

## **Chapter 2: Introduction**

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This Chapter introduces the business need for the Integrated Piping Engineering Design Management Model. It may be noted here that this second chapter is the introduction to the topic describing the business need for an integrated model of piping engineering design management in India's oil & gas sector. While not going into the comprehensive literature review that is discussed in details in the third chapter, this second chapter lays the preamble need for the research and depicts the flow of chapters.

### **2.1 The Business Management Problem: Need for an Integrated Model of Piping Engineering Design Management**

Ever since 1944, there have been some researches in this broader field of *Multidisciplinary Engineering Design Management for industries other than Oil & Gas* as seen from literature study; it has been found that these studies have been done for Architecture, Civil, Construction, Electronics, Transportation industries and do not throw any light on the state of design management affairs in the oil & gas industry. There have also been some researches in the *Management of specifically Piping Engineering Design in industries other than Oil & Gas* (as chronicled in Literature Review section); it has been found that these studies have been done for Architecture, Civil, Construction, Electronics, Transportation industries and do not throw any light on the state of design management affairs in the oil & gas industry.. However, these researches' findings may not hold true for oil & gas piping design management since design thinking & corresponding

*design activities in different industries in differing situations have crucial differences (Visser, 2009).*

From the comprehensive reviews of existing available literatures in piping engineering design management (discussed in Literature Review) it has been found that all *researches, except one (Sheremetov et al., 2008), focused on the product side of piping in industries other than oil & gas, and furthermore, all of these have focused only from a purely engineering point of view, leaving a colossal dearth of focus on the management aspects in the product as well as the process sides of design management.* The only one research found on *Oil & Gas Piping Engineering Design Management* has been done too purely from an engineering point of view outside India (Sheremetov, Batyrshin, Chi, & Rosas, 2008); Sheremetov et al.'s (2008) research has been focused on only 1 issue (integrating piping analysis like stresses and flexibility with piping design like layouts, etc. discussed later) of oil & gas piping engineering design management but this research's engineering recommendations too may not be applicable to India since *design management practices vary from country to country (Sun, Williams, & Evans, 2011).* Moreover, any available literature of research into Multidisciplinary Engineering Design Management or Piping Engineering Design Management approaches & models in India have not been found. Further, from the extensive reviews of existing literatures, no evidence of research has been found on the Process Side or on the Product-&-Process-Sides-Integrated-Cycle of Piping Engineering Design Management (Dutta, 2013a). In the available *researches, it has been found that all of these have focused only from a purely engineering point of view, ensuing a prodigious paucity of focus on the management aspects in the product as well as the process sides of design management.*

The researcher's extensive literature reviews of over three hundred available publications on the subject yielded some issues plaguing effective

design management (discussed in Literature Review). But, design management practices vary from industry to industry (Visser, 2009) as well as country to country (Sun, Williams, & Evans, 2011) as discussed with examples in Chapters 3 & 4. As a result, identified issues, undertaken in other industries & also outside India, are uncertain in terms of their applicability to the oil & gas industries as well as to India and there has been no research on their applicability to either the oil & gas industry or to India. Moreover, previous researchers have stressed the growing & indispensable need for a comprehensive design management model and there has been no research on engineering design management in India. Therefore, this research, sought to address these omissions by reporting a qualitative study of oil & gas piping design management practices & non-integrated models that are presently in vogue in India and, this study has used a novel and effective research method in order to identify the issues & arrive at or compile an integrated model of Oil & Gas Piping Engineering Design Management as detailed in relevant Chapters. In this introductory Chapter, let us take a deeper look at the business management problem.

*In order to sustain the competitive advantage of the company effective design management is indispensable* (Bruce, Cooper, & Vazquez, 1999; Chua & Tyagi, 2001; Heller, Jager, Schluter, Schneider, & Westfechtel, 2004; Andersen, Nycyk, Jolly, & Radcliffe, 2005; Owen, 2006; Mozota, 2006; Mozota & Kim, 2009; Mozota, 2010). Effective design management is also required to *prevent time loss* (e.g. reworks from a variety of causes, conflicts, etc.), *opportunity loss* (e.g. job dissatisfaction of employees leading to higher attrition, product quality lowering leading to lower customer satisfaction and loss of market to better competitors, etc.) and *revenue loss* (e.g. shrinking market share, the various effects of time & opportunity losses on the revenue, etc.). For example, practical site requirements may vary in quite many aspects from the theoretical conditions considered in design and thus not communicating with end users can cause a lot of rework in the later urgent stages leading to time & manhour wastage;

