

The Comprehensive Research Process Design with Six Face Research Methodology

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Abstract

Purpose: A number of research methods are available to any researcher for investigating theories and then to validate it, however no standard methodology is available for conducting research as a process. The present paper is an attempt to develop a comprehensive research methodology based on process approach. **Methodology:** The paper is based on a case of PhD research on six sigma applications. Understanding the key components of research and mixing them together is very important aspect for research and researcher. Present paper is an attempt to establish research as a process and bring out various aspects of research with help of a case study. **Findings:** Every research targets a set of objectives from one or different research methods. A newly proposed innovative Six-Faced-Research-Methodology (SFRM) is one of the most innovative process-approach for conducting research on any topic. It is an innovative process to do quality research with innovative research design approach. **Conclusion:** The application to different research areas will prove its worth in future; however it is the present limitation also. The proposed method is of great value to researcher, scientist, managers and implementers.

Keywords: Six-Faced-Research-Methodology (SFRM), six-sigma, process management, innovation, research-design

1.0 Introduction

The research methods are divided into two broad categories: quantitative and qualitative research methods; these research methods have different approach, techniques and tools to conduct a research (Collis et al, 2009). Quantitative methods are the main focus in the development research while qualitative research methods are based on desirable outcomes. New tools and solutions are continuously developed and integrated to mix these research methods (Creswell, 2003). There is a need to understand the process of research and standardize research process. Any research has six stages to study and understand the need for research, understand and reveal the actual facts of present situation/problem, prove the known facts scientifically, find out hidden facts about the problem and to develop a new way to solve the problem. Through application of this research paper a new comprehensive research plan and design can be developed for any research area. Before proceeding further review of literature can be of great insight. There are numbers of

research methods used by different researchers for the same, a review of some selected are presented hereunder.

2.0 Literature review

This literature review aims to provide a comprehensive overview of research methods commonly employed in the social sciences. It covers various quantitative, qualitative, and mixed methods approaches, highlighting their strengths, limitations, and applications. The review also discusses key considerations such as research design, sampling techniques, data collection, and analysis methods. By synthesizing relevant studies and scholarly works, this review offers valuable insights for researchers seeking to select appropriate research methods for their investigations. Creswell (2014) provides a comprehensive guide on research design, covering qualitative, quantitative, and mixed methods approaches. The book explores various research designs, such as experimental, correlational, and case study designs, and discusses their applicability in different research contexts. Neuman (2016) offers an extensive overview of social research methods, focusing on both qualitative and quantitative approaches. The book emphasizes the importance of understanding research methodologies and their implications for data collection, analysis, and interpretation. Bryman (2016) presents a comprehensive text on social research methods, encompassing a wide range of topics, from research design and sampling techniques to data analysis and ethical considerations. The book provides practical guidance for researchers in selecting appropriate methods for their studies. Denzin and Lincoln (2017) compile *The Sage Handbook of Qualitative Research*, a seminal resource for qualitative researchers. This handbook covers various qualitative research traditions, such as ethnography, phenomenology, and grounded theory, and discusses key considerations, including reflexivity and the role of the researcher. Creswell and Poth (2017) delve into qualitative inquiry and research design, offering researchers a framework for choosing among five approaches: narrative, phenomenology, grounded theory, ethnography, and case study. The book explores the distinctive features, data collection methods, and analytical techniques associated with each approach. Babbie (2016) provides a comprehensive overview of the practice of social research, covering both qualitative and quantitative methods. The book emphasizes the importance of research design, measurement, and data analysis in producing reliable and valid research outcomes. Merriam (2017) focuses specifically on qualitative research, offering a guide for researchers in designing and implementing qualitative studies. The book addresses key aspects of qualitative research, such as developing research questions, selecting appropriate methods, and analyzing qualitative data. Yin (2017) specializes in case study research and applications, providing researchers with guidance on designing and conducting effective case studies. The book explores different types of case studies, data collection techniques, and approaches to data analysis in the context of case study research. Johnson and Christensen (2019) present an educational research text that covers quantitative, qualitative, and mixed approaches. The book addresses the unique considerations of educational research, providing examples and practical advice for conducting studies in educational settings. Silverman (2016) offers an in-depth examination of qualitative research, exploring various qualitative methods and their application in different research contexts. The book highlights the importance of researcher reflexivity, data interpretation, and ethical considerations in qualitative research. Teddlie and Tashakkori (2019) focus on the foundations of mixed methods research, highlighting the integration of quantitative and qualitative approaches in the social and behavioral sciences. The book provides researchers with guidance on designing and conducting rigorous mixed methods studies. Guest, MacQueen, and Namey (2012) introduce applied thematic analysis as a qualitative research method. The book offers practical guidance on conducting thematic analysis, including steps for coding and analyzing qualitative data. Creswell and Clark (2017) provide a comprehensive guide to designing and conducting mixed

