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Novel Assessment of Innovation in Projects and Mega-Projects

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***Abstract*: A project manager / investor / decision-maker has limited resources. To improve project management and results, innovative technology can be introduced, or available resources can be managed in an innovative way. We note this in this paper: innovative substance or innovative use. We will develop a novel, user-friendly model to guide project managers, senior management, city councils and political / economical leaders in their choices for the utilization of technology in projects and mega-projects.**

***Keywords*: guide decision-making, innovation grading, innovative substance, innovative use, ultra-advanced innovation.**

I. INTRODUCTION

Project management is changing rapidly with the advances in technology and management techniques, empowered by the technical and / or human input. However, project managers, senior managers, policy makers and political leaders face two key challenges, with, naturally, different intensities:

1. They don't have an idea of what they would gain if they use a given technology. It is therefore difficult for them to decide on a given investment if they do not have a perception of the plausible *return on investment*. This becomes a critical issue with recurrent breakthroughs in new technology
2. They have to ensure that they will improve their use of available resources

The first point can help developing and enabling the second

Therefore, it is necessary to provide project management with innovative ways to overcome these challenges. To that end, we present in this wrok the following concepts, which correspond to the two precited challenges:

1. **Innovation as a new substance**
2. **Innovation as a new use**

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We schematize these two types of innovation in the following figure:

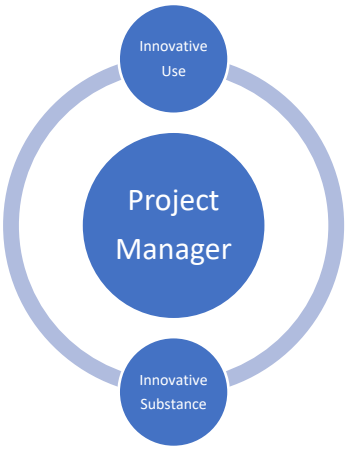

Figure 1: Innovative use and innovative substances in project management

II. PROPSED METHODOLOGY

In each project, new innovations can be adopted, adapted or developed based on needs and objectives. In a globalized and modernized world, it is necessary to ensure competitive advantage in the short- and long-run, particularly with the use of revolutionary advanced technologies. To resolve this issue, we present a simplified methodology to assess the impact of technology use, and the involved benefit.

A given project can be represented as the combination of some *costs* to achieve a given goal. The costs are related to the number of production units (e.g., workforce, equipment, infrastructure, etc.). Each production unit has a given unit cost and unit production (or productivity) in order to achieve the objective of the intended project. We denote these parameters as follows:

Parameter	Meaning
C	Cost
C_u	Average unit cost
N	Number of production units
P_u	Average Unit Production

The involved problem can be modeled as follows:

$$\begin{cases} Cost & = N \times C_u \# \\ Objective & = N \times P_u \end{cases}$$

A director, officer, political leader, an investor, each at his level, aimed at the following:

$$\begin{cases} Reduce\ Cost \# \\ Reach\ Objective \end{cases}$$

a. BLOCK DIAGRAM

We represent the involved block diagram inFigure 2: Block diagramFigure 2.

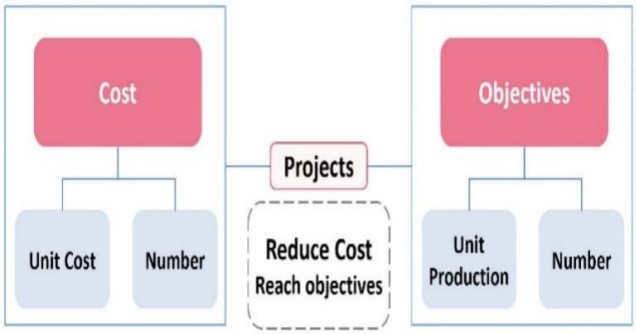

Figure 2: Block diagram

b. ALGORITHM

The question researchers ask, is how to reach the objective, even exceed it, while reducing costs? **The most obvious way is to reduce production units.**

However, that will lead to not reaching the objective (i.e. $N \times Pu < Objective$). If this paper, ***we suggest reducing production units, and thus reducing cost, and introduce innovative technology to increase productivity***, and thus make sure to reach, if not exceed, the objective. On the other hand, this innovation one wants to introduce has a cost, hence the overall cost will experience an increase. We define C_{inv} to be the innovation investment cost:

