Infrastructure development is a dynamic process; it is multidisciplinary in nature and involves various resources. With the continuous increase in the power demand, there is an inevitable requirement of increasing the supply of power to reduce this demand supply gap.

Almost 70 percent of thermal power plants in India were set up during the late nineties and have been facing the problems of declining efficiency and as recommended by the Central Electricity Authority of India (CEA, 2016) are due for renovation and modernization (R&M).

Based on the R&M programme of the Government of India (GoI), CEA in 2013 found units with 36,000 MW of capacity to be over 25 years old, which should either be renovated or retired. In the National Perspective Plan of the CEA under the 12th five-year plan, R&M works for 65 units were identified amounting to approximately 17000 MW. However, the investors and utilities faced many challenges during the planning and implementation of these projects that derailed the objectives of the project and as a result, only 37% of the projects were actually completed on time (CEA 2013). Even though R&M projects were initiated in the mid-nineties and were successful in improving plant efficiency, the actual implementation has not been satisfactory and the reasons for such unsatisfactory performance have not been reported anywhere nor seem to have been documented. Various studies carried out in the past have highlighted one common concern of the poor and deteriorating efficiencies of the thermal power plants in India. However, none of these studies could provide solutions to improve efficiencies of the plants or even check reasons for such deterioration thereof. This motivated the researcher to take up the study in the area of R&M of existing thermal power plants in India.

The aim of the research was to develop a risk management framework to ensure effective implementation of R&M projects, which would act as a tool for utilities, to plan such projects in an efficient manner and ultimately lead to an increase in efficiency of thermal power plants.
The research also aimed at generating some standard guidelines for managing the risks identified for ensuring better implementation of the R&M projects in India.

The research included the study of 35 operational thermal power plants, which have undergone R&M at different stages of their life. The study period considered was of ten years between 2006-2016. The Malmquist Productivity Index (MPI) technique of Data Envelopment Analysis (DEA) was used to carry out an efficiency study. The study revealed that even though the overall plant productivity was declining over the ten year time period (2006-2016), the change in the technology/R&M in these plants over the years has contributed positively in enhancement of the plant efficiency. A questionnaire survey and factor analysis approach was therefore undertaken to identify the key risks associated with the implementation of R&M projects in India. Six key risks significantly affecting the rate of implementation of R&M projects in India were identified which included contractual risks; funding risks; planning risks; regulatory risks; market related risks and manpower related risks. In the study 3 out of 6 risks were found to be the most significant, these are namely, the contractual risks, planning risks, and manpower related risks.

These risk factors were then taken up for further analysis and preparation of the risk model using structural equation modelling (SEM) to help the utilities and other stakeholders to understand the interdependencies of risks and their cumulative impact on the rate of implementation of R&M projects. The study also develops strategies for dealing with the key risks associated with implementation of R&M projects in India. A case study approach was adopted to capture the experiences of various stakeholders and to understand their concerns, challenges and success strategies while planning, managing & implementing R&M projects at national & international level through which the industry best practices were identified. Meetings and consultations with stakeholders were also conducted for formulation of strategies. These industry best practices were taken forward to develop a strategic framework
for better implementation of R&M projects, which was subsequently validated by the industry experts before it could be recommended for use. As a result, the study establishes the significance of R&M in the life span of a thermal power plant and its impact on plant efficiency and identifies the major risks faced by various stakeholders during planning and implementation of R&M projects in India. The proposed interdependency risk management model is a significant outcome of the study, which can act as a guideline for various stakeholders for proactive planning for project risks associated with R&M projects in India. Furthermore, the strategic framework for timely mitigation of risks associated with effective planning, management and implementation of R&M projects is a unique contribution made by this study to help utilities effortlessly manage such projects.

Key Words: Thermal power plants, Renovation & Modernization, technological efficiency, Total productivity factor, risk management, strategic framework