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Abstract:
The paper focuses on the development of the ex-post conceptual holistic framework for Project Evaluation on Strategic, Tactical and Operational Levels, the PESTOL model, by reviewing different definitions of project success and/or failure and combining the findings with the logic framework. The model reflects the project life cycle by considering all project phases, such as identification and conception. To demonstrate the relevance of the developed model, the authors applied it to a project case, the Algerian East–West Highway megaproject. The project has attracted media attention and a number of media discussions of the project have been limited to the completion of the project in a short-term perspective. In this regard, the discussions have been notably associated with delays and expenditures coming in over budget, referring to project efficiency. One reason for the media focus on these aspects alone is that they can easily be measured. The relevance of the project and its effects - whether it attains its goals and objectives measured in terms of effectiveness, including impact and sustainability - can only be verified at a later stage, after the project has delivered its results. These are much broader aspects and are therefore difficult to measure.

Keywords:
PESTOL model; evaluation; efficiency; effectiveness; relevance; impact; sustainability; megaproject.

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1. Introduction

All social institutions, whether medical, educational, religious, economic, or political, are required to provide "proof" of their legitimacy and effectiveness in order to justify society's continued support [1]. This is also the case for construction and infrastructure projects, especially large-scale projects, in light of the colossal budgets spent on them. Requests for funds must compete with those of other agencies, and new projects and programs must be justified, while old projects and programs must be shown to have been efficient and effective. In this contest for public projects, evaluation is a major "weapon" [1, 2]. Suchman [1] justifies the need for "proof" through evaluation as due to the need to determine the extent to which current programs and projects are meeting the challenge of a rapidly changing world.

Various definitions of evaluation have been presented over the years. The American Public Health Association [3] defined evaluation as "the process of determining the value or amount of success in achieving a predetermined objective." Scriven [4] stated that evaluation is "The process of determining the merit, worth or value of something." Patton [5] defined program evaluation as "the systematic collection of information about the activities, characteristics, and outcomes of programs for use by specific people to reduce uncertainties, improve effectiveness, and make decisions with regard to what those programs are doing and affecting." However, his definition is too broad and it reflects especially ex-ante, monitoring, and mid-term evaluations. In this paper, we focus on ex-post evaluation. The OECD [6] has defined evaluation as "A systematic and objective assessment of an ongoing or completed project, program or policy, its design, implementation and results." Ex-post evaluation can be described as an evaluation of an intervention (in our case, a project) after the intervention has been completed. In addition, ex-post evaluation is conducted after a certain period following the completion of a target project, with emphasis on the effectiveness and sustainability of the project. Such evaluations aim to derive lessons and recommendations for the improvement of future projects and programs [6]. Ex-post evaluation is often considered the weak connection in the planning, implementation, and operation of public projects. To date, the assessment methods have tended to rely on ex-ante appraisal, making predictions of how a scheme or policy might perform, rather than being based directly on the outcomes of past decisions [7, 8]. Worsley [7] mentioned that ex-post evaluation can serve multiple purposes, of which the two primary ones are learning and/or improvement and accountability and/or control. Weiss [9] defined evaluation as "evaluation research, the tools of research are pressed into service to make the judging process more accurate and objective. It collects evidence systematically from a representative sample of the units of concern".

The purpose of this paper is not only to develop a model for evaluation but also to use it as a framework for evaluating a project case and to gather the lessons learned so that they could be applied to similar projects in the future. A further purpose is to improve decision-making by applying a holistic view to the evaluation of similar projects instead of making decisions based on a narrow, short-term vision.

This paper consists of seven sections: (1) "Introduction", in which we explain what motivated us to write this paper; (2) "Methodology and research design"; (3) "Theoretical framework"; (4) "Development of the PESTOL model", in which the step-by-step development of the model is presented; (5) "The megaproject case"; (6) "Evaluation of the megaproject based on the developed framework", in which we describe the application of the developed model to the megaproject case; and (7) "Conclusions".

