

Benefits of Mining Project Management with Artificial Intelligence

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Abstract

Some of the major research going on project management on climate change, sustainability, AI, industrial strategies to support the digital technologies, blockchain, mining oil, gas, minerals, offshore reserves, renewable energy, and battery technology and so on. The applications of AI techniques in the project management performance domains show that the number of influential publications on artificial intelligence-enabled project management has increased significantly over the last decade. The findings indicate that artificial intelligence, predominantly machine learning, can be considerably useful in the management of construction and IT projects; it is notably encouraging for enhancing the planning, measurement, and uncertainty performance domains by providing promising forecasting and decision-making capabilities. Based on the results of scientific research, more innovations in all related technologies are expected.

Keywords: International scenario, Industrial Engineering, Project innovations, Artificial Intelligence, Machine Learning, Mining Applications

1. Introduction

Sustainable development is one of the United Nations' Global Goals that it would like to achieve by 2030. As a part of this strategy, it has developed 17 Sustainable Development Goals (SDGs). Engineering will play a key role [1] in helping the UN as it strives to make progress toward these objectives and helping [3] to solve global challenges. PMI [4] discusses the role of AI in PM, highlighting that AI changes the types of projects being delivered and also how they are managed. Although such reports highlight that project leaders say that AI technologies are encouraging PM productivity and enhancing the quality of work, AI technologies in PMPDs, which are introduced in the Project Management Body of Knowledge 7th edition (PMBOK7).

Innovation is going to be one of the key areas of focus that will enable companies to progress for a powerful [5] and positive impact on society, and better use of both new and existing technologies. SMART goals help us to stay focused on our long-term plans by completing smaller tasks that improve our job performance and satisfaction. One of the most significant challenges engineers face is the advancement of technology. AI-based heuristics comprise different methods and algorithms such as genetic algorithms (GAs) [17] or ant colony optimization (ACO) algorithms [18]. In short, GAs are search processes to find a solution for optimization

ML is a mathematical model based on sample data, known as "training data" mainly used for data classification and data prediction without being explicitly programmed for doing so. That is, ML algorithms use computational methods to learn information from a set of data which is used for training the model. Once the model is trained, it can be used for classifying and predicting. There is a wide range of ML algorithms such as Random Forest (RF), Support Vector Machine (SVM), Decision Trees, and k-means improvement but have found their everyday working lives enhanced by the changes made.

2. Industrial Engineering

AI-assisted scheduling issues in the construction sector: reviewed the research on automation in construction scheduling, where different AI approaches are employed: case-based reasoning, knowledge-based techniques, GAs, expert systems, and NNs. They concluded that GAs are dominant. An automated project schedule planning framework that contains a knowledge-based expert system connected to Primavera

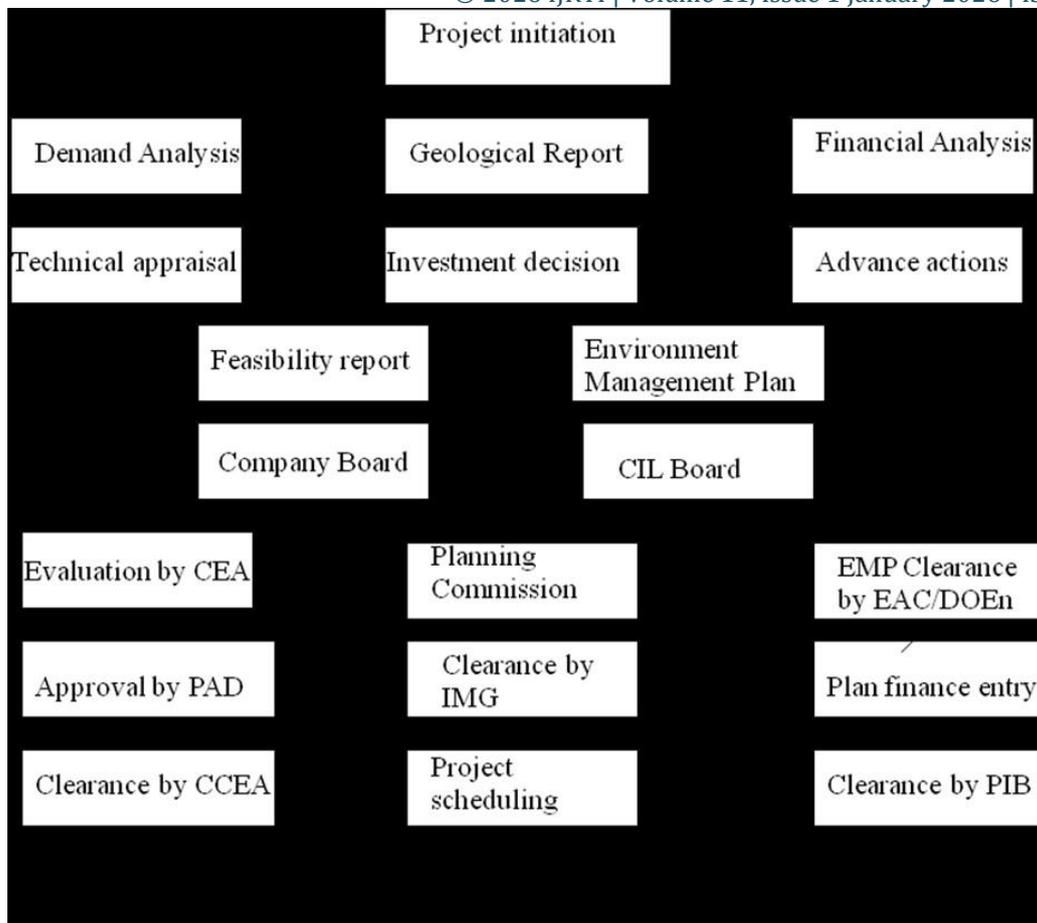
software was made. The developed AI-based scheduler retrieves construction design elements from BIM, and it provides the derived project activities and their sequencing on Primavera.