methods research. The book outlines the sequential and concurrent mixed methods designs, highlighting their advantages and challenges, and provides examples to illustrate their application in different research studies. Patton (2014) presents an extensive resource on qualitative research and evaluation methods. The book covers a wide range of qualitative methods, including interviews, focus groups, and document analysis, and emphasizes the importance of rigor and validity in qualitative research. Onwuegbuzie and Leech (2019) explore sampling designs in qualitative research, focusing on making the sampling process more transparent and rigorous. The article discusses different sampling techniques, such as purposive sampling and snowball sampling, and provides insights into sampling considerations in qualitative studies. Morse (2015) offers a critical analysis of strategies for determining rigor in qualitative inquiry. The article discusses concepts such as credibility, transferability, dependability, and conformability and provides recommendations for enhancing the quality and rigor of qualitative research. Johnson and Onwuegbuzie (2004) advocate for the integration of mixed methods research in educational research. The article explores the benefits of using mixed methods, including complementarity and expansion, and discusses the challenges and opportunities of employing this research paradigm. Morse (2015) emphasizes the importance of enhancing the quality of qualitative research. The article discusses strategies for ensuring rigor, trustworthiness, and credibility in qualitative inquiry, including triangulation, member checking, and reflexive journaling. Crotty (2016) explores the foundations of social research, focusing on meaning and perspective in the research process. The book provides a philosophical and methodological understanding of social research and highlights the role of interpretation and context in shaping research outcomes. Bryman (2016) offers a comprehensive text on social research methods, covering various aspects of research design, data collection, and analysis. The book provides insights into different research approaches, ethical considerations, and challenges researchers may encounter during their studies. Mayoux (2005) suggested that quantitative methods are derived from experimental and statistical methods of research. The qualitative research methodologies focus on the selection of small scale that are investigated by using a combination of formal and in formal methods like interviews, observations and the newly introduced tools like photography and video footages (Grunow,1995). Petty et al. (2012), paper explores a number of commonly used methodologies and methods in qualitative research, a brief history of its development and variants is presented, followed by typical methods of data collection and analysis. Barratt, et al. (2011), examines the state of qualitative case studies in five operations management problems. They reported that there is a lack of consistency in the way the case method has been applied. The debate between quantitative and qualitative is divisive and, hence, counterproductive for advancing the social and behavioral science field (Onwuegbuzie and Leech, 2005). Meredith (1993) documented the advantages and rigor of case/field research and argues that these methods are preferred to the more traditional rationalist methods of optimization, simulation, and statistical modeling for building new operations management theories. Perry (1998) reports on the Australian development of a successful, structured approach to using the case study methodology in postgraduate research. As per McCutcheon (1993), case study research is a primary means of exploring field conditions but the case study method is viewed with scepticism by those who consider it to be a weak form of research, one that lacks rigor and objectivity. As per Stuart, et al (2002), despite many calls for case-based operations management research, the successful publication rate of such articles in top-tier journals has been less than stellar.

However Stuart, et al (2002) proposed the mixed methods research as the natural complement to traditional qualitative and quantitative research. It is needed to utilize both quantitative and qualitative techniques when conducting research (Onwuegbuzie and Leech, 2005). Meredith (1993) also concluded that alternate research methods are not mutually exclusive and, if

combined, can offer greater potential for enhancing new theories than either method alone. A key feature of mixed methods research is its methodological pluralism or eclecticism, which frequently results in superior research. Mixed methods research will be successful as more investigators study and help advance its concepts and as they regularly practice it (Johnson and Onwuegbuzie, 2004). Based on these literature review it is clear that researchers are always interested to know the best methodology to suits their requirements.

3.0 Objectives of the Research

The researchers are always worried about the suitable research method fit for the research. There is no standard process to conduct comprehensive research, hence the objectives of this research are:

- To propose and validate a comprehensive research methodology based on process approach.
- Researchers should be able to identify the process of research, input, output of research process and interaction among the research sub-processes.
- How researchers can plan for complete design of research, including tentative title of research papers also.