Parameter	Meaning
C_{inv}	the cost of investment in innovation

Therefore, the new situation project managers/leaders/sponsors will find themselves in is the following:

$$\begin{cases} Cost & = N_{inov} \times C_u + L_{inv} \# \\ Objective & = N_{inov} \times P_{u,inv} \end{cases}$$

While N_{inv} is the reduced required production unit number after introducing the innovation, and $P_{u,inv}$ is the production acquired after introducing the innovation:

Parameter	Meaning
N_{inov}	the new number required number of production units through innovation
$P_{u,inv}$	the new unit average production achieved through innovation

At this point of our work, and to help Project Managers make a convenient decision, we introduce **Innovation Grading Concept** (adopted and adapted from our work in [1,2])**.**

1. **Suboptimal:**

$$P_{u,inv}(N_{inov}) = a.N_{inov}^{\alpha}, \alpha < 1$$

Production units are underperforming. we are talking about inefficiencies that affects performance. **This is not an objective of our work.**

2. **Linear-manual:**

$$P_{u,inv}(N_{inov}) = a.N_{inov}^{\alpha}, \alpha = 1$$

That takes place when production units are proportional to outcome; this is a typical case of manual work using no technologies or utilizing rudimentary ones. This is the case of small projects, in which, typically, project managers don't need advanced skills.

3. **Advanced:**

$$P_{u,inv}(N_{inov}) = a.N_{inov}^{\alpha}, \alpha > 1$$

That takes place when well-advanced technologies are used, where production units lead to results, which are unproportionally better than outcome; **this is a typical case of replacing manual tasks in supply chains or in production lines by machines through automation**

4. **Ultra-Advanced:**

$$P_{u,inv}(N_{inov}) = a.e^{\alpha.N_{inov}}, \alpha > 1$$

That takes place when production units are **super-performing.** This model is crucial to keep up with the last decade ideas and breakthroughs, and to implement and develop them in innovative ways. In this context, we can mention:

- Data mining / analytics technologies
- Big data advancements

- Remote intelligent monitoring of supply chains
- All the above combined integrated with artificial intelligence, which ensures a continuous and intense improvement of procedures, techniques, algorithms, and processes

This model, with eventual modifications, would be convenient to look at the case of highly innovative rapidly growing nations, e.g. Singapore and the U.A.E.

We present the $P_{u,inv}$ effect as follows:

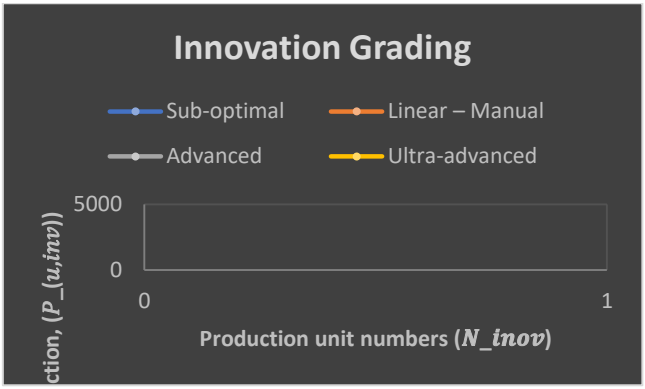

Figure 3: Innovation grading

We assume that the Project Manager/Leader/Sponsor of a mega-project (e.g. city level, country level, global level, a large construction project, a major oil & gas or telecommunication project etc.) decide to utilize or to develop an **Ultra-Advanced Innovation**. Hence, the new problem will be as follows:

$$\begin{cases} \boldsymbol{Cost} & = \boldsymbol{N_{inov} \times C_u + L_{inv}\#} \\ \boldsymbol{Objective} = & \boldsymbol{N_{inov} \times a.\, e^{\alpha.N_{inov}}} \end{cases}$$

Thus:

$$\begin{cases} \boldsymbol{Cost} & = \dfrac{\boldsymbol{Objective \times C_u}}{\boldsymbol{a.\, e^{\alpha.N_{inov}}}} + \boldsymbol{L_{inv}\#} \\ \boldsymbol{Objective} = & \boldsymbol{N_{inov} \times a.\, e^{\alpha.N_{inov}}} \end{cases}$$