Objective of my earlier PhD thesis, under Dr. S.K.Sinha, Director, ISM was focused on the clauses of the topic, firstly development computerized methods by developing models with data-based computer programs, secondly for multi-project scheduling and monitoring to be viable and thirdly for better all-round performance in Indian coal mining. For success of multi-project scheduling, as no two mines are alike, because of geological incongruence, every coalmine project should be critically analysed for improvement. So, applying principles of Operations Research (OR), models had been designed, coded and run. Most of the field work and data collection was done from ECL, and CIL for coal mine projects and program runs. Program run data are from ECL with reserve of 44.95 billion tonnes (Bt), spread over 1620 sq.km with 16 opencast, 83 underground and 7 hired mines

3. Artificial Intelligence

There are many scopes of applications of Artificial Intelligence, in mine planning and projects as two mines are not alike. The "Vision Coal 2025" Report of CIL/CMPDI are basis of further research. Coal India Ltd (CIL), the country's largest coal mining company, had raised Rs 13,000-crore through an IPO to fund the infrastructure projects in the country. The company has offloaded around 630-million shares through a book-building process launched. India has to adopt high productive technology, requiring computer control systems as well as methods for scheduling and monitoring. Computer project software and networking through internet has been growing very fast and some of the recent related developments are listed, 330 versions in Table No-2.6 in Appendix. WebGIS can provide a real time and dynamic way to represent information about mineral resources through maps and statistics.

Reorganized underground projects were mostly unviable and so the researcher suggests innovative methods, justifying them with data-base computerized cost benefit analysis, on which planning, scheduling and monitoring recommended. The researcher reviewed the latest published works on related subjects, to help develop the thesis. There are a large number of private companies engaged in coal production in USA and only ten major companies account for 70% of coal production. The production in 2030 is likely to be over 1600 Mt. Mining Equipment & Technology – Best of them from Bauma, Atlas Copco, Liebhör, Bauer, Wirtzen, Siemens, SMT Scharf etc. Environmental Impact Assessment during Project Execution Phases to a Stage-Gate Project Management of the Energy Sector cannot be neglected. Integrated Energy Policy envisages a coal demand of 1.5 Bt in 2031-32 under the least coal intensive option or 2.6 Bt otherwise. As projected in Coal vision 2025 document, the demand at 8% GDP will be 1.25 Bill T by 2025. Figure 1 displays the various steps from planning to implementation of mining projects.



4. Mechanized Mining

The main focus should be on multifarious dimensions of growth facing the grave challenges of climate change. A coalmine project construction spans over several years, called gestation period with many parallel activity paths from start to finish. If a single activity slips, next activities in the chain have to be hastened or else path would turn critical for project completion deadline, where computerized monitoring helps. When dealing with several projects, there are many complications, which need to be solved by multi-project implementation for making it cost-effective.