2. Methodology and research design

The work reported in this paper utilized several approaches and research methods. First, a literature review was conducted of existing evaluation frameworks and models in order to understanding what aspects they encompass. A search for sources that have proposed different relevant frameworks was conducted through relevant library and science databases covering all journals that we considered relevant (e.g., *International Journal of Project Management*, *Journal of Project Management*, *Project Appraisal Journal*, *Administration in Social Work Journal*, and many other academic journals related to evaluation). Our research was extended to other journals related to social sciences, behavioral sciences, psychology, public heath practice, and health care, since these were the first to publish articles specifically on

evaluation and evaluation research. Other databases and search engines were utilized to uncover books published since the 1960s, technical reports, and public documents as well as more "marketing-oriented" sites (e.g., OECD and USAID). We used a wide range of search terms, including "evaluation", "project success", "project performance", "ex-post", "effect", and "diagnosis". The logic model was deemed most relevant for further analysis, on the basis of its suitability and extent of use for the evaluation of projects. Additionally, we examined other frameworks and models originating from the OECD, NORAD, CONCEPT, USAID, and JICA, many of which have been developed based on the logic model. The literature review was concluded by analyzing the existing models along two dimensions: (1) the evaluation dimensions covered, and (2) whether the evaluation was conducted by an external third party or by the project itself.

Next, the principles of design science (e.g., [10-13]) were applied to develop an alternative evaluation framework. The design process was initiated from the gap not covered by existing frameworks. However, the strengths of extant frameworks were used as guidelines for the design of the alternative model. As prescribed by proponents of design science, the development was carried out through an iterative process of identifying requirements, developing conceptual solutions, evaluating these, and further refining the most promising ones until a final design was reached. Ultimately, a new evaluation framework was developed that built on existing ones.

Finally, an illustrative case project was used to demonstrate how the new evaluation framework could be applied to actual projects. As described by Siggelkow [14], the purpose of an illustrative case is not to attempt to verify empirically an evaluation framework. This would require further research, in which the framework would be applied to a larger set of case projects and systematically evaluated, something we intend to do in the future. Rather, as in our case, the purpose of a case study is to provide a rich description of how the framework can be applied in practice, thus both aiding readers in understanding how the framework has been composed and what the different aspects of the framework entail in practice. The challenge in our study pertained more to the validity and the reliability of the collected data. To achieve good validity with high triangulation quality, we used a qualitative case study research approach, as described by Yin [15]. In case studies, typically a combination of methods is used in data collection, such as archives, interviews, questionnaires, and observations. The data may be qualitative (e.g., words), quantitative (e.g., numbers), or both. For our case project we used a qualitative method, with primary data (interviews) and secondary data (materials and data obtained internally from the project sponsor's website [16], database, and official archived documents, as well as externally from other websites and media archives with numerical audio-visual records). Between the middle of the third quarter and the whole of the fourth quarter of 2014 more than 30 interviews were held with users, contractors, and other stakeholders (internal and external to the case). Most of the interviews were conducted as virtual interviews by conference calls or phone calls. During the same period, data were also collected during on-site inspections (more than five visits to some of the sites of activity). The data collection followed a pre-defined protocol that incorporated information and facts such as transcription of the interviews, gathered data, and codification of the results so that they would fit the evaluation framework.

Reliability in qualitative research can be improved by focusing on various aspects, such as transparency. Moisander and Valtonen [17] described both research process transparency and theoretical transparency as ways to improve reliability in qualitative research. We applied both types to our research to ensure its reliability.

3. Theoretical framework

When discussing ex-post project evaluation, it is relevant to look at the degree of success (and/or failure) associated with the project as a whole. How project success is defined, described, and categorized forms the basis for discussing evaluation criteria, such as efficiency, effectiveness, relevance, impact, and sustainability [18, 19]. Since the PESTOL model is based on the logic model, which dates back to late 1960s, it is necessary to present a brief historical review of logic models. Furthermore, since the model's framework reflects the whole project life cycle, we review some of the project life cycle models that have been developed over the years.