interdisciplinary conflicts, arising from interfacing disciplines not interacting with each other to understand other disciplines' specific requirements may have conflicts at later stages, again leading to time loss; haphazard management of design lowers cycle efficiency leading to excessive work pressure, decreased job satisfaction that causes higher attrition as well as loss of competitive edge which, in turn decreases the business opportunities for the company; all these issues plague the management of engineering design management cycle and reduce the company's revenue in the long run (Visser, 1996; Lee, Sause, & Hong, 1998; Kiwan & Munns, 1996; Case & Lu, 1996; Kim, Liebich, & Maver, 1997; Chen, Frame, & Maver, 1998; Kalay, Khemlani, & Choi, 1998; Lee, Sause, & Hong, 1998; Chapman, 1998; Chapman, 1998; Swink, 2000; Dutta, 2013a). *Previous research has proven that the more effective the design management practices of a firm are, the more the firm is successful in business* (Bruce, Cooper, & Vazquez, 1999). The researcher's extensive literature reviews of over three hundred publications on the subject yielded some issues plaguing effective design management (discussed in Literature Review). But, design management practices vary from industry to industry as well as country to country that are discussed with examples in Chapters 3 & 4. As a result, issues identified in other industries & also outside India, are uncertain in terms of their applicability to the oil & gas industries as well as to India and there has been no research on their applicability to either the oil & gas industry or to India. Moreover, previous researchers have stressed the growing & indispensable need for a comprehensive design management model and there has been no research on engineering design management in India at all.

In addition to the preceding, the following widely accepted research proven facts are highlighted: *80-90% of production costs are determined at the conceptual design stage* (Barbeau, 1998), *piping consumes more than 40% of any plant's design engineering activities* (Sheremetov, Batyrshin, Chi, & Rosas, 2008), *engineering design management is of crucial importance in any*

*organization's capability development* (Owen, 2006; Mozota, 2006; Mutanen, 2008), *in order to sustain the competitive advantage of the company effective design management is indispensable* (Bruce, Cooper, & Vazquez, 1999; Chua & Tyagi, 2001; Heller, Jager, Schluter, Schneider, & Westfechtel, 2004; Andersen, Nycyk, Jolly, & Radcliffe, 2005; Owen, 2006; Mozota, 2006; Mozota & Kim, 2009; Mozota, 2010).

Research has proven that *the companies who do not have effective engineering design management practices/models are much less successful in business than the ones having it* (Bruce, Cooper, & Vazquez, 1999) as the absence of an effective design management model induces loss of competitive edge of the company in terms of time loss, opportunity loss & revenue loss (Turner, 1985; Ughanwa, 1988; Wallace & Burgess, 1995; Kiwan & Munns, 1996; Lee, Sause, & Hong, 1998; Chua & Tyagi, 2001; Owen, 2006; Mozota, 2006; Mozota & Kim, 2009; Sun, Williams, & Evans, 2011). Previous research has further proven that a model for integratively catering to all identified issues/challenges becomes innately effective in flourishing the competitive advantage of any company (Turner, 1985; Ughanwa, 1988; Wallace & Burgess, 1995; Kiwan & Munns, 1996; Bruce, Cooper, & Vazquez, 1999, Lee, Sause, & Hong, 1998; Chua & Tyagi, 2001; Owen, 2006; Mozota, 2006; Mozota & Kim, 2009; Sun, Williams, & Evans, 2011). Thus the *business management problem* is:

An *integrated model for managing engineering design* is indispensably needed to aid design engineers/managers in their management decisions and to sustain the *competitive advantage of the company*.

To solve this business problem, address the research gaps, answer the research questions and fulfill the research objectives, the existing practices of piping engineering design management that are being used in the piping

engineering design department of India's largest oil & gas company have been studied, issues identified, compared with other researchers' finding, each research step has been deeply thought upon, profoundly analyzed, rigorously verified and an integrated model of piping engineering design management has been proposed.

Now that an introduction to the business management problem has been discussed, a deeper delve into the review of existing literatures that give rise to the Research Gap, Research Problem, Research Questions and Research Objectives have been detailed in following Chapter 3.

