AI-Enhanced Project Estimating, Monitoring, and Forecasting

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Abstract

Worldwide investment in projects consumes a large slice of global GDP, but project outcomes and success rates continue to lack luster, resulting in significant value destruction for organizations and economies. A call to action is warranted for project management to deliver demonstrable and measurable results. This paper will provide preliminary but cogent evidence that artificial intelligence (AI) has the potential to transform project management from an *"arts and crafts"* discipline to one that has a guiding science capable of delivering improved project outcomes and realizing comprehensive value-enhancing solutions to organizational work challenges and economic imperatives. While estimating, monitoring, and forecasting are used merely as illustrations of how AI can enhance current project management tools (both traditional and agile), the overall thrust of the paper is on exploring how AI could elevate the perception and practice of the project management discipline, redefine the skillset of project managers, and reshape project management standards, education, and training.

1. Introduction

Investment in projects consumes a large slice of the $105 trillion annual global GDP[1], with some reports suggesting that the annual investment is as high as $48 trillion – or slightly under half of annual global GDP [1]. Project outcomes and success rates, however, continue to be concerning. For example, the 2020 Standish Group Report [2] estimates that 42% of software projects using the agile approach are successful, 47% are challenged, and 11% fail. The respective numbers for the traditional approach are 13%, 59%, and 28%. Various other reports on project success rates (that include non-software projects as well) suggest similar or worse track records (see [3], for example, which claims that 99% of big projects fail!). Equally concerning is the fact that project success rates do not appear to have shown a statistically significant upward trend over the past decade [4].

These concerns warrant a call to action for reevaluating how the project management discipline is perceived, practiced, and taught. Project management has primarily curated knowledge from other disciplines instead of creating new knowledge consistent with the times and with emerging technology, work, and social trends. For example, how much of the fundamental knowledge, models, artifacts, tools, and techniques in project management textbooks, standards, and bodies of knowledge have been created in the past

[1] As of 2023 (https://www.visualcapitalist.com/visualizing-the-105-trillion-world-economy-in-one-chart/)

20 years? A thoughtful evaluation will reveal that almost all of the project management discipline, as it exists today, comprises knowledge and techniques dating back to the previous century, and the vast majority of them are adapted from other disciplines.

By way of comparison, disciplines like marketing and finance have been briskly creating knowledge, tools, techniques, and artifacts that are abreast of evolving consumer and stakeholder needs and trends, and which utilize the technologies of the times. For example, marketing has adapted to the internet age and social media [5] and finance and investment have made similar adjustments. Consider the various financial and investment instruments created relatively recently and *Wall Street*'s use of AI for quite a while [6].

In discussions with numerous executives, organizations, and leading business schools over the past two decades, this author has encountered the consistent perception that project management is indeed vital to delivering results but that the discipline itself is not considered mature and consequential enough to merit favorable standing among rivals such as sales, marketing, finance/accounting, and HR. For example, none of the Fortune 100 CEOs appears to have emerged from a project management background, at least according to a 2019 Forbes report [7]. Many well-known MBA and business school rankings typically include rankings by discipline [8], and project management is usually not among the disciplines ranked, although some rankings (like *US News* rankings) have only recently started to include project management. Further, most MBA programs do not include a core course in project management [9].

The irony is that project management is the only business discipline that incorporates a very circumspect, integrated, and cross-functional view of an organization's work, addressing aspects ranging from scope, schedule, and cost all the way to quality, risk, communications, procurement, leadership, strategy, value-driven and mission-aligned delivery, stakeholder management, decision-making, emotional intelligence, etc. Moreover, demand for project managers continues to be very high, with one recent Project Management Institute (PMI) report stating that "*2.3 million people will be needed each year to fill all of the project management oriented positions expected to open by 2030*" [10]. One would expect that, with such a breadth of knowledge and skills, coupled with a growing demand for those skills, project management should be the ideal background for a CEO or a senior executive. Sadly, that is not the case.

One key reason for project management not being ensconced in the echelons of disciplines like sales, marketing, and finance is that it is generally perceived as more of an art that invokes craft knowledge and skills which have been slightly adapted from various other disciplines and have evolved over time from practitioner experiences - and therefore does not embody a unifying or guiding science or theory. It is not regarded as a discipline capable of delivering comprehensive and end-to-end value-enhancing solutions to broader strategic organizational work imperatives and challenges. Consequently, it is generally viewed as a tactical discipline that lacks a strategic backbone. The adoption of agile approaches that emphasize brisk value creation and alignment with strategy, vision,

and mission has indeed helped somewhat to favorably address this perception, but not enough to significantly move the needle.