Choice of mining equipment in different mining conditions require knowledge of machine learning literally from the beginning. Opencast mines could be designed with scrapers, draglines, rope or hydraulic shovels, pay loaders, dozers, dumpers, etc. according to design standards as prescribed or evolved through research and study. High-wall mining is high productive method, yet to be adopted in India, but can be applied to old opencast mines with thick seams.

Underground mining methodologies are usually designed with the following appropriate mining technologies as applicable among many others:

1. B & P with SDL/LHD/UDM (Universal Drilling Machine)
2. PSLW Mining
3. CM Technology
4. Shortwall Mining
5. Special Methods
 - a. Blasting Gallery (BG) method
 - b. Caving with wire-netting
 - c. High Pressure water jet mining (Hydro -mining)
 - d. Integrated sub-level caving
 - e. Sub-level caving with High Pressure Air Breaking System
 - f. Short longwall method for extraction of standing pillars
 - g. Longwall Top Coal Caving (LTCC) technique
 - h. Jankowice Method (for steeply dipping seams)

New technologies can overcome the ban on plastic by recycling, reusing, and non-recyclable can be used in roadmaking in conjunction with pitch. Plastic continues to be the handiest and

Coal demand projections

Million tonnes

Plan	Period	Power	Non – power	Total
XI	2011/12	436	164	627
XII	2016/17	603	221	824
XIII	2021/22	832	299	1131
XIV	2026/27	1109	408	1517
XV	2031/32	1475	562	2037

Integrated Energy Policy (Plg Comm 2006)

cheap packaging preferred [5] by households, compared to other alternatives. Fortunately, there are many companies engaged in recycling and the ready market. Municipalities should ensure that no plastic waste is dumped in drains and water bodies, as non-biodegradable. Countries should ensure that no plastic waste is dumped in drains and water bodies, as non-biodegradable.

5. Mining Computerization

According to a release by the WEC, The Energy Web Foundation (EWF) is building open-source blockchain tools and technologies, working with more than 80 energy companies' affiliates and start-ups. During planning a mine project, a planner has to examine many fuzzy parameters, like reserve, thickness and quality of seam etc. where vagaries of nature are unpredictable, like weather, super computers are being used. In this chapter, the researcher has developed a small model Expert System for determining the most viable long-term method of new projects. Blockchain in energy has the potential to upend the energy system that was created over a century ago, but it has a long way to go. Global investments [9] in clean energy technology were about USD 333 billion in 2017 as compared to USD 324 billion in 2016. In 2017, China was the leading investor with USD 132 billion followed by the US with USD 57 billion.

Systems engineering has an emerging set of digital tools, a similar pathway for all engineering disciplines. A Smart Company is a hybrid model of a Limited Company (Ltd) and a Decentralized Autonomous Organization (DAO), making the model the first of its kind combining full legal compliance and the advantages of blockchain technology such as speed, technical resistance, and transparency. Smart Engineering Consultants [13] for projects is growing around the world to achieve the intended aim of the company. In the process, the staff not only understood and embraced the need for change and improvement but have found their everyday working lives enhanced by the changes made.

The triple constraints of the software project like time, cost, and scope are directly dependent on the requirement of the project. Agile methodology is the iterative way of developing the software project for frequent changes, fast delivery and reduce risk. Software project management also plays important role in agile based software project. Agile methodology influence software project management at 10 knowledge areas. In this study, we carried out a survey of different software companies and it shows that almost every software company uses agile development (Scrum) and has a positive impact on the software project management.