## 2.2 Breviloquent Vista of Research Gaps

From the review of existing literatures two research gaps emerged as follows:

Extensive literature review yielded no references of any *design approaches & models for oil & gas piping engineering design management in India*. There has been no research to know how design is being managed in India.

From the existing literature review, it has been found that no research has focused on whether there are any issues plaguing the management of engineering design in India. The existing studies have identified issues plaguing engineering design management worldwide in other industries & outside India. Further, design management practices vary from industry to industry and from country to country. Therefore, the *applicability of those identified issues to the Indian oil & gas context is uncertain*. No study has focussed on their applicability to either the oil & gas industry or on their applicability to India. Moreover, previous researchers have stressed the growing & indispensable need for a *comprehensive design management model* and in India no research has focussed on engineering design management.

Previous studies have established that an integrated management model for managing engineering design is indispensably needed. The previous studies have their respective limitations. Some researchers have focused only on the Product Side of Engineering Design Management and have so far found out three issues challenging the efficient management on engineering design on the Product Side. Whereas some other researchers have focused only on the Process Side of Engineering Design Management and have so far found out four issues challenging the efficient management on engineering design on the Process Side. Existing literature review has evidenced that engineering design management can be effectively managed if the identified issues are catered to. Previous studies for specifically piping engineering design management have focused only from a pure engineering point of view, ensuing a colossal dearth of focus on the management aspects in the product as well as the process sides of design management; the existing studies did neither focus on the piping engineering design management aspects present in both the product sides and the process sides nor into any integrated model for the complete cycle that caters to the management issues of the product as well as the process sides. Further, it has been found that no research has focused on whether there are any issues plaguing the management of engineering design in India. An extensive literature review covering over three hundred relevant available literatures yielded no references of any design approaches & models for oil & gas piping engineering design management in India. The previous studies neither throw any light on the design management in the global oil & gas industry nor on the design management issues of any industry in India. There has been no research to know how design is being managed in India. The existing studies have identified issues plaguing engineering design management worldwide in other industries & outside India. However, previous studies have established that design management roles, practices and activities significantly & crucially vary from industry to industry and from country to country. Therefore, the applicability of those identified issues to the Indian oil & gas context is uncertain. No study has focussed on their

applicability to either the oil & gas industry or on their applicability to India. Moreover, previous researchers have stressed the growing & indispensable need for an integrated design management model and in India no research has focussed on engineering design management. The identified research gaps have not been addressed by any of the previous studies. This present research tries to answer these questions and thus address these dodged research gaps in a bid to improve engineering design management in India.

### **2.3 Laconic Overview of Research Design**

The detailed research design has been described in a dedicated Chapter 4; however a concise overview is presented in this section as an introduction. On careful consideration of established methods & approaches, a descriptive qualitative case study with a grounded theory approach has been chosen as the philosophy of this research owing to the approach being the best suitable research mode for this particular study of the problem through the objectives. This is because the present research purpose has been descriptive (fact finding about a state of affairs), research process has been qualitative (for a phenomenon related to quality) and research approach has been a grounded outlook (to systematically generate theory from data through inductive thinking about a phenomenon of interest). Sample selection has been done in three stages, while decreasing sample size by using the Theory of Elimination and unit of analysis has been critically chosen in line with the research objectives. Detailed case study questionnaire has been developed in three steps so as to enable an appropriate research into the answers to the research questions. Data have been collected and analysed in line with the research philosophy and rationale. All evidences substantiating the case study have been archived and are being maintained with the researcher. The validity of the case study has been verified by employing a number of tactics. To ensure construct validity & internal validity, two tactics have been employed.