It behooves project management leaders, practitioners, and educators to reflect on the above reality and act in concert as a community to elevate the standing of the discipline and profession. That action is a broader and longer-term consideration that obviously is not (and cannot be) meaningfully addressed within the scope of this AI-focused paper, but some broad high-level suggestions are offered towards the end of the last section.

The primary goal of this paper is to provide preliminary but cogent evidence that AI has the potential to be an instrument that, if appropriately and skillfully harnessed, can elevate the art of project management – both agile and traditional - by tilting it towards a science that is capable of offering strategic solutions to organizational work challenges, as opposed to merely addressing tactical considerations for managing individual projects or programs. Based on the success rates provided earlier, performance on the latter is still very far from satisfactory.

While estimating, monitoring, and forecasting are used merely as examples to illustrate how AI can enhance current project management tools (both traditional and agile), the overall thrust of the paper is on exploring how AI is likely to transform the perception and practice of the project management discipline, to redefine the skillset of project managers, and to reshape project management standards, education, and training.

2. AI: Threat or Opportunity?

Sam Altman, the storied CEO of OpenAI, recently opined that AI could create a one-person unicorn[2]. Even though that may be a stretch, others do not dismiss the notion that a three-person unicorn is a distinct possibility in the future [11]. The point here, of course, is that AI could drastically reduce the need for human skills, which in turn might decimate jobs that humans now perform. This is perhaps not likely to happen in the next year or two but cannot be ruled out in the not-so-distant future.

Over the past few years, and particularly in the past couple of years, several studies have addressed project management job trends and the impact of AI on jobs. Here are a few:

A. *AI Won't Replace Humans — But Humans With AI Will Replace Humans Without AI* (Harvard Business review) [12]
B. *25 million new project professionals are needed by 2030* (PMI 2021) [10]
C. *By 2030, 80 percent of the work of today's project management (PM) discipline will be eliminated as artificial intelligence (AI) takes on traditional PM functions (*Gartner*)* [13]
D. *Goldman Sachs Predicts 300 Million Jobs Will Be Lost Or Degraded By Artificial Intelligence* [14]
E. *AI was responsible for 3,900, or roughly 5% of all jobs lost in May 2023* (Challenger, Gray & Christmas) [15]

[2] A unicorn is a startup valued at over one billion US dollars before it goes public.

F. *Robots would eliminate 200,000 jobs in the banking industry within the next 10 years* (Wells Fargo study) [16]

While none of these studies can claim crystal ball status, they do have a common denominator: AI will disrupt the jobs that humans perform. Job disruption does not necessarily equate directly to job elimination. Kent Walker, Alphabet Inc.'s top lawyer, says about AI and about ATMs automating some bank teller tasks, "*AI automates tasks, not jobs. We now have more bank tellers than we've ever had before in the United States because ATMs made it cheaper to open up bank branches around the country. Tellers went from just handing out cash to helping customers with loans and other kinds of financial services*".

So, although B and C above may appear conflicting at first sight, they may not necessarily be so. It is certainly possible that more project management jobs will be created while AI replaces project management tasks! If B and C are both possible, then a logical consequence is that the new project management jobs created would involve tasks very different from those performed by present-day project managers, and these tasks would require new skills capable of creating more value for organizations and enabling strategic and comprehensive work solutions.

The takeaway is that AI is partly a threat to jobs that humans perform, partly an opportunity, and definitely a disruptor. If history is any indication, the opportunity is likely to eclipse the threat. Great disruptions – such as the printing press, electricity, and internet - have almost always seeded outsized growth, opportunity, and prosperity, consistent with the process of creative destruction, a notion first articulated in 1942 by the Austrian economist Joseph Schumpeter. A PwC study estimates that AI will contribute $15.7 trillion to the world economy by 2030 [17]. A 2024 *World Economic Forum* report supports a similar view, asserting that *"AI will augment humans, not replace them"* and emphasizing that *"AI will usher in an economy that puts people first"* [18]. It would appear from these reports that there will be numerous exciting and highly rewarding jobs ahead for project managers who expand their comfort zone to include the right skills, as is already playing out in finance and marketing – consider *fintech* skills, for example.

3. How can AI Enhance Project Management?

As noted in the introduction, project success rates are dismal. Graded on the traditional academic scale where a 90%+ success rate equates to an 'A' grade, project success rates would earn a failing grade or a 'D' grade at the very best. Alternatively, using a Six Sigma-like scale where a *"defect"* is defined as a failed project, the *"quality"* of the project management discipline (or *"process", a*s a whole) would fall short of even a lowly 2-sigma quality rating. A product with less that a 2-sigma quality rating would certainly be either discontinued or subjected to a rigorous quality audit, and will not be able to survive in any competitive marketplace unless and until the quality issues are rectified.