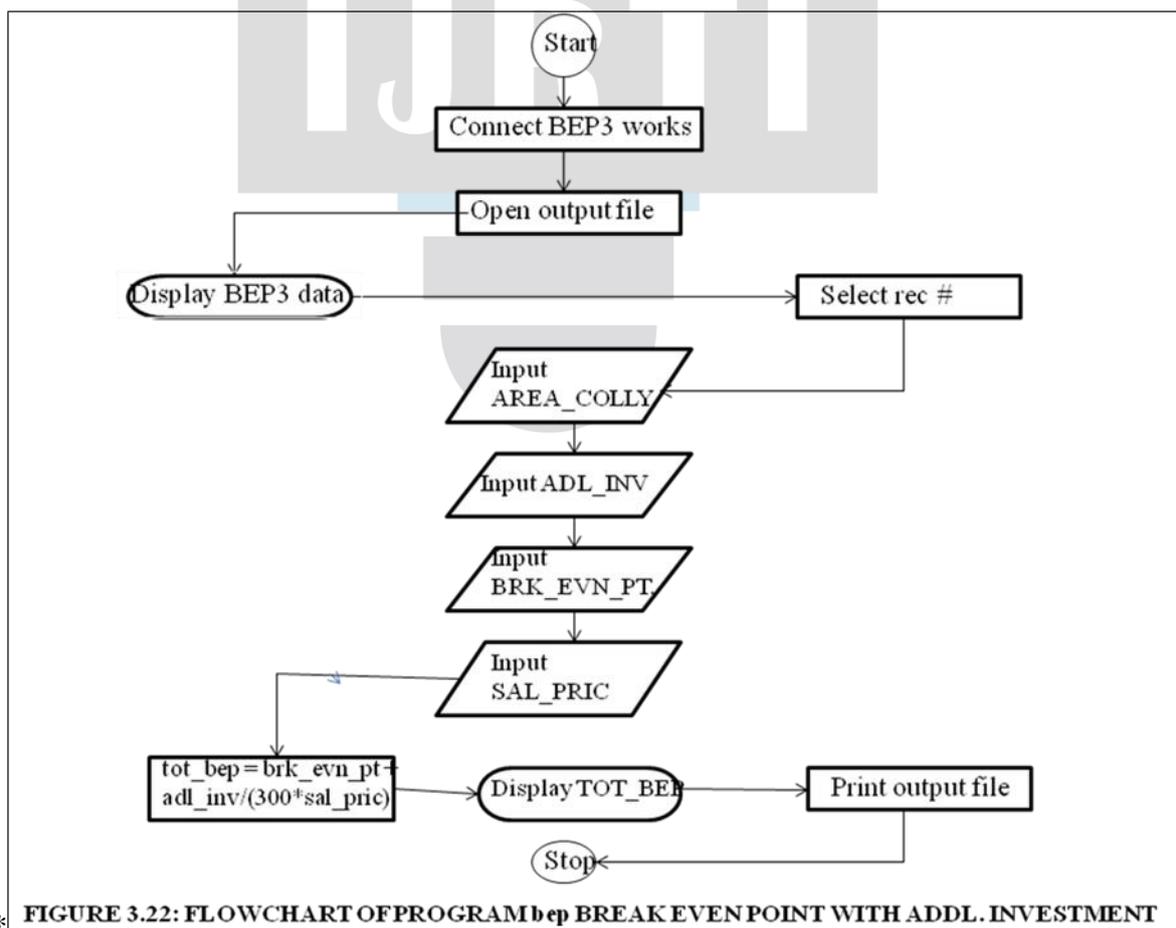
Artificial Intelligence, (AI) has been successfully used for years in advanced applications. Fuzzy logic computations are for dealing with uncertain and complex problems. Profitability Index (PI), Return On Investment (ROI), or Discounted Cash Flow (DCF) rate of return are some of the indicators of profits. All the packages are further divided into sub-packages and the sum is made head-wise, applicable for all types of mining, in conformity with budget heads.

6. Project Management

Mining is the most dangerous peacetime profession in the world, so safe and productive technology is needed for viability. Underground mining sustainability is on the wane, because of environmental, ventilation, and support legislation resulting in poor productivity. Longwall mining is a highly productive underground coal mining technique, provided a very large area with an undisturbed roof is available. Being a highly capital-intensive Longwall Power Supports System (LWPS), as well as Continuous Miner System, require project and operation management to be interlinked. The studies also showed that project management methodologies/ models should be customized/ tailored for the different projects so as to best fit the scenario and reduce cost and time. Activities having floats in critical paths have to be crashed even with additional costs to achieve the target date of completion of the project. Finding the Critical Path, activities will affect the project's success. When deciding to crash a project, must add resources to one of the activities on the critical path.

Investment decision of projects should be done on: -

- i. Pay out time- *i.e. when Break Even Point is reached, applied here.*
- ii. Average yearly payout- *in terms of capital, works, crew, materials etc.*
- iii. Accounting Return or net profit on original investment- *used in this model program, as main criterion.*
- iv. Operating Return- *indicated in the model program annually.*
- v. Present worth of Cash flow discounted @10-20%- *used in the E.S for projection over 6 years.*
- vi. Net Profit- *is computed excluding taxes and royalties.*
- vii. DCF Return- *could be computed from the model program.*
- viii. Sensitivity Analysis- *Change in output by change in input- indicated by higher BEP.*
- ix. Actuarial analysis for model program estimating service life for depreciation- *in CIL for 9 years.*
- x. Incremental cost analysis for marginal cost etc. - *could be computed from the data generated.*



8. Evolving AI Types

Machine Learning (ML) is a subset of AI focusing on systems that learn from data and improve without being explicitly programmed for every single rule. Instead of writing code that says "if this, then that," you feed the algorithm data and let it find the patterns. Machine learning divides into three primary learning paradigms, each suited to different problem types:

Supervised Learning: The most common form in business. It uses labeled data (input-output pairs) to train algorithms. For example, you might show the model 1,000 emails labeled "Spam" or "Not Spam," and it learns to classify the next email. Common algorithms include Linear Regression, K-Nearest Neighbors (KNN), and Decision Trees.

