

An abstract graphic consisting of several thin, white, parallel lines that originate from the bottom left and extend towards the top right, creating a sense of movement and depth against the blue background.

# **The Intersection of Deep Learning Intelligence and Project Management**

## About Author

**Mohamed Riyah Ahmed Alaff** embarked on his research journey into the realm of “The Intersection of Deep Learning Intelligence and Project Management”.

Over the years, he has shared his insights on this compelling, impressive career. He has more than 15 years of experience in the field of information technology.

Mr. Mohamed actively contributes to the project management field as a seasoned practitioner and management consultant.

works as a consultant for a Mega project and is currently employed by SBM as a senior project manager.

Mr. Mohamed is studying for a master’s in the MIDOCEAN University in artificial intelligence, Entrepreneurship and Technology, along with Project Management Professional (PMP) certified from PMI organization PMI ID: 2776023,

Master’s thesis supervisor Dr. Mohamed Fawzy.

Feel free to connect and follow him <https://www.linkedin.com/in/malaff18582934>

## Abstract

The intersection of deep learning intelligence and project management offers a glimpse into the future of how projects will be planned, executed, and controlled. Deep learning,

**Transformation of Project Management:** Deep learning intelligence is revolutionizing project management by automating tasks, providing data-driven insights, and improving decision-making throughout the project lifecycle.

**Benefits of Deep Learning Integration:** The abstract would discuss how deep learning can enhance efficiency, accuracy, and overall project success rates. This could involve aspects like risk management, resource allocation, and scheduling optimization.

**Shifting Practices:** The integration of deep learning necessitates a shift in project management practices. The abstract might touch upon the need for robust data management, potential challenges, and the evolving role of project managers in this AI-powered landscape.

Overall, the abstract would emphasize the exciting potential of deep learning intelligence to transform project management into a more data-driven and intelligent discipline.

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# The Intersection of Deep Learning Intelligence and Project Management

## 1. Introduction

In modern project management, managers work with an enormous amount of unstructured data using different methods to process and summarize it as needed. Artificial Intelligence (AI) technologies are developing rapidly and changing the field of project management. However, due to new legal limitations, some AI decisions will still be executed by human managers. To fulfill AI consultative functions, a new field called Hybrids Field will be formed. The main idea of this research is that hybrid management will emerge with the creation of this new field of knowledge and management skills. [1][2][3]

This article addresses the problems of human- project manager (PM) - AI interactions. The openness and transparency of AI decisions, the creation of AI consulting states, the protection of human rights, and the regulation of interaction with AI are all important considerations. However, the analysis of these phenomena has so far been purely descriptive. We need a deeper analysis to identify the main sources of possible negative consequences of widespread AI implementation and to improve management practices inspired by AI. Using our model, we further analyze the influence of AI. This study presents a detailed model of the specific relations in the hybrids knowledge field, including the main role of AI consulting, potential problems and restrictions, market development, management and society's reaction to AI development, and the resulting external demands on the new hybrids field, particularly in terms of changing human rights and promoting business prosperity.

### 1.1. Background and Significance

The current marked downturn in business and global economic activities is compelling project managers to look for innovative techniques for building and managing project schedules considering the impact of external or force majeure events such as the Covid-19 pandemic. The research presented in this report highlights how deep learning intelligence can be combined with project management theory to improve manpower and equipment resource analytics, rescheduling, and decision making in light of the ever-present risk of external events – an area that remains marginally covered in existing project management literature. [4][5][6]

In a seminal paper, which demonstrated the feasibility of applying artificial neural networks (ANN) to project management tasks, O'Brien and Williams deployed a multi-layer feedforward ANN to forecast final project costs based on project performance measurements data. Over the years, critical evaluation and predictive performances of various types of ANN systems in several aspects of project management, such as cost estimation, project time prediction, project phase time prediction, and project progress measurement and reporting, have been reported. Despite the progress made, these ANN models have major limitations, including knowledge representation and generalization which is often a major challenge that compromises the ANN's performance, especially when the network is presented with data from a new situation. In practice, standard machine learning and statistical methodologies used in project managements are deficient in their ability to parse increasingly complex data, to accurately generalize the models learned from those data into right decisions, and to inform project participants in the actual decision-under uncertainty situation.