First, two levels of analyses are undertaken during data analysis – conceptual and detailed. Secondly, the case study reports are reviewed by key informants and then their feedbacks have been incorporated in the final research. This present research study is expected to provide depth and so the study intended to provide an insight into the probable relationships suggested and therefore to generalize beyond this particular research area would require additional confirmation of results that is beyond the scope of this particular research and has been included as a further research scope. Although the research is limited to only one organization that has been selected as a representative of the oil and gas industry in India based on the fact of that company being the largest (in terms of revenue, size as well as market share) among all oil & gas companies in India, however, a point to be noted here is - this research establishes that the seven challenges of design management identified outside India are applicable to the oil & gas industry in India plus there are some additional five challenges specific to the Indian oil & gas context and therefore, theoretically it can be inducted that most/all of the found out issues and their solution model proposed through this research shall be applicable to the other oil & gas companies as well (the researcher, through his previous work experiences, has also experientially observed these issues to be plaguing design management in some other oil & gas companies in India as well as abroad); further, external validity is beyond the scope of this particular research and is a future research arena. Reliability has been highly ensured through apt instruments, archival of all evidences and use of data analysis software Atlas.ti. This research employed a number of approaches to ensure high reliability while applying procedures for data collection and analysis. First, the case study protocol has been used to guide the research process as the protocol is a major tactic in increasing the reliability of a case study research and is intended to guide the researcher / investigator in carrying out the case study. The protocol has comprised of instruments as well as procedures and general rules that have been followed. This ensured consistency in the areas covered. Secondly, to reduce the likelihood of forgetting or misunderstanding the data and to allow

independent data analysis by other researchers, interviews have been taped, transcribed and all original evidences are archived. Thirdly, the use of Atlas.ti qualitative analysis software allowed systematic & consistent analysis of the qualitative data and further increased the reliability of this research because procedures can be repeated. Fourthly, the field notes taken by the researcher have been also transcribed for future reference. Different levels of coding, within case analysis (conceptual & detailed), theory triangulation, employment of case study protocol, use of software Atlas.ti, archival of all evidences, etc. have been carried out to ensure high quality (construct validity, internal validity & reliability) of the study.

## 2.4 Chapter Flow

This thesis consists of **eight chapters**.

The **invaluable contributions** of all the associated stakeholders in this research are graced before the first Chapter as well as referenced in relevant sections.

The **first chapter** is the **problem statement** and the **background** of the research.

The **second chapter** is the **introduction** to the topic describing the **business need for an integrated model of piping engineering design management in India's oil & gas sector**. While not going into the comprehensive literature review that is discussed in the third chapter, this second chapter lays the preamble need for the research. For example, in order to *sustain the competitive advantage of the company*, effective design management is indispensable. Effective design management is also required to prevent time loss

(e.g. reworks from a variety of causes, conflicts, etc.), opportunity loss (e.g. job dissatisfaction of employees leading to higher attrition, product quality lowering leading to lower customer satisfaction and loss of market to better competitors, etc.) & revenue loss (e.g. shrinking market share, the various effects of time & opportunity losses on the revenue, etc.). *Previous research has proven that the more effective the design management practices of a firm are, the more the firm is successful in business.* The researcher's extensive literature reviews of over three hundred publications on the subject yielded some issues plaguing effective design management (discussed in Literature Review). But, design management practices vary from industry to industry as well as country to country that are discussed with examples in Chapters 3 & 4. As a result, issues identified in other industries & also outside India, are uncertain in terms of their applicability to the oil & gas industries as well as to India and there has been no research on their applicability to either the oil & gas industry or to India. Moreover, previous researchers have stressed the growing & indispensable need for a comprehensive design management model and there has been no research on engineering design management in India at all.

The **third chapter** is the **review of existing literatures** that identified the existing research gap, research problem, research objectives & research questions, and lays the **conceptual framework** for the study.

The **fourth chapter** explains the **research design**, the **research methodology**, **rationale** of the study, **quality** ensurance, **scope** of this research work, **case selection**, **data collection plan** and the **data analyses strategy & rationale**.

The **fifth chapter** discusses the **actions taken in the case study** as per the research design or plan & the **findings**; it comprises of **detailed case study protocol** used, **data collection process** employed in the study, **analysis methods**

applied, **tools as well as the findings** from the case study along with the **inductive analyses**.

The **sixth chapter** describes the **modelling techniques**, the workable **ingredients** of the new model and verification of **fulfillment of the research objectives**.

The **seventh chapter** depicts the **new model of piping engineering design management for the oil & gas industry in India** named **Doctonaut** and its **integrated working**.

The **eighth chapter Conclusion** presents a brief touchup of the **main points in this research**, the salient **features & advantages of the new model Doctonaut**, the **limitations** of this research and the **recommendations on further research scopes**.

Finally the **Bibliography & Appendices (Appendices A, B, C, D, E, F, G & H)** are presented for reference.

In this Chapter the precursory business need for this research and the flow of chapters have been depicted. The proceeding Chapter lays out the conceptual framework for the study that is developed from the review of existing literatures.