3.1. Project success or failure and subjectivity in project evaluation

Project evaluation is highly complex and subjective. Inherently, it involves a combination of basic assumptions underlying the activity being evaluated and of personal values on the part of both those whose activities are being evaluated and those who are doing the evaluation [1]. Evaluation and agreeing on project success or failure has been a central topic in project management literature since the mid-1980s [20-34]. The research within this topic has included efforts focusing on defining what makes a project successful, who should judge the results, and when the judgments should be made [35]. There have also been efforts to examine how success should be measured [30, 31, 35-37]. Jugdev and Müller [35] have shown that the definition of success has progressed from definitions that were limited to the implementation phase of the project life cycle to definitions that cover the entire project and product life cycle by different stakeholders. Success is now defined through several dimensions and according to different stakeholders, ranging from the efficiency of the project management effort or adhering to planning (project management success), to criteria that reflect the impact of the project on its end-users, on business, on societies (project success), and on creating opportunities for the future [22, 24-26]. However, the question of how to measure success is still unclear in project management literature [36]. Ika [30] has demonstrated that the various approaches to measuring success may be categorized into two broader groups: the "objectivist" and the "subjectivist" approach. In the former, success measures have been viewed as those that can not only be defined upfront but also measured objectively at the end of the project, regardless of any contextual changes during execution or after delivery. This objectivist approach has been subject to significant criticism because it assumes that [36]:

- Estimated time and cost to produce the specified deliverables can be predicted at the beginning of the project;
- The time frame for determining success is immediately after the project has been completed;
- With the exception of financial benefits, other expected benefits such as customer satisfaction from a project are usually hard to quantify or measure;
- All stakeholders come to the same conclusion about a project's ability to achieve its expected benefits.

In recognizing the flaws of the basic assumptions in the objectivist view, the subjectivist approach views success as extrinsic to the project. Success is regarded as a result of a political and dialogical process and that different stakeholders evaluating the same project might come to different conclusions [31, 34]. Many different approaches have been used to assess success in subjective terms. Myers [38] argued that success is an opinion and consequently could be both objective and subjective and could change over time. By contrast, Wilson and Howcroft [39] argued that project evaluation can be seen as efforts by one group to establish their narrative of the project as the "legitimate" version of events surrounding the project. Objective measures are used to legitimize their narratives and enroll supporters and to marginalize those who are opposed to their position.

3.2. Brief historical review of logic models

Logic models date back to the late 1960s. Suchman [1] was the first author to use the term "logic model" in combination with evaluation research. He built on the work of Greenwood [40] and Chapin [41], who offered conceptual and methodological analyses to experimental approach, which considerably broadened the logic model to include longitudinal and "ex-post facto" social surveys [1, 40, 41]. In 1970, the U.S. Agency for International Development (USAID) developed the Log Framework Approach (LFA) to assist in the planning, management, and evaluation of development activities. Other contributions were made by Weiss [9] and by Wholey [42], who developed techniques to check the readiness of a program to be evaluated. Bennett [43] contributed the hierarchy of evidence, which he had developed to evaluate the effectiveness of extension programs and document evidence of their impacts. In his hierarchy of evidence the true impact increases farther up the hierarchy because the lower levels are important precursors but are not necessarily evidence of impacts [44, 45]. The widespread use of logic models is probably to some degree due to the United Way of America's book *Measuring Program Outcomes: A Practical Approach*, published in 1996 [46], as this significantly helped to increase its popularity and application worldwide [45, 47]. Since then the logic model has been used by most international agencies [48]. Improvements to and use of the logic model by evaluators has continued to result in a broad array of theoretical and practical applications.

3.3. Brief historical review of project life cycle or lifespan models

All projects consist of a number of different phases that form their project life cycle or lifespan. Patel and Morris [49] outlined the life cycle as unique in distinguishing projects from non-projects. They defined project life cycle as "the sequence of phases through which the project will evolve. The basic life cycle follows a common generic sequence: Opportunity, Design & Development, Production, Hand-over, and Post-Project Evaluation. The exact wording varies between industries and organizations. There should be evaluation and approval points between phases, often termed 'gates'". Project life cycle is defined in the current edition of the *PMBOK Guide* [50] as "the series of phases that a project passes through from its initiation to its closure. The phases generally are sequential, and their names and numbers are determined by the management and control needs of the organization or organizations involved in the project, the nature of the project itself, and its area of application". Archibald [51] mentioned that the project life cycle has an identifiable start and end that can be associated with a time scale. Stuckenbruck [52] said that the project life cycle consists of sequential phases: Conceptual, Definition, Production or Acquisition, Operation, and lastly Divestment. Kerzner [53] drew a clear distinction between the project lifespan and the product lifespan. Cleland and Ireland [54], in their generic project life cycle, made an important distinction between the various phases, which are decision points at which an explicit decision is made concerning whether the next phase should be undertaken. Their thinking represents an important development for two reasons: (1) it introduces the idea of strategic high-level decision gates, at which a decision is taken as to whether to continue; and (2) it is distinguished from earlier research that emphasize that such phases may, and frequently do, overlap [55]. Today, most companies, institutions, and large organizations of all types have a tailored project life cycle model to meet their own strategic plans.