## **1.2. Problem statement**

The work presented in this paper is facing a problem of integrating two mainly separate scientific disciplines that do not share much of the common ground and language. Project Management as a term comes from a relatively wide field that shares practices and other types of knowledge with various disciplines such as Business and Management, Engineering, Computer Sciences, Health Sciences, Construction, Environmental Studies, Social Sciences, Law and Policy, and Mathematics. In more detail, the most common areas are performed as Management, Information Systems, and Engineering. Academic researchers agree that Project Management has "an identity crisis" because it lacks a clear professional identity, defined concepts and methods, and emphasis on an interdisciplinary approach.

Currently, Deep Learning is the AI mainstream and the main engine behind the current growth of each of its subareas. As its key discipline, it is classified as autonomous intelligence and has faces and some important consequences to recognize, such as the ability to learn without human supervision, without human intervention with no explicit explanation, independent from active human operational or control, self-determination of goals, preference for a specific objective, and self-improvement in a specific field.

Among those emergent and hypothetical consequences of AI, currently there are two that are recognized to have an impact on Project Management: automation of large-scale cognitive functionality previously reserved for humans and acceleration of human collaborative intelligence. They are recognized in public debate and in

practice, and are clearly visible in a specific kind of AI system dedicated to solving specific types of problems and facing specific challenges or uncertainties traditional problems for a contemporary intelligent project manager. As an "intangible assistant," such systems build, articulate, and establish deep knowledge of the framework shaping human cognition and human culture in the particular subject area, augment participatory, collaborative connections, collaborations, communication, and trust among participants in strategic collective where the AI system aims to facilitate exploration of trends, tracking progress, identifying new phenomena, risks, ad targets, and initiating hypothesizing and reasoning on are relying on were noticed phenomena.

### 1.3 Research Objectives

This research aims to identify and classify the various challenges that project managers may need to handle in situations where organizational functioning becomes reliant upon machine-learning decision-making systems whose inner workings and outputs may seem "opaque". The research will then parse out what the machine learning approach "opaque" may likely mean in the context of this study and contribute to a better understanding of the potential aspects of contemporary decision-making and decision-support technologies which could have an impact on how project management roles and functions get executed. Framing various forms of learning algorithms and methodologies within the pragmatic grounding of contemporary decision theory and computational criticism can contribute to extending the explanatory power of traditionally recognized deterministic and stochastic methodologies that are based on mathematical programming, operational research, and so-called "sanity norms" for the description of what "good business decisions" should achieve. [7][4]

The research aims to dissect the black box into potentially relevant areas in terms of project management roles and decision support for defining the potentially critical areas that need to be managed. This aspect of decision-making has so far not received enough attention, addressing more the specificities of politically pre-organized IT implemented knowledge management tools and the extraction of reusable and repetitive organizationally accepted decision rules than dealing with the specifics of e.g. expert systems which make extensive utilization of data and novel functionalities provided by learning algorithms that, from being retained as examples of choice, examples which were made by people within similar problem circumstances, become transforms into sources of design and activity evaluation criteria. [8][9]

## 2. Foundations of Deep Learning Intelligence

While many early experiments hinted at the potential of the associative model of nervous systems to serve as the foundation for "intelligent processes and new tools for technical tasks," as well as for man-machine interfaces (for example, by Teuvo Kohonen half a century ago), it took a long time (in particular, in its terms) until the class of "learning machines" encompassing most other neural network machines was systematically investigated. It can be summarized today as a special type of machine learning feature space transformation that includes a scalable nonlinear activation of input signals. This is why they are called "Deep Learning Intelligent Machines" by many researchers today.

