journals during specified period. There is chance that more research articles can be cited which are not included in this study.

## 8.4 SCOPE FOR FUTURE WORK

Following future works are suggested to extend this study:

- More numbers of quality enabled factors can be identified for each phase of the benchmarking model, taking the recent literature in view.
- A comprehensive questionnaire based survey can be carried out to know the impact of the identified quality enabled factors in the manufacturing Industries.
- Developing nature of Indian economy keeps changing the quality and other aspects. Hence this study represents the current situation and may not be correct for coming years.

## 8.5 MANAGERIAL IMPLICATIONS

The benchmarking model developed in this work will provide an insight to the management of automobile service industry about the critical success factors for the implementation of benchmarking process. Using this benchmarking model, the managers can compare their industries to the best performer of global market. The industries can easily analyze their gaps for improvements and may fulfill these gaps to overcome the different issues in benchmarking. The developed model based on MADM output is unique contribution of this research work, which identifies the most effective critical success factors to be utilized in industries. Its practical implication is to make use of the manager's experience and knowledge to provide a fundamental understanding of a complex situation.

The motivating finding of this work is identification of appropriate benchmarking, which helps the managers for implementing benchmarking as the results have strong impact on customer satisfaction and increasing efficiencies for service industries in Indian scenario. A destination with customer satisfaction, good services, credibility which assures security, value for money, timeliness offers impressive reliability for the industries and can also satisfy the barriers of benchmarking and resulting in implementation of benchmarking model with proper recommendations.

**APPENDIX -1**

## QUESTIONNAIRE

### SECTION 1: ORGANIZATION PROFILE

1. (a) Name of organization ----------

   (b) Type of business ----------

2. Please indicate the number of employees at your organization:

   (a) Less than 100 (b) 101-500 (c) 501-1000
   (d) 1001 to 3000 (e) More than 3000

3. Please indicate the total turnover of your organization in Rupees (Crores):

   (a) Less than 10 (b) 10-50 (c) 50-100
   (d) 100 to 500 (e) More than 500

### SECTION 2: Quality enabled factors of various phases in Benchmarking system

Quality enabled factors are those factors which are essential for the accurate and efficient decision making in different phases of Benchmarking system. Therefore, you are requested to rate of five for most necessary and one for least desired quality enabled factor.

**Phase 1: Planning for the system**

**1 (a) Customer Requirements**

| S. No | Customer Requirements | Rating | | | | |
|---|---|---|---|---|---|---|
| 1 | Workmanship compatibility to customer desires | 1 | 2 | 3 | 4 | 5 |
| 2 | Value to service rendered | 1 | 2 | 3 | 4 | 5 |
| 3 | Promptness to Serve | 1 | 2 | 3 | 4 | 5 |
| 4 | Grievance Redressal response level | 1 | 2 | 3 | 4 | 5 |
| 5 | Customer retention policy implementation | 1 | 2 | 3 | 4 | 5 |
| 6 | System Governance & Attention to customer queries | 1 | 2 | 3 | 4 | 5 |
| 7 | Employer's Attitude at workplace | 1 | 2 | 3 | 4 | 5 |
| 8 | Warranty & Claim settlement initiatives | 1 | 2 | 3 | 4 | 5 |
| 9 | Adherence to Professional ethics | 1 | 2 | 3 | 4 | 5 |
| 10 | Ambience at workplace | 1 | 2 | 3 | 4 | 5 |

**1 (b) Team Formation**

| S. No | Team formation factors | Rating | | | | |
|---|---|---|---|---|---|---|
| 1 | Attitude to learn & deliver workmanship | 1 | 2 | 3 | 4 | 5 |
| 2 | Employees skill level | 1 | 2 | 3 | 4 | 5 |
| 3 | Participation to Technological update initiatives | 1 | 2 | 3 | 4 | 5 |
| 4 | Recognition and Reward expectations by the employee | 1 | 2 | 3 | 4 | 5 |
| 5 | Multi-tasking capabilities & specialties at workmanship level | 1 | 2 | 3 | 4 | 5 |
| 6 | Hierarchical coordination at employee levels | 1 | 2 | 3 | 4 | 5 |