4.0 The Methodology

To achieve these objectives a solved problem of doctorate level research is presented as a case study. It is illustrated how to develop and design research with innovatively proposed mixed research methodology named as Six-Face-Research-Methodology (SFRM). This is based on actual research work of substantially good quality. Further discussion is actual implementation of SFRM to a selected and well defined research problem of doctorate level research.

5.0 The Case study

5.1 The Problem

The research problem of the case study is to identify & measure a set of performance indicators; analyze these item wise findings with appropriate tool and then to model them with suitable tools to establish relationship among them. The topic of the problem was 'Modeling and Analysis of Six-Sigma Systems in Manufacturing'. The deliverable outputs from the research are:

- To analyze the status of six-sigma implemented in manufacturing sector.
- To formulate and test hypotheses related to the variables of six sigma system.
- To develop the model for the enablers of six sigma and to obtain the driving power and dependence of enablers.
- To develop the model for the barriers of six-sigma and to obtain the driving power and dependence of barriers of six-sigma.
- To model relationship among critical success factors project goals, key matrices and associated benefits.
- To Develop improved method for six-sigma project handling

5.2 Research process

A six faced research process is adopted to conduct proposed research covering all key performance indicators related to six sigma applications (Figure 1). Further, Table 1 to Table 6, are used to cover six kinds of research problems faced by the researchers.

Table 1.1: Research Methodology front face, Face 1

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Problems type 1	Characteristics	Situation	Examples
To establish the known facts empirically.	Facts are self evident but there is no proof of them.	Front face 1 of the cube in the figure, visible directly, nothing hidden.	Critical success factors of six-sigma, barriers and tools of six-sigma.
Methodology used: <ul style="list-style-type: none"> • Qualitative research method with pre-tested structured questionnaire is used. • Interpreting structural modeling technique is used to establish the hierarchy of relationship among the barriers 			

Table 1.2: Research Methodology Right side face, Face 2

Problems type 2	Characteristics	Situation	Examples
To prove the known facts empirically and scientifically.	Facts are self evident but there is no logically proved relation	Right side face of the cube, visible directly nothing hidden	Advantages, limitation and future of six sigma
Methodology used: <ul style="list-style-type: none"> • Qualitative research method with pre-tested structured questionnaire is used. • Hypothesis testing with help of statistical software is used to verify the relationship among the variables. 			

Six Face Research methodology

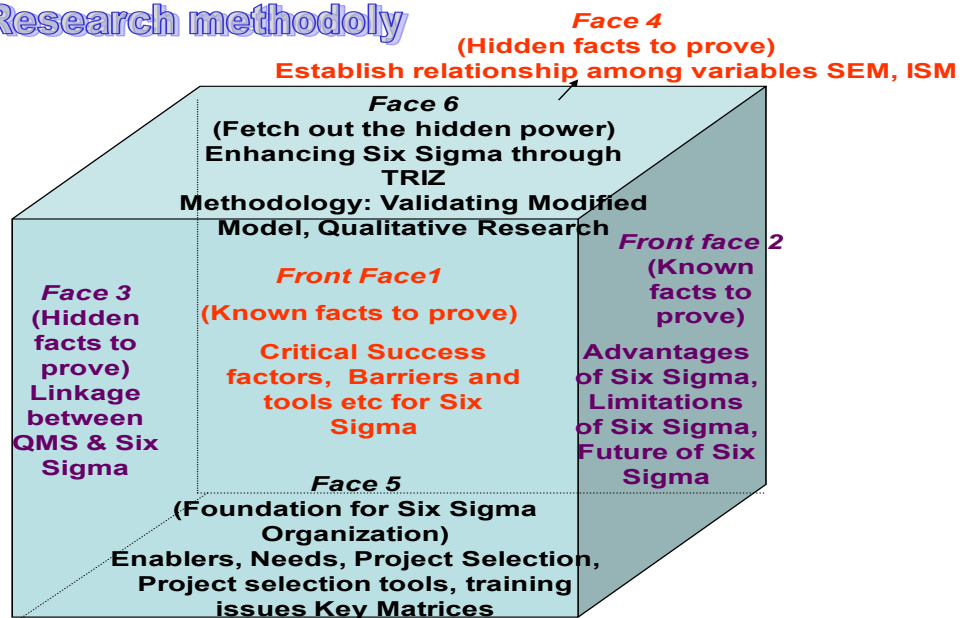


Figure 1: Six Face Research Methodology

Table 1.3: Research Methodology left side face, Face 3

Problems type 3	Characteristics	Situation	Examples
To prove the hidden facts scientifically.	Facts are not accepted unless proved.	The left side face is en- visible from front. Power of integration is not known.	Linkage between QMS and six-sigma.
Methodology used: <ul style="list-style-type: none"> • Qualitative research method with pre-tested structured questionnaire is used. • Hypothesis testing with help of statistical software is used to verify the relationship among the variables. 			