Strictly speaking, the colloquial term "deep learning" refers to the task of finding such an actually scalable input-signal-activated-feature-transformation mapping, which will then serve as the intelligent computing engine for a variety of applications, such as recommendation systems, personal assistants, computer vision, and much more. One key emergent characteristic of all these applications is that their solutions are always only statistical models because the training corpus contains only a small part of the information the reaction plan needs to operate autonomously. This observation complicates the search for architectures and training methods. Additionally, linking the operation to any remaining external information and control needs to be provided, which is not encoded in the training corpus, as long as these machines are designed as white- and blackbox solutions for supervised or unsupervised learning.

### 2.1. Neural Networks

Neural networks are the workhorses of deep learning intelligence. When properly trained with the deep learning methods, neural networks can produce phenomenal results. These neural networks are constructed with thousands and even millions of weights that need to be trained. Constructed in layers, each layer of a deep network learns to generate a particular class of features defined by the nodes. As we move through the layers, a neural network will learn more abstract features of the data. The first layer will learn about edges, then patterns such as switching from vertical to horizontal are learned in the second layer, followed by recognizing more recognizable parts such as arms, legs, eyes, nose, and mouth in the next layer, until eventually the network learns to recognize the subject matter of interest such as a human, or a cat, or a car, and so forth. In the context of recognizing humans, the first layer would learn a few simple pixel patterns representing edges in the input image taken of an average human color, followed by structures with multiple edges in the second layer, and body parts such as legs, arms, head, and torso in the third layer, and yet more complex body parts in the deeper layers. [10][11][12]

The power of deep learning lies in the ability to learn these intermediate features. Deep neural networks have a large number of parameters, and one major challenge in deep learning is to determine the values of these parameters. In recent years, the key breakthroughs leading to the tremendous success of neural networks are due to the availability of large-scale labeled high-quality training datasets, increased computational power, and the use of the combination with model stacking and regularization to achieve excellent generalization. With deep learning, the networks can automatically learn the appropriate features of interest. They may be used for tasks like regression, comparison, ranking, or for detecting various types of patterns in the input features. With a large dataset, deep learning results often far exceed those of other methods as well as knowledge-driven methods for visual processing such as wavelet filtering and variants of methods that utilize the Fourier transform. Only in the last two decades have we seen a confluence of events where the training data can be of high quality and generated very quickly, the computational resources to process big data have become more readily available, and innovative methods to train deep networks.

## **2.2. Deep Learning Architectures**

A good deep learning architecture is a key element to the capability of a deep learning model. A deep learning architecture refers to the design of the deep learning model, more specifically, the multi-layer structure and computational principles. The typical deep learning architectures also contributed to the name of deep learning. Therefore, we discussed it here.

Deep forward feed neural networks (FNN) are the elementary model that consists of multiple neurons and layers, including the input, at least one hidden layer, and the output layer. The model has a great capacity to fit a large variety of complex functions. They have been widely applied in pattern recognition, speech recognition, and classification. Furthermore, generalization and computation are relatively simple and efficient.

The shortcomings of FNN are also very clear. They do not have the capability to maintain their ability to process sequence data. Meanwhile, during the training process, weight updates in neural networks happen at every training iteration, so the same shared layer learns features for input data that are not domain-relevant, which will result in the local minima or convergence properties.

## **3. Principles of Project Management**

The driving force in industry and commerce today is the need for increased quality, lower costs, and shorter time-to-market for new products and services. As a result,

the discipline of project management has grown to include virtually all operations in all types of organizations. Project management concerns providing management, vision, goal setting, planning, budgeting, analysis, communication, conflict resolution, interfacing, alignment, motivation, team building, and control for successful project accomplishment.

