

Executive summary (not exceeding 500 words)

The ultimate aim of this project is developing a sustainable safety management system (SMS) for industries with primary focus on steel sectors for eliminating fatalities and reducing lost time injuries to people at work. Three integrated safety modules namely, (i) Module-1: creation of safety analytics database, (ii) Module-2: development of prediction models for predicting accidents/injuries across employee demographics, such as job-wise, location-wise, function-wise, age-wise, experience-wise, etc., and (iii) Module-3: design of prevention and mitigation programs and technologies based on the analysis of safety data will be developed.

In total 15 research objectives have been identified. Under Module-1, the study encompasses the development of a central safety analytics database by incorporating the data-challenges from data definition and classification standards, data availability, acquisition and coverage, data integration, data quality, and data security points of view. Traditional data collection methods, and real-time advanced information and communication technology (ICT) enabled collection methods will be explored. Under Module-2, the study exploits the benefits of data analytics in terms of visual analytics and predictive analytics through visualization of safety database, development of models for evaluation and prediction of operational hazards and accidents coupled with root cause analysis, and development of mapping strategy to establish a link between leading and lagging indicators of safety. Under Module-3, the study focuses on designing prescriptions for preventing occupational accidents and mitigating its consequences (prescriptive safety analytics) including safety by design, monitoring & control, and competency building (training).

The key deliverables of the project with respect to the industries in general and the support industry in particular are: (i) information & communication technology (ICT) based data capture system, (ii) performance indicators and model for evaluating the effectiveness of the SMS, (iii) prediction models including GUI based software, (iv) hazard-specific bow-tie and root cause analysis framework for safety by design, (v) virtual reality (VR) based training modules, and (vi) enhancement of the current safety programs.

The project will help IIT Kharagpur in upgrading the existing safety analytics laboratory through development of (i) experimental facility using ICT and VR, (ii) central cloud-based infrastructure for storage, maintenance and updating of safety database, and (iii) integrated safety database for use by industry and academia. In addition, the project will help in establishing a knowledge centre on safety analytics that will act as a national hub (i) for storage and analysis of occupational safety data, (ii) to produce excellent quality human resource for industries' support, (iii) to carry out cutting-edge research in safety, and (iv) to conduct varied training programmes on safety engineering and management.

The complete task is envisaged to be carried out in tandem with TATA Steel. The past research of IIT Kharagpur on the SMS of TATA Steel has thrown considerable amount of light on the current safety scenario at workplaces, particularly in steel-manufacturing, construction-projects, raw-material-handling, and underground-mines and hence, TATA Steel will act as a test case for the novel ideas and evaluate the success of the ideas before deploying for others.

Background and motivation (not exceeding 500 words)

Managing safety is a perennial problem to every organization. Today, lead industries spend huge amount of money and efforts for improving safety standards and building competency among employees in safety. Safety management systems are in place, which is a primary source for safety related data. Second, the use of IT and sensors increases the amount of data manifolds. Even then, the list of problems associated with managing safety is endless. One of the major problems which acted as the root of the motivation behind this project is that even though there is the rapid influx of large amounts of data in the area of safety management, there lacks the capacity or skill to analyse the same. Without appropriate analysis of the data, the entire exercise of extensive data collection, however robust it may be, is nothing but a waste of resources. This project attempts to bridge the gap between the industry data collection systems and academic analytical skills by facilitating the creation of centralized safety database with both off-line and on-line data pertaining to safety management systems of various industries.

Apart from the lack of appropriate usage of the data being collected, this project also finds its motivation from another problem which plagues the safety scenario of people at work. Over the last decade, the development of information technology has been rapid and as a result, there has been a number of patents and inventions which connect IT with safety management systems. Inventions like indoor GPS systems, real-time remote sensing technology, and virtual reality based training systems are flourishing in the other parts of the world but unfortunately, they have not gained popularity in India because of the out-dated safety monitoring practices. This project shall attempt to bridge the gap between rapidly advancing technological inventions and the safety management systems used. This will increase the safety data quality manifolds because such cutting-edge system results in an improved quality of data along with a much more reliable and automated safety monitoring system.

The area of data analytics has found increasing applications in various industries but, safety analytics is still an undervalued area in India. This project has the potential to change this and replicate the global success of data analytics in occupational safety management in India.