These measures of project success should be a concern for any project management educator, practitioner, manager, or executive, and to any organization that invests in projects. It stands to reason that a rethinking of how project management is perceived, practiced, and taught is long overdue. Reflective of Newton's first law of motion, objects, people, organizations, and even professions tend to display inertia: the tendency to resist change unless acted upon by an external force. (In fact, *clinical inertia* is a term used in the medical profession.) Could AI be that external force? The remainder of this paper will present preliminary but cogent evidence that suggests that the answer could be a *"yes"*.

The definition of project success is invariably linked to targets associated with schedule, cost, quality, stakeholder satisfaction, value creation, etc. These targets are in turn based on estimates that shape the project plan: for example, the estimated schedule or cost or value created. During project execution, appropriate monitoring needs to be in place to assess performance against plan, and the assessed performance parameters can then be used to develop forecasts for subsequent performance - and to implement appropriate and timely corrective actions if those forecasts indicate that the original estimates could be compromised.

Consequently, one could argue that effective estimating, monitoring, and forecasting constitute the core engine of project management. In a hypothetical world in which project estimating, monitoring, and forecasting were perfect, it would be very likely that all projects would achieve their targets. Similar logic would suggest that the current low success rates of projects are likely due to issues traceable to the inadequate effectiveness of estimating, monitoring, and forecasting techniques.

For purposes of illustration only, consider four commonly used estimating, monitoring, and forecasting techniques: parametric estimation, PERT, Earned Value Analysis, and Monte Carlo simulation. The table below summarizes some of the key limitations of these techniques (in both the traditional and agile project management contexts) and the overall perceptions about the profession that these limitations create.

Technique	Limitations	Perceptions created
Parametric estimation	Formula or function is often a quantitative idealization, so often clashes with practical considerations; "hidden" parameters are often not considered	▪ **Limited practical utility of the techniques/profession** ▪ **Stagnancy and short on thought leadership** ▪ **Lacking solid theoretical foundation** ▪ **Borrowed knowledge: inadequate originality**
PERT	On shaky theoretical ground unless associated distributions are all normal, which impairs practical utility	
Earned Value Analysis (EVA)	EVA forecasting formulas can overlook trends, seasonality, work performance patterns, external influences, etc.	
Monte Carlo Analysis	Can be misleading if underlying probability distributions (and their parameters) do not reflect reality	

There are three principal factors that account for these limitations and perceptions:

1. The techniques themselves are idealized or heavily approximated, and therefore do not adequately capture the circumstances and the realities of the projects that use them. For example, Earned Value Analysis (as it is currently applied) cannot

capture differing trends in sub-components of project work, so the formulas that use earned value analysis for forecasting can produce unrealistic and sometimes misleading forecasts.

2. All the widely used project management estimating, monitoring, and forecasting tools are skewed by what is known in statistics as omitted-variable bias (OVB), meaning that not all relevant variables are considered. There are many more variables that impact estimates and forecasts than those that project management tools acknowledge: for example, innovativeness, employee motivation and engagement, organizational culture and politics, communication, transparency, decision making, empowerment, etc. Several reputable studies have examined the impact that these factors have on productivity, goal attainment, and project outcomes (for example, see [19]), but none of the current project management techniques (like parametric estimation, for example) considers such factors.

3. An adequate distinction is not made between so-called *industrial work* and *knowledge work*. Estimates and forecasts for projects involving knowledge work are usually more elusive [20] and are more prone to be impacted by omitted-variable bias (OVB).

Can data science in general (and AI in particular) rescue project management from the above limitations? This paper will offer some preliminary but persuasive evidence that this could indeed be the case. Before presenting that evidence, it is necessary to clarify a few basic AI concepts and terms, specifically supervised learning, unsupervised learning, and semi-supervised learning. These are three broad classes of AI/machine learning. (One more class is reinforcement learning which we will not address here.)

Supervised learning refers to *"teaching"* a machine (or a software app or program) to make inferences by providing it with labels: for example, providing it with a thousand pictures labeled 'CAT' and a thousand pictures labeled 'DOG'. The machine then learns how to use those labels and pictures to construct its own *machine logic*, so to speak. This process is sometimes also referred to as *"training"* the machine. Once appropriately trained, the machine will then be capable of correctly classifying (at least most of the time) other cat/dog pictures (not among the original two thousand). For example, the machine may be able to correctly classify a picture of your neighbor's pet cat as 'CAT'.