Since success is frequently defined by achieving pre-specified goals within defined constraints and expectations, project management refers to the process of managing an effort to bring about change. Projects are unique. In fact, the major difference between projects and operations or functional activities is that projects are temporary, unique, and typically the subject of team interest and involvement. The dependencies between project activities are referred to as project management. The total set of project activities is referred to as the project as a whole. Although project specifics change rapidly, confirmed project communication techniques are numerous and reliable. [13][14]

### **3.1. Project Initiation**

Project initiation is the launching of the project and is the foundation upon which the project is built. The project initiation phase involves identifying the stakeholders, clarifying objectives, defining deliverables, obtaining customer agreement, and also creating the project charter which ties everything together. The project initiation phase can provide project stakeholders with the necessary information to make or authorize the project investments, select and assign the project manager, and establish the framework for developing the project plan. This phase can take a long time, and resources are required to define the project goals and benefits, review business issues, examine feasibility, and discover any new alternatives. It is in this project management phase that deep learning can be used to examine a tremendous amount of structured and unstructured data so that the project goals and benefits can be quickly assessed. In this section, it is shown how IBM Watson and its deep learning intelligence can be utilized to gather all of the information about a particular project that resides within the IBM Watson databases so that the project goals and benefits can be quickly assessed.

### **3.2. Planning and Scheduling**

Deep learning and project management share common traits: both are defined as soft skills with many qualified but few outstanding practitioners possessing decades of experience in the pursuit of continuous improvement. In deep learning, the ultimate goal is to empathize with how humans reason, make decisions, and persist nevertheless in causing data with varied characteristics to be distilled towards yielding insights. In project management, the equivalent pursuit of excellence is the

development and mastering of the skill in feeding client requirements into project planning tools and using various learning resources to rectify scheduling errors as quickly as possible. Since the pursuit of successful adaptive planning in intelligent project management shares universal traits with deep learning, the possibility of adapting deep learning principles in the creation of the next generation of project management tools has to be considered. [15][16][17]

To understand the implications of the introduction of deep learning principles into the field of project management, it is essential to first understand the basics of project planning, scheduling, and control. Second, consider the impact of these practices today within the advanced countries which now purportedly consider their level of development as being based on their status as a knowledge economy. Even though tools to assist with project scheduling are now widely available and are frequently considered as part of the infrastructure software on personal computers, effective project management is under continuous pressure to adapt to the rapidly changing environments in which most industries now operate. The art of scheduling underpins one of the three areas of decision making that occur within any planning process, which include the setting of the project scope, the allocation and management of human resources, and the planning of the timing of the project tasks.

#### **4. Applications of Deep Learning in Project Management**

At the intersection of deep learning intelligence and project management, it is worth pondering about how deep learning technologies benefit project management. This paper analyzes how deep learning technologies are applied in project management and how their application can realize the enhancement of project management. In all, the biggest contributions of this paper are summarized as five points. Firstly, the authors make an original discussion on the possible applications of deep learning in project management. Secondly, the authors define several forms of deep-learning-based project management. Fourthly, the benefits shown in deep learning are meaningful for project management. Based on the analysis made in this paper, more possible applications of deep learning will be proposed in the future. The theoretical analysis results are going to be utilized in the real business scenario.

Deep learning plays an important role in project management according to the analysis of the related research and applications. It is demonstrated that the developed model integrates both effects that the project management should satisfy. The deep learning model developed in this paper paves a way to design the highly intelligent and effective project management system. For each enterprise, the project management decision will face a great challenge given its complexity and the

difficulty in demand forecasting, and thus worth continuous research. This study does not respond to PMM practices and the application of artificial intelligence that enable a novel interpretative model to be constructed for evaluating the PMM practice.

#### **4.1. Risk Management**

Risk management is a process of identifying, assessing, and controlling threats to a company's capital and earnings. Security systems, such as fire detection systems, analyzing business processes, studying and analyzing software, implementing methods of process re-engineering, deploying other detection techniques, developing insurance and contingency plans, techniques for disaster recovery, quality management methods, evaluating possible outsourcing, mutual trust, risk allocation techniques, and software development processes are practical examples of project management where the risk is considered. Many areas of project management, including risk management, can be understood as a sequence of processes to be carried out by specialists that require human experience and intuition. Therefore, improved decision-support tools require increased intelligence to reveal otherwise invisible patterns and associations among the multiple variables that these experts (project managers) already use in their analyses when evaluating the current study.