We denote α the **Ultra-Advanced Innovation Grade**. The above means that, since the term $e^{\alpha.N_{inov}}$ is growing rapidly as shown in Figure 3, the term $\boldsymbol{e^{\alpha.N_{inov}}} \dfrac{Objective \times C_u}{a.e^{\alpha.N_{inov}}}$ goes fast to 0 (*in mathematical terms, tends to 0*), and ultimately in due course**, the Project Manager/Leader/Sponsor will succeed to metamorphose his initiation traditional problem to the following innovated one:**

$$\begin{cases} \boldsymbol{Cost} & = \boldsymbol{L_{inv}\#} \\ \boldsymbol{Objective} = & \\ \boldsymbol{very\ large\ (outstanding\ result)} & \end{cases}$$

Given the above, an algorithm can be put in place to assess the *grade* of an innovation as follows:

a- Represent the productivity $P_{u,inv}$ as a function of N_{inov} (the function $N_{inov} \rightarrow \dfrac{P_{u,nv}(N_{inov})}{N_{inov}}$)

b- Plot $N_{inov} \rightarrow \dfrac{P_{u,nv}(N_{inov})}{N_{inov}}$

a. If The trend is a “constant”
   i. "Suboptimal innovation »

b. if not :
   i. if the trend is "decreasing"
      1. "Linear Innovation"
      2. If not :

1. Plc $N_{inov} \rightarrow \dfrac{P_{u,nv}(N_{inov})}{e^{N_{inov}}}$ the trend is a exponentially “decreasing”, then “Advanced Innovation” If not : "Ultra-Advanced innovation"

End of the algorithm

c. Flow Chart

. The algorithm suggested can be presented visually in a flow chart as shown in Figure 4.

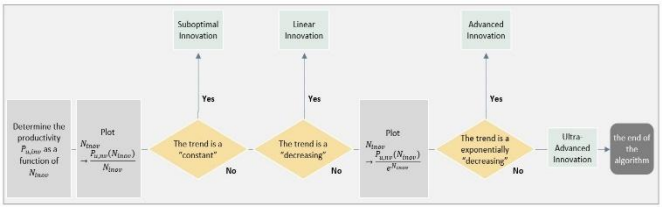

Figure 4: Innovation grading algorithm: Flow Chart

III. RESULTS AND RESULT ANALYSIS

a. Results

A *creative* methodology has been developed to assess innovation by associating it with a *grade*. Therefore, an actionable and practical way is developed to inform decisions, especially investment-related ones. In other words, using our approach, investors can evaluate the value they can generate by using innovative technology.
For practicality purposes, and to allow investors and project practitioners to use our suggested approach, a framework is suggested in Figure 5.

Figure 5: Results, Summary

b. Discussion

From the analysis performed above, the following points can be highlighted:

- The utilization of ultra-advanced innovations in mega projects will allow project managers / leaders / sponsors to substantially reduce long-term cost (cut it essentially to the cost of investment in innovation). ***Finding and using the proper innovation is an intra-discipline research matter. Hence, pluri-disciplinary teams are required when the management opts for leveraging Ultra-Advanced Innovation***
- Using ultra-advanced innovations in mega projects, the project manager / leader / sponsor will be able to exceed its planned target of unlimited exceptional and unexpected results
- Using Ultra-Advanced innovations in megaprojects, the project manager/leader/sponsor will be able to exceed its planned objectives and ***create an enabling environment for new economiesand synergies***
- The innovation used will be a *quasi-free asset* (free, excluding depreciation) for future project managers. As a result, the cost savings for these projects will be even greater than the *first pilot project*, in which ultra-advanced innovation was introduced. Therefore, we can talk about a ***"generation of founders"*** (who supported the investment), which made it much easier to manage projects for succeeding generations and achieve success much more easily and cheaply. ***Two prominent illustrations of "generation of founders" are the post-war European leaders and investors and leaders of the GCC (Gulf Cooperation Council) countries after the discovery of oil.***

IV. CONCLUSION

Project Managers / Sponsors, Leaders and Decision / Policy Makers find themselves faced with a myriad of questions regarding the investment to engage and the gain to expect. In addition, a few countries, cities, and mega-projects' holders are turning into one of the most difficult choices to make: investing heavily in today's innovation to achieve outstanding results in the future. We have proven using an easy-to-understand model that in the long term, innovation is an optimal way to reduce costs, and reach outstanding objectives depending on the chosen innovation. In this context, a practical algorithm is suggested in order to *grade* the innovation and a process is developed to support users in their innovation selection and utilization journey.

An intra-generation dimension has been highlighted in this context. That can be subject to further exploration by multidisciplinary research teams (especially, engaging data scientists, project practitioners, mathematicians and engineers).

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