Project outcomes (please list specific objectives): *The project should address a specific need of the industry/industries and there should be clear expected outcomes from the project. It is expected that joint patents will result from this project.*

The primary outcomes of the project spans across 3 broad modules.

Module 1: Creation of Safety Analytics Database

- (i) Identification of safety data sources and development of safety database integrating safety management principles
- (ii) Standardization of data collection systems across different companies in a particular industry
- (iii) Development of central cloud-based framework for storage, maintenance and updating of safety database
- (iv) Improvement of quality of data using techniques like data profiling and cleansing
- (v) Provision of reliable security service for the centralized database

Module 2: Modelling and Analysis of Safety data

- (vi) Implementation of visual analytics for infographic analysis of safety performance
- (vii) Prediction and forecast of future occupational safety related incidents for design of improved preventive and corrective measures
- (viii) Development of a framework to conduct root cause analysis for high risk incidents
- (ix) Identification of leading and lagging indicators and modeling of dependence between them
- (x) Modeling, evaluation and monitoring of hazard identification and risk management practices

Module 3: Prevention of Accidents and Mitigation of Consequences

- (xi) Designing customized key performance indicators to assess the effectiveness of safety management principles
- (xii) Optimization of maintenance schedules and resource allocation for improved safety management
- (xiii) Incorporation of virtual reality based competency building and data collection practices
- (xiv) Deployment of long-term action plans in view of sustainable improvement of efficiency, effectiveness, and reliability of the safety management system
- (xv) Implementation of robust prevention strategies including safety by design, maintenance (asset management), monitoring & control, consequence management and competency building

Scope (not exceeding 1500 words): *The scope should clearly lay out the contributions of the academic partner and the industry partner.*

Module 1: Creation of Safety Analytics Database

Identification of safety data sources and development of database integrating safety management principles: Usually safety data are stored off-line or on-line or both. The accident/injury database, inspection data, operation and control data, hazard identification records, compliance data, asset management data, contractor safety records, etc. are kept in safety management system (SMS), a computerized database. Real-time data are collected using visualization technologies such as remote sensing technology, GPS, virtual prototyping (VP) technology, and augmented reality (AR). Real time safety data integration from various stakeholders will enable better transparency and perception towards workplace safety. It will also help in adequately communicating of safety management principles among different parties, apart from carrying out typical DBMS tasks such as the querying, updating, and sharing of data. The scope of the study involves identification of both off-line and on-line data sources and creation of data generation system with the help of visualization technologies developed over the years. Both IIT Kharagpur and Tata Steel will take active part to achieve this.

Standardization of data collection systems and data quality: It is not uncommon that for reporting a similar accident under similar situation in the same industry, different formats are being used. The key definitions of safety terminologies are also misunderstood. The inspection processes as well as practices also vary from company to company, industry to industry, and nation to nation. At least, there must be standardized systems and formats for different companies under a particular industry. Standardization ensures information symmetry across various safety stakeholders. Besides, it improves safety data quality. If data is of inadequate quality, then the knowledge workers who query the data warehouse and the decision makers who receive the information cannot trust the results.

The scope includes standardization and data quality with reference to: (i) definition conformance, (ii) completeness of values, (iii) validity or safety rule conformance, (iv) accuracy of source, (v) precision, (vi) non-duplication, (vii) derivation integrity, (viii) accessibility, and (ix) timeliness. These characteristics will be justified by analysing safety data warehouse of Tata Steel. Both IIT Kharagpur and Tata Steel will take active part to achieve this.

Centralised cloud-based framework: Based on the success stories of cloud-based technology in production, service or healthcare sector, it is now imperative to say that its use is inevitable in safety management. A cloud based information infrastructure will be developed to avail the opportunities such as easy and ubiquitous access to safety data among various clients to utilize the services of experts which is otherwise unavailable in the field. This will also help in developing web based systems to imitate human experts to provide early warnings and solutions to safety related problems. Additionally, cloud based solutions for preventing accidents using network modes connected to the stakeholders' SMS can be made real-time.

The scope includes development of cloud-based infrastructure for maintenance and updating of centralized safety database. Both IIT Kharagpur and Tata Steel will take active part to achieve this.