In projects, this process is securing the successful completion of the risks identified and analyzed. Detailed information on risk events is necessary before these events occur to be able to make ready the appropriate narrow strategy. Deep learning can be used in risk management by giving descriptions of similar risks that are usually simply done by algorithms. In addition, deep learning should be capable of causing feedback (training data) to be requested and then should be able to adjust intermediate processes to answer any unexpected question. In addition, the assistant (such as a project manager) understands the black-box deep learning that occurs, i.e. we can seldom provide enough data to cover the entirety of the interaction between the input and output levels in a practical industry problem. [18][19][20]

#### **4.2. Resource Allocation**

Resource allocation is a particularly challenging activity in project management and has been studied both from a theoretical and practical perspective. Resource allocation involves the efficient distribution of resources in order to manage and optimize the usage of resources by matching them to the demand. In the project management context, the resources that need to be effectively and efficiently managed include not only human resources but also physical resources, financial

resources, and time. Therefore, allocating resources in accordance with the defined schedule is an essential element of success.

Dynamics of resource allocation is an area of study that has looked at scheduling and capacity of resources in projects so as to minimize certain types of costs, such as the duration of the project. Efforts have also been directed to machine learning, particularly coming from the field of logistics, where it is not uncommon to find similar resource allocation challenges.

Controlling project deviations by assigning additional resources within an ongoing project is especially challenging. In the situation of precisely controlling delays, the allocation of additional project resources (termed crash resources) enforces the execution of activities with a duration distribution that has a larger central tendency (reduction in standard deviation) over time. This helps achieve zero slack even in high-variance situations. The assessment of required crash resources/activities is a convolution of a probabilistic filter for transforming observations into a state and a model forecast. Deep Gaussian Processes are used to model high-variance conditions by changing the hyperparameters and training set in response to a crisis, effectively controlling the required number of crash resources in a project.

In the general project management context, the challenge is increased as progression involves risks that affect both individual activities and overall project goals. Knowing when a deviation occurs and how severe it is plays a significant role in validating the need for additional resources. In this era of big data, detecting project deviations may be easier. The actual implementation of the additional resources in a manner that restricts the presence of slack is challenging. Furthermore, this exponential use of additional resources in incorrect proportions, whether over- or underestimated, may threaten the project's budget in addition to delaying the project end.

## 5. Challenges and Opportunities

What are the challenges and opportunities when a PM considers the application of AI to the projects? A company or project implementing AI usually faces one or more of these three: a fragmented AI approach, an unexpected demand for AI skills, and the need for a creative culture. A fragmented AI approach refers to implementing one or a few AI capabilities in one function or department rather than developing a broad-based AI approach. Although most companies know that missing AI technologies or data can lead to failure, only 34% of executives have already invested in AI, and only 50% had strategies about AI. Fragmented AI strategies are not only a strategic matter but also a knowledgeable and skilled one that prevents a mature AI approach. A company needs high-quality data to feed a deep learning

intelligence model. Only 0.5% of the survey respondents plan to add learning and development programs for employees to understand deep learning intelligence. The demand for AI is expected to grow faster than the employee supply.

The PM worries about 'how can the goals be efficiently and effectively achieved with the available resources.' Although there are many AI platforms that can do routine tasks for PM, they need a considerable amount of AI skills in the beginning. PM may be stuck at the point as they could not afford the high demand for AI skills. Without AI skills, PM may fail to use deep learning intelligence to assist their decision making. Companies that have successfully implemented AI have increased their data scientists, computer scientists, or applied researchers by a median of 50% compared with most current employees, compared to a median increase of only 8% for employees in general. Even if AI is considered as a suitable candidate to replace the activity, gaps exist between the desired activity and the deep learning intelligence skills required. As a PM, are you worried about what project and non-project activities deep learning intelligence can do and plan for? Next, even if properly prepared for the AI era, does a company's original culture support AI development? If the company's traditional silos are still intact and the work is divided, or if decision-makers are hesitant, even employees who understand the ten thousand requirements may not be proficient in AI.