**Phase: 2 Analyzing Phase**

**2 (a) Data Collection**

| S. No | Data requirement factors | Rating | | | | |
|---|---|---|---|---|---|---|
| 1 | Process need assessment | 1 | 2 | 3 | 4 | 5 |
| 2 | Group size and stakeholders identification | 1 | 2 | 3 | 4 | 5 |
| 3 | Tool & Techniques model assessment | 1 | 2 | 3 | 4 | 5 |
| 4 | Data flexibility to process upgradation modeling | 1 | 2 | 3 | 4 | 5 |
| 5 | Data collection objectivity of the process | 1 | 2 | 3 | 4 | 5 |

**2 (b) Evaluation**

| S. No | Evaluation factors | Rating | | | | |
|---|---|---|---|---|---|---|
| 1 | SWOT analysis w.r.t. competitive service providers | 1 | 2 | 3 | 4 | 5 |
| 2 | Process failure & Risk assessment strategy | 1 | 2 | 3 | 4 | 5 |
| 3 | Process technological upgradation flexibility | 1 | 2 | 3 | 4 | 5 |
| 4 | Customer desires Vs Functional requirement compatibility | 1 | 2 | 3 | 4 | 5 |
| 5 | Value for Money evaluation | 1 | 2 | 3 | 4 | 5 |

**Phase 3: Implementing Phase**

| S. No | Implementation factors | Rating | | | | |
|---|---|---|---|---|---|---|
| 1 | Quality of conformance | 1 | 2 | 3 | 4 | 5 |
| 2 | Process improvement planning | 1 | 2 | 3 | 4 | 5 |
| 3 | Optimal resource utilization policy | 1 | 2 | 3 | 4 | 5 |
| 4 | Perceived quality | 1 | 2 | 3 | 4 | 5 |
| 5 | Ergonomics in process | 1 | 2 | 3 | 4 | 5 |
| 6 | Aesthetics | 1 | 2 | 3 | 4 | 5 |

**Phase 4: System Effectiveness**

| S. No | Effectiveness factors | Rating | | | | |
|---|---|---|---|---|---|---|
| 1 | Impact assessment strategy | 1 | 2 | 3 | 4 | 5 |
| 2 | Formative questionnaire design criteria | 1 | 2 | 3 | 4 | 5 |
| 3 | Adaptability to modifications/ reforms implementation | 1 | 2 | 3 | 4 | 5 |
| 4 | Process assessment complexity | 1 | 2 | 3 | 4 | 5 |
| 5 | Market recognition | 1 | 2 | 3 | 4 | 5 |
| 6 | Measurand and Measurable complexity | 1 | 2 | 3 | 4 | 5 |

**Respondent profile**

1 Name (if you please): ----------

2 Designation:

(a) GM/AGM (b) Sr. Manager (c) Manager (d) Supervisor

3 Your functional area:

(a) Sales (b) Marketing (c) Service (d) Quality control

(e) Any other (Pl. specify)

4 Your association in years with current organization:

(a) Less than 5 (b) 5-7 (c) 8-10 (d) More than 10

5 Would you like to share the finding of the survey?

(a) Yes (b) No

**Thank you for your valuable feedback**

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# BRIEF PROFILE OF THE RESEARCH SCHOLAR

BHUPENDER SINGH is working as an Assistant Professor in the Mechanical Engineering Department at the YMCA University of Science and Technology, Faridabad, Haryana India. He has passed his Bachelor of Engineering in Mechanical Engineering from RGPV, BHOPAL in 2005, Master of Technology in Manufacturing and Automation from YMCA Institute of Engineering, Faridabad and pursuing his PhD from YMCA University of Science and Technology, Faridabad, India. He is having eight years' experience including Teaching and Research. He is currently doing research on Benchmarking processes. His area of interest is in the field of Quality Management System, Service Management, Industrial Engineering and Automobiles. He has published over 20 research papers in various international journals and conferences. Some of reputed publishers including Inderscience, Springer, Emerald etc. and attended international conferences at Dubai (UAE), IIM Kozhikode, DTU Delhi, PEC Chandigarh, etc.