Table 1.4: Research Methodology bottom face, Face 5

Problems type 4	Characteristics	Situation	Examples
To obtain factors needed as foundation	Factors are necessary for six-sigma organization	Bottom face of the cube, not visible directly	Enablers, needs, project selection criterion & tools, training and key matrices used.
Methodology used: <ul style="list-style-type: none"> • Qualitative research method with pre-tested structured questionnaire is used. • Hypothesis testing with help of statistical software is used to verify the relationship among the variables. • Modeling the enablers using Interpreting structural modeling technique. 			

Table 1.5: Research Methodology back face, Face 4

Problems type 5	Characteristics	Situation	Examples
To obtain the relationship among various problem variables	There is relationship among the variables but Facts are not established	Back face of the cube which is invisible	Advantages, limitations, tools of six-sigma.
Methodology used: <ul style="list-style-type: none"> • To validated the hypothetical model by using Structural equation modeling with AMOS. 			

Table 1.6: Research Methodology top face, Face 6

Problems type 6	Characteristics	Situation	Examples
Breakthrough improvement desired	To fetch out hidden power	Top transparent face of the cube, can help to see inside the box	Integrating six-sigma with TRIZ, Use of TRIZ for SMEs
Methodology used: <ul style="list-style-type: none"> • Qualitative research method and hypothesis testing with help of statistical software is used. • Case study to find the effect of TRIZ integrated six-sigma. • TRIZ contradiction matrix is used to get readymade solution 			

6.0 Execution of SFRM

A research questionnaire has been developed for conducting a nation-wide survey on six-sigma practices in Indian manufacturing companies. Research Questionnaire is designed based on the findings of more than 100 research papers. All the Objectives of research have been focused along with extensive coverage of all published research literature. The questionnaire survey was followed by development of two case studies; first one a product type and second one on process type of manufacturing industry. The questionnaire based survey together with case studies provided an in-depth understanding of six sigma issues. It was observed from the literature, questionnaire-based survey and case studies, that a number of barriers hinder the companies during the implementation of six sigma program in their organizations. These barriers have mutual interdependence amongst themselves. So, an Interpretive Structure Modeling(ISM) is used to find out the relationship among the barriers of six-sigma. Six sigma deployments are influenced by some enablers variables by which improved productivity and performance in six-sigma could be achieved. So, another ISM-based model is developed to identify the key enabler variables, which the top management should focus to improve productivity and performance of the organization.

Empirical results have been analyzed, hypothesis about the relations among variables have been tested using appropriate statistical test. Further, Structure Equation Modeling (SEM) technique is used to check the relationship among various variable simultaneously. SEM is used to develop and validated path diagram among various variables.

Next phase of research focused on limitation of six sigma tools. From the literature survey and during the interaction with six-sigma respondents/users, it has been felt that there are many issues related to six-sigma. Some of these issues can be solved through enhancement of the productivity of six-sigma tools by innovation tools of TRIZ. The same is validated successfully in a six sigma project in an electronics manufacturing industry. Finally, the contradiction matrix of TRIZ is used to get quick solutions of frequent problems of six sigma projects in manufacturing processes. Total six research publication based of above research process validates the effectiveness of the research.

7.0 Result and Discussion

The research paper is unique and it helps researcher not only to design comprehensive research design, but also helps them stepwise with illustrated research work on six-sigma application. Any researcher or policy makers or corporate business owner interested to get into the depth of any research/business/social problem can use proposed SFRM to find out facts and figures. Anyone implementing SFRM can become expert of selected topic with using sequence adopted. SFRM can be one of the best research processes for all stack holder as it reaches to root of an issues, further it helps you to solve the issue also. A lot of real research applications are needed for more refinement of SFRM this is just an ignition for world of knowledge.

8.0 Conclusion

The paper provides comprehensive research pedagogy including different research methods. The ultimate aim of paper is to develop research as a process and to manage this process with innovative SFRM. Many research problems are solved by the researchers through any one or more methods proposed in SFRM but the proposed model of mixed approach can provide a good quality research output and better insight of research problem. The paper is useful for all domain of researcher, policy-makers, engineers, managers, scientist, social researchers and economist also, as it define a complete research process. It is expected that wide applications of the proposed method will improve the acceptability and capabilities of the research pedagogy among the researchers.

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