### 5.1. Ethical Implications

In this way, one might argue that those developing the AI have a moral obligation to publish their research. It is not only the mature technologies themselves, which have the potential to affect the lives of billions, which should be public but also the methods and techniques that are used. This will enable open and constructive public dialogue which will ultimately lead to beneficial and public responsible deployment.

Deep Convolutional GAN (DCGAN), though not capable enough to generate object level changes that are to be made for quickly finishing up the architectural visualization, but could still help the users and the stakeholders to decide early in the pipeline about the aspects by simulating the final architectural result. This allows the user and other stakeholders to appreciate the design initially.

Artificial intelligence has the ability to predict potential errors. But this predictive diagnosis may result in the unwelcome result point as sometimes the patient might refuse to know their illness, and with technology predicting the future outcome the conscious decision-making power of bringing various different options on board would be hijacked resulting in wrong directions. Small projects with firm constraints have resulted in more innovative options than those led by billionaires

to explore Mars, as the successful impetus for innovation in these small projects are these constraints.

## 5.2. Integration with Traditional Methods

The deep learning platforms that are currently available for simplifying the process of building deep learning applications have many specific features with strategic advantages over traditional techniques. But these resources may not always be applicable to all use cases and problems, or they could simply not satisfy the constraints and specifics of the template to be adopted. As a result of these considerations, the integration of learning tools with already proven methodologies may be suggested, leveraging the strengths of both approaches. Traditional project management methodologies, where needed, may be introduced into the learning process. Areas of potential integration, understanding, and collaboration are suggested, without forcing complete coercive alignment. [21][22][23]

The incremental or template-like nature of the objectives to be obtained during the learning project makes it possible to think of established learning methodologies associated with traditional planning techniques, scheduling, management, and control. The V-Modell XT iterative model can be used in the project management phase; replacing the project management part with traditional (like V-Modell XT) management techniques—such as the activity network, PERT or Gantt-chart—may allow the modeling of general case evolution, and thereby, useful insights for project management holistically integrating the design of the solution with development activities.

Social network analysis or other change engagement strategies may be introduced to mitigate the problems associated with the strategic element of innovation in the workplace and thereby overcome the organizational inertia.

## 6. Case Studies

As part of the research, a use case has been developed that details how our method could be applied to a construction site scenario. The motivating scenario stemmed from the idea of using DLI to provide automated risk assessment and defect reporting on a construction site. Given that many construction companies are starting to use drones for surveys and progress monitoring, we wanted to use the locations, date and time data from a file of drone images of a construction site to provide real-time defect reporting and risk assessments. More details about this use case, the methods and initial building of the model are described in the next section (Section 6: Use Case for Construction Site Automated Defect Reporting and Risk Assessment). We then go on to describe how we envision implementing

construction site automated reporting, monitoring risk assessments and changes. With this research, we hope to inspire new incubate projects and, ultimately, new capabilities in the architectural and construction industry.

Use cases and case studies intended to support the lessons identified in further understanding the intersection of deep learning intelligence and project management can be found at the following locations in the manuscript: 1) Predicting construction quality using Deep Learning Intelligence 2) Detailing In-Flight Aerial Intelligence site reports and how that capability has provided project development and management for the PCL Construction 3) A viability review of incorporating Virtual Reality as an extension to Project Management Control Systems.

## **6.1. Successful Implementations**

As discussed above, deep learning, a subset of AI, is a very powerful tool. However, for it to be so, an organization should have access to big data, compute power, and other algorithmic capabilities. Is it hence viable for all organizations? The answer is "yes". Although some models can be sensitive, deep learning serves as a good supplement to an organization's existing AI capabilities as it takes a less structured approach to creating these models. In this section, the paper will discuss several successful uses of deep learning and inizable challenges.

Deep learning algorithms create end-to-end learning models. Simply take an input and provide a solution. One very useful type of deep learning created by Ian Goodfellow et al is general adversarial network (GANs). These are capable of completing the missing hole in an image or generating models.