Unsupervised learning does not provide labels to the machine. Suppose, for example, you provided the same two thousand pictures (1,000 cat pictures and 1,000 dog pictures) to the machine, but do not provide the machine with the 'CAT' and 'DOG' labels for those pictures. Unsupervised learning refers to the ability of the machine to "learn" that there are two different categories of pictures among those two thousand, meaning that it can recognize that some of the pictures fall in one category and the others fall in another category. Of course, you know that these categories are 'CAT' and 'DOG', but the machine does not know that! All it knows is that there are two different categories, say

category A (which you know is ‘CAT’) and category B (which you know is ‘DOG’). If you then provide the machine with another cat/dog picture (not among the original two thousand), it will correctly classify that picture as either Category A (if the picture is of a ‘CAT’) or Category B (if the picture is of a ‘DOG’).

Semi-supervised learning is a compromise that provides the machine with only a few labels. Reverting to the two examples above, suppose you provide the machine with labels for only a few pictures: for example, suppose you give it a thousand cat pictures and a thousand dog pictures, but you provide it with a ‘CAT’ label for only two of the thousand cat pictures and a ‘DOG’ label for only three of the thousand dog pictures. Note from the previous paragraph that the machine, using unsupervised learning, is able to distinguish two categories: A (which you know is ‘CAT’) and B (which you know is ‘DOG’). Since you have tipped the machine off that two of the pictures in category A have a label ‘CAT’ it will then infer that everything in category A probably has the ‘CAT’ label! Similarly, because three pictures in category B have ‘DOG’ labels, it will infer that everything in category B has the ‘DOG’ label. In other words, with minimal *“supervision”* (or labels), the machine is trained to correctly label cat and dog pictures.

Neural nets and regression are examples of supervised learning. Clustering, anomaly detection, Principal Component Analysis (PCA)/dimensionality reduction, and association rules/recommender systems are examples of unsupervised learning. Semi-supervised learning includes fraud detection, content classification, and audio and image analysis. Supervised, unsupervised, and semi-supervised learning all have potential applications in project management. Actually, even reinforcement learning can conceivably be applied in project management. Time series analysis, an AI technique which can utilize supervised learning (in part, at least) could also be used in project management – to enhance Earned Value Analysis, for example.

To maintain focus, and due to length limitations, this paper will present an application of only supervised learning that addresses the three principal factors listed earlier (that currently impair project estimating, monitoring, and forecasting). This application which utilizes neural networks (supervised learning) offers preliminary but cogent evidence that artificial intelligence can tilt project management towards a science capable of providing strategic insights and comprehensive solutions to organizational work challenges.

4. Example of a AI Supervised Learning Application in Project Management

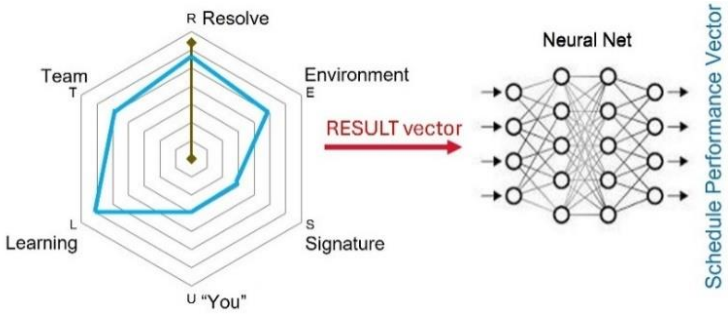
The example is based on a technique the author developed around 2005 and used in his training and consulting engagements and interactions with various organizations of many types and sizes and in diverse industries. The technique is called *RESULT Analysis*©, where *RESULT* is an acronym of sorts: **R**esolve, **E**nvironment, **S**ignature, yo**U** (a phonetic play), **L**earning, and **T**eam.

Each of the six letters has subtending factors. For example, *“Resolve”* refers to the collective resolve (intentions plus supporting actions) of an organization to improve the effectiveness of its project management practices. Factors that subtend to *Resolve* could

be leadership championing/support and investment in project management technology, for example. *Signature* refers to the intrinsic nature of the project itself, and its subtending factors could be project complexity, novelty, riskiness, etc. *U* (*You*) refers to individual team member attitudes and characteristics, and its subtending factors could be training, motivation, sense of empowerment, etc.