Unsupervised Learning: The algorithm is given unlabeled data and must find hidden structures or patterns on its own. This is often used for customer segmentation (clustering). K-Means Clustering and Principal Component Analysis (PCA) are among the most commonly used algorithms.

Reinforcement Learning (RL): Taking a different path entirely, RL teaches agents through trial and error using a reward-and-penalty system. An RL agent receives feedback on its interaction with the environment, and gradually learns which behaviors maximize cumulative rewards over time. This is the method used to train robots and advanced game-playing AI, such as AlphaGo.

9. Conclusions

The paper focuses on AI applications in rock mechanics, mining method selection, mining equipment, drilling-blasting, slope stability, environmental issues, and relevant geological engineering. Artificial Intelligence (AI) and Machine Learning (ML) are transforming the mining industry by enhancing efficiency, safety, and sustainability. These technologies are being integrated into various stages of the mining process, from exploration to production and reclamation.

1) Exploration -AI and ML can significantly improve the exploration phase by enabling faster, cheaper, and more accurate analysis of geological data. These technologies can predict the location and quality of ore bodies by analyzing satellite images, geochemical surveys, geophysical measurements, and historical records. AI and ML algorithms can detect patterns, anomalies, and classify data to identify mineral deposits more effectively.

2) Predictive maintenance- Another critical application of AI in mining. By analysing equipment data, AI can forecast when machinery might fail, allowing for timely maintenance and reducing downtime. This proactive approach optimizes maintenance schedules, minimizes emergency repairs, and extends the lifespan of mining equipment.

3) Autonomous mining equipment- such as self-driving trucks and robotic loaders, are equipped with AI and IoT sensors to operate without human intervention. These machines can navigate, avoid obstacles, and perform tasks with high precision, improving safety and efficiency. For instance, proximity detection sensors and wearable technology help prevent accidents and monitor worker safety.

4) Data Collection and Real-Time Monitoring - Modern mining operations generate vast amounts of data related to geological formations, equipment performance, safety, and environmental conditions. AI and IoT sensors enable real-time data collection, monitoring, and analysis, enhancing decision-making and operational efficiency. Sensors such as gas detectors, accelerometers, and temperature sensors monitor machinery and environmental conditions, ensuring safety and optimal performance.

5) Environmental Monitoring- AI and ML can also be used for environmental monitoring and management. By analyzing environmental data, these technologies can predict the impact of mining operations and help mitigate adverse effects. This ensures compliance with environmental regulations and promotes sustainable mining practices.

6) Benefits of AI and ML in Mining- Increased Efficiency, Improved Safety, Sustainability and Cost Savings.

With the advent of modern technologies [23] of investigation, sensor networks, and intelligent applications, mining-specific and generic optimization techniques in the mining industry is deeply rooted in the discipline of operations research (OR). There are various models of Operations Research, namely 1. Optimization

model; 2. Simulation model; 3. Network model; 4. Multi-criteria decision-making (MCDM) model; 5. Global optimization model.

AI and fierce global competition with the development of the digital economy [22] will enable people to offer their services virtually, being based anywhere in the globe. Computing power has increased drastically; “Big Data” gathering and storage of digital transactions through “the Internet of Things”. The mining industry in Australia already uses remotely controlled trucks.

Disruptive technologies and workplace contextual issues to gain momentum to transform the nature of work. Work tasks will tend to be non-routine, specialized, and complex requiring system integration capabilities characterized by collaborative and resilient behaviours. The world is currently entering the fourth revolution, where work is increasingly being digitized and automated. With AI applications it is likely that many processes will be undertaken through digitized processes and analysis algorithm mechanisms. AI applications can be in terms of Assisted intelligence, Augmented intelligence, and Autonomous intelligence. Technology transfer policies and licensing agreements are being streamlined to be more user-friendly.

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