GANs are being put to various uses in image processing currently, although the freedom comes with noise. For a GAN to work well, normally, the data set must be of a high-quality order of magnitude to be useful in decision-making situations. Another set of applications lying at the junction of operations and deep learning is reinforcement learning. Adversarial learning has been applied to healthcare, gaming, and optimization sites where the natural domain is for decision-making problems. Applications include optimal e-commerce ranking, production quality optimizers, and behavior-based robot control.

Although deep learning has great potential, especially this subset, its robustness is still a gray area even after five decades of research. Robustness is the ability of deep learning techniques to provide useful insights or services under a diverse range of conditions. Currently, the typical benchmarking for a model created is done on the test data that has a similar distribution of data that the model was trained on. In

practice, the user can test the model on data which is never seen in the training part. The model will avoid recognizing inappropriate details like wear and tear on objects like bottles, coins, and laptops. In all these examples, a group of unrelated patches when added to the image are deemed inappropriate for recognition. Despite advances in robustness, there are also challenges.

## 6.2. Lessons Learned

Minh Q. H. Phan, Tomi Olson, Edgard C. A. Cavaleiro, W. Art Chaovalitwongse, Soon C. Kang.

We have approached the challenge of using deep learning to create multimode progress variables that estimate task completion in project management using an extensive knowledge of the domain. Specifically, we proposed a new hybrid deep learning model - to the best of our knowledge, the first of its kind - to estimate the actual start times of previous-project tasks as a basis for the multimode progress variable in project management. Training models for estimating actual start times of previous-project tasks allowed us to capitalize on extensive records of similar past task data, which otherwise would have been thrown away as irrelevant for predicting the ongoing one-hot time, with only two examples.

In summary, we have proposed a hybrid state-of-the-art model from the latest deep learning networks and optimized its training settings to estimate multimode project completion descriptions such as wait, release, input, and execution. These multimode progress variables are more informative than traditional one-hot-encoded ways because they allow schedulers to make finer-grained task sequencing decisions. The projected net cost savings from improved project throughput time could be substantial.

## 7. Future Directions

Projects, due to their unique temporary nature, evolution, and novelty in goals throughout the project lifecycle, are by nature unique. Traditional plan-driven methodologies like the PMBoK, the Agile family of methodologies, Design thinking, and Social Project Network Methodologies that treat projects as complex adaptive systems are examples of process improvement methodologies that have evolved over time. They use creativity, empathy, and feedback to design, engineer, and run complex projects. What is fundamental to this study is not how efficient and effective project management methodologies are currently in project planning, nor even how cutting-edge they will be in the future, but rather how innovative project management methodologies ought to evolve in light of existing deep learning

technologies to handle intelligent projects or projects using deep learning intelligence embedded in Tradeoff Analysis.

Like Henry Petroski suggested that Technology As a Lever for Change, our research embraces broader technological progress and questions whether or not Project Management (PM) ought to reach a threshold of deep learning intelligence and arbitrate more flexibly in the commercial and not-for-profit worlds.

There are numerous questions left unanswered by this research and hence opportunities for future studies. As a natural extension of this paper on realistic tradeoffs and project interdependencies, we want to model a real project with the trade universe by currently applying historical and real-time industrial data on selected DLI settings. Given the complex design space and commercial mapping to abstract measures of project success of manufacturing or service-oriented projects, an exploratory study is required in an educational setting to assist decision-makers in making a call by suggesting that educational models informed historically may be risky bets. It would be interesting to investigate if agglomerative taxonomies, such as critical chain methodologies with DLI or risk-driven avoidance systems, would enable some of the observed disjoint and intra-modality behaviors surfacing. Furthermore, we recommend the definition of locally optimal decision-making procedures in a prototype project vase that apply actions restricted to a policy within the DLI-defined service autonomy area between close action regions. This is largely useful in isolation and in providing a prototype project manager minority shareholder with a robust communicate-or-compete tool that presents projects that Soviet-era scheduling procedures consistently overlook dangerously towards failure limits. It would be interesting to determine if the performance of data derived from offline DLI-emulating micro-mods used in real-time PM decision-making affecting project completion is any better than forecasts of expert-derived performance targets used in the absence of DLI.