Delving into all the details of the RESULT analysis would lead us too far afield from this paper's focus on AI. Suffice it to say, that the RESULT analysis, which is ideally performed before a project starts, scores various factors associated with each of the six letters to arrive at a *RESULT score* or a *RESULT vector*. For example, if a 1 to 5 scale were being used (with 5 representing the highest possible and most favorable score), then a RESULT vector of (3, 4, 2, 1, 3, 3) would mean that the project scored 3 on *Resolve*, 4 on *Environment*, 2 on *Signature*, etc. In a sense, the RESULT vector is a gauge of (or proxy for) the overall conduciveness of an organization to the success of its projects – and it encompasses objective as well as subjective factors.

Having RESULT analysis information/data spanning over a decade from several hundred organizations and projects, the author wondered whether AI could be used on this data to enhance estimating, monitoring, and forecasting. For example, how well could the RESULT vector predict project outcomes? Using the RESULT vector as an input to neural networks that classified project outcomes with various output label types (or classes) - for example: a schedule performance vector such as (*beat schedule*, *met schedule*, *missed schedule*, *badly missed schedule*) - the labeling accuracy rate of the trained neural networks was encouragingly high (80% to over 90%, depending on the specific neural network). Surprisingly, the neural networks appeared to predict outcomes better than any of the prevailing project management techniques were capable of accomplishing. The most likely reason is that the RESULT vector is a good proxy for variables (some of which may be intangible or soft factors) that current estimating, monitoring, and forecasting tools are incapable of incorporating, so the RESULT analysis-based neural networks are, among possibly other things, compensating for the omitted-variable bias (OVB) that besets non-AI techniques and are thereby better capturing the true pulse of projects.



As is often the case with neural networks, even though predictability may be high, *explainability* is typically low – so, at this time, it is difficult to explain why the neural networks perform as well as they do. That presents an avenue for further research. This neural network example offers preliminary but encouraging evidence that AI (and data science in general) can add a bent of science to the art of project management, thereby empowering it to provide strategic insights and solutions to organizational work

challenges. AI could facilitate modeling and monitoring broader organizational work (projects included) and enable robust forecasting, which in turn can provide early-alert systems to enable organizations to make timely course corrections that significantly raise the likelihood of successful outcomes for work, projects, and strategic initiatives like organizational transformations. Other AI tools like clustering (unsupervised learning) could also be applied in project management, and the author has some encouraging evidence for that as well (which will be further explored in future research).

Generative AI leverages supervised, unsupervised, and semi-supervised learning. It discovers patterns in data (using neural networks) to generate new content. This type of machine intelligence will also find application in project management and is likely to replace many routine tasks in project initiation and closing, as well as some tasks in project planning. Other non-generative AI techniques (like neural networks) will replace many other planning tasks and probably the majority of present-day monitoring tasks. Of course, project execution will hold out against AI except in situations where work is amenable to automation. Generative AI could also replace some types of execution.

Universities will need to stay abreast of AI's impact on project management. Curricula will require revisions that anticipate AI and the new project management skills necessitated by AI's deep erosion of today's project management tasks. Students should be provided opportunities to perform some of today's project management tasks using AI and to acquire higher-level project management and business skills that leverage AI to devise strategic solutions to broader organizational work challenges and to enhance value creation. These higher-level skills will certainly include data science skills and broader business and technology skills – for example, AutoML tools at the very minimum. This author would not be surprised if the role of *project manager* eventually evolves to the role of something like *work scientist* – which would incorporate a blend of skills from data science, project/program management, operations/process management, strategy, and other business disciplines (such as finance, marketing, HR, etc.).

Finally, project management standards will need to come of age by incorporating knowledge, tools, and techniques that harness the full potential of AI and evolve project management to a blend of art and science that can realize high project success rates and provide organizations with strategic and comprehensive work solutions. This may necessitate a paradigm shift in the direction of engaging all key stakeholders in the development of standards: industry practitioners, managers, and executives; university faculty from various business schools and business disciplines – not just project management; data scientists and business strategists; and think tanks and other thought leaders. This is consistent with the project management best practice of engaging all key stakeholders and is a strategic imperative, especially at a time when the project management discipline is at an inflection point and its future state is very likely to be pollinated by data science/AI and by other business and technology disciplines as well. Creative cooperation, and even coopetition, between industry, academia, and standards organizations – via a consortium/alliance, for example - could be considered, which can

facilitate creation of high-quality content for the project management discipline of the near future. This would in turn generate efficiencies for universities and level the access to premium project management education, while enabling faculty to efficiently retrain for the forthcoming tectonic shift that AI is likely to effect on the project management discipline and profession. It could also foster broader stakeholder acceptance of project management as a discipline that is on par with other key business disciplines and lead to the realization that the transformed AI-powered science and art of project management deserves its rightful representation in MBA curricula – and to its recognition as a discipline that provides preparation for senior executive and C-level positions.

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