# LIST OF PUBLICATIONS OF THESIS

## i. List of Published Papers

| S. No. | Title of Paper along with volume, issue no., year of publication | Publisher | Impact Factor | Whether paid any money for publication or not | Referred or Not Referred | Remarks |
|---|---|---|---|---|---|---|
| 1 | Weighted ISM approach to Interface amongst the Barriers of Benchmarking in Indian Service Industries, International Journal of Advanced Operations Management, Vol-7, No.4,2015,pp.317-340 | INDER SCIENCE Publisher | - | NO | YES | |
| 2 | An Empirical Study of Benchmarking Evaluation using MCDM in Service Industries, Managerial Auditing Journal, Managerial Auditing Journal, Vol-32, No.2, 2017, pp.111 – 147. | EMERALD group publisher | - | NO | YES | |
| 3 | Integrated MCDM for Benchmarking techniques in Indian Service Industries, International Journal of Innovation and Technology Management, Vol. 13, No. 6, 2016, 1750005-18. | WORLD SCIENTIFIC Publisher | - | NO | YES | |

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|---|---|---|---|---|---|---|
| 4 | An Analytic Hierarchy Process for Benchmarking of Automobile Car Service Industry in Indian context, Management Science Letters,Vol-5,No.6,2015,pp.543-554 | GROWING SCIENCE publisher | - | NO | YES | |
| 5 | An assessment model for Benchmarking techniques in manufacturing sector, Journal of Advance Research Production and Industrial Engg.,Vol-2,No.2,2015,pp.3-11 | ADR Publications | - | NO | YES | |
| 6 | A Benchmark model for Internal assessment of Industry using Fuzzy Topsis Approach, International Journal of recent advancement in Mechanical Engineering (IJMECH),Vol-4,No.1,2015,pp.93-105 | WIREILLA Publications | - | NO | YES | |
| 7 | Application of Benchmarking model in Manufacturing Industries, International Journal of Hybrid Information Technology, Vol.8, No.12, 2015, pp. 241-252 | SERSC publisher | - | NO | YES | |

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|---|---|---|---|---|---|---|
| 8 | Analysis of factors for Benchmarking Implementation in Service Industries: Evidence from Indian Context, Journal of Advance Research Production and Industrial Engg., Vol.2, No.3/4,2015,pp.6-10 | ADR Publications | - | NO | YES | |
| 9 | An overview of Benchmarking process : The Continuous Improvement Tool, YMCAUST International Journal, Vol.1,No.2, 2013,pp.80-83 | YMCA University | - | NO | YES | |

## ii. List of Accepted papers

| S. No. | Title of Paper along with volume, issue no., year of publication | Publisher | Impact Factor | Whether paid any money for publicatio n or not | Referred or Not Referred | Remarks |
|---|---|---|---|---|---|---|
| 10 | A Novel Hybrid model for selection of Benchmarking technique in Indian Service Industries, International Journal of Process Management and Benchmarking (In Press) | INDER SCIENCE, Publisher | - | NO | YES | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11 | Evaluation of benchmarking attribute for service quality using multi attitude decision making approach, International Journal of System Assurance Engineering and Management (In Press) | SPRINGER International Publisher | - | NO | YES | |
| 12 | A Benchmarking model for Indian service industries using MICMAC and WISM approach , International Journal of System Assurance Engineering and Management (In Press) | Springer International Publisher | - | NO | YES | |

## iii. List of Communicated papers

| S. No. | Title of Paper along with volume, issue no., year of publication | Name of International Journal | Publisher | Whether you paid any money for publication or not | Refer red or Not Refer red | Impact Factor | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | Applications of MOORA method for Benchmarking decision in the Industries | International Journal of Advanced Operations Management | INDER SCIENCE Publisher | NO | YES | -- | |

## iv. List of Papers in Conferences

| S. No. | Title of Paper | Name of Conference | Year |
|---|---|---|---|
| 1 | A Benchmarking model for Indian Service Industries | International Conference on CAR & FOF at **College Engg. & Mgmt, Kolaghat**, Kolkata, India | 2016 |
| 2 | Identification of gaps among manufacturing and service industries | International Conference and Exhibition on **Industrial Engineering Dubai,** UAE | 2015 |
| 3 | Application of Different Techniques used in Service Industries | International conference at **IIM Kozhikode**, India | 2015 |
| 4 | Effectiveness of success factors for Implementation of Benchmarking Technique | International Conference at **NIET, Noida**, India | 2015 |
| 5 | Ranking of Benchmarking Technique by using MADM (TOPSIS) Approach | National Conference at **PEC Chandigarh**, India | 2014 |
| 6 | Intensity of Critical Factors for Implementing Benchmarking Technique– An ANP Approach | ISTE Delhi Convention at **Delhi Technological University**, Delhi, India | 2013 |
| 7 | A systematic Review on Benchmarking | National Conference TAME - 2012 at **YMCAUST**, Faridabad, India | 2012 |