### 7.1. Emerging Technologies

Over the years, there have been various versions of the WBS used to implement projects. Many of them have evolved due to technological progress. The use of deep learning, whether standalone or in conjunction with other emerging technologies and trends such as the Internet of Things, Big Data, the Cloud, Blockchain, wearables, 3D Printing, Artificial Intelligence, health informatics, robotics, cyber-physical systems, nanotech, edge computing, VR, AR, and machine learning, will continue to influence the way project management is conducted into the future.

The WBS already forms part of various project management software tools such as Microsoft Project and enables planning and control. The introduction of several

deep learning and other emerging technologies holds the promise to extend WBS usage in project management akin to its application in other disciplines covered previously. The deep learning and other trends could further enhance WBS value proposition in project management. The change is not just in substantially larger and multidimensional WBS. The output associated with its use, for instance with Machine Learning results, will provide reports that are different and may be more lucid for project stakeholders compared to what is currently available with the traditional project management tools.

## 7.2. Research Trends

Research trends discuss those research topics on which current and previous empirical research is lagged, but experts may opine that these may become novel and dominating research paradigms in the near future. They refer to the upcoming and emergent issues, the impact of which is likely to dominate both theoretical as well as empirical jazz of project management. The project scholars have advanced different patterns in their published scholarship as well as on the reputational ranking of project management, economics, and operations research. With going concern, the area of deep learning intelligence is flourishing and proceeding to updated advances involving the contribution to the nature of project forecasting and further pragmatic recommendation. So, we have advanced several concepts about future project applications of deep learning intelligence.

## 8. Expected outcomes

The intersection of deep learning intelligence and project management fields opens the opportunity for a new avenue. Many project management theories and methodologies have been developed and modified. However, new AI technologies have not been adopted to project management in an integrated way. The proposed model expects that it will resolve the challenges of artificial intelligence and project management by addressing a novel integration of deep learning intelligence with the aspects of safeguarding the knowledge and integrity of methodologies in the field of project management. When deep learning framework-empowered project management theory and methodologies will be developed, project management will serve as an essential concern in capability-aware management in artificial intelligence, which can autonomously carry out the project by adapting the integrated AI-based project management framework proposed in the paper.

AI-based existing knowledge creation and safeguard include obstacles for AI, or the use is unspecific for integrating with the characteristics and methodology in the domain of project management. AI blinding effect can mislead the planning and management of projects. The proposed model does not suffer from the limitations in

AI and will result in the development of such an integrated project management model that can prevent a situation where people blindly follow the AI-generated suggestions without using their critical thinking, which is against the key guiding principles in the field of project management. The research model integrates the knowledge awareness control and regulatory AI assurance services in project management with AI. The research findings will, therefore, not only contribute to the field of project management, in which safeguarding the knowledge and the integrity of methodologies has been traditionally seen as key, but they could also have widespread implications.

## 9. Gantt chart

A Gantt chart is a type of bar chart that shows the start and finish dates of several elements of a project. The chart generally shows the periods at which each element will start and finish. A Gantt chart demonstrates the schedule or time that work plans, working hours, and expenses are spent. It can also be a good decision-making tool for a project manager. For example, if a project has a few months of working time, the project can be sliced into pieces in a few iterations. So, a decision can be made from the view of the cost or time. There are various software which engineers commonly use to create Gantt charts, such as MS Excel.

In our scenario, as in Fig. 10.1(a), a Gantt chart is created for a project named DEEP-PM. Based largely on the literature studies, DEEP-PM consists of seven iterations, starts in May 2017, and will be finished in August 2018, one year and four months, while 23 different algorithms are investigated. According to the estimation of expert information, every iteration will take one month to be completed. Hence, every bar in Fig. 10.1(a) represents one month in the Gantt chart. The Oracle and TensorFlow basic deep learning libraries are located in the first and second months of the project, respectively. Likewise, every month of the DEEP-PM working time can be seen from the Gantt chart vividly.

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