4. Development of the PESTOL model

4.1. Developing the logic model and the associated evaluation criteria

Our review of a number of models that built on the original logic model led to the development of the logic model shown in Fig. 1.

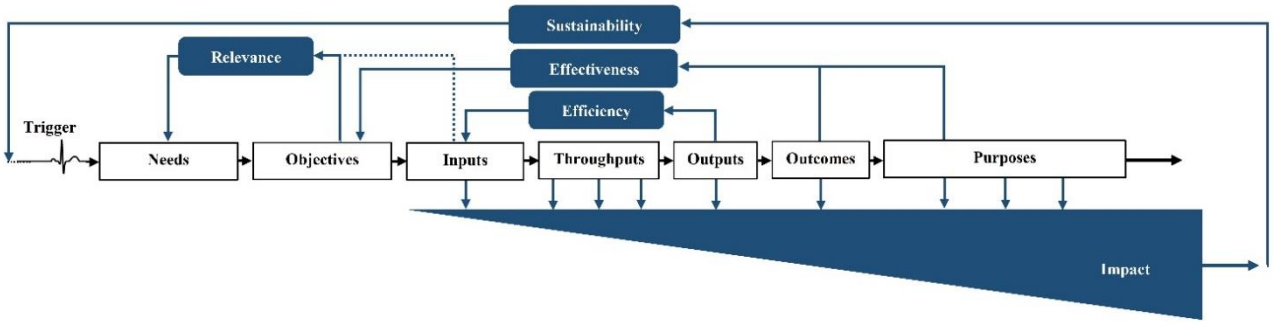

Fig. 1. The logic model and the associated evaluation criteria.

By using circular interplay between the logic model and the project life cycle (Fig. 2), we initially tried to extract a rational generic project life cycle and thereafter to define a project life cycle that met our logic model. This interplay resulted from superposing both models on each other to harmonize them in a consistent approach.

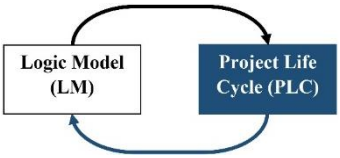

Fig. 2. Circular interplay.

The new elements in the model (Fig. 1), which did not exist in the pre-existing models, are as follows. In Fig. 3, which is part of the logic model's sequence used by earlier models [6, 43, 46, 56-60], "inputs" go through a black box called "activities" to give "outputs." "Outputs" will lead to "outcomes," which in turn result in "impacts".

In the model in Fig. 1, this logic model has been changed. Since the concept is based on cause and effect, we have the following perception. In the short sequence of the logic model related to "activities" (see Fig. 4), each cause has an effect: a "Trigger" (inputs) results in "Needs" (outputs), "Needs" (become inputs) then result in "Objectives" (outputs), and so forth. Thus, the "outputs" from previous element become "inputs" for the next element. "Activities" are not part of the logic model but they belong to the project life cycle. Consequently, each element from the logic model always relies on "Activities" to be transformed into the next element. For example, "Needs" as inputs will need a group of activities, which we call the "Conception" phase, in order to be transformed into outputs, which are "Objectives", and so forth (see Fig. 5).

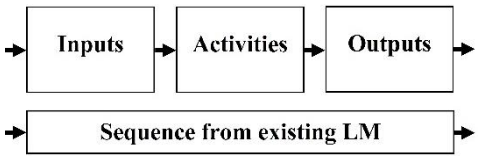

Fig. 3. Sequence of the existing logic models.

Fig. 4. New interpretation for the logic model.

Since the newest element in the logic model sequence is "Throughputs", it must be defined. Since we could not find a definition in project management sources we resorted to a definition from business and strategic management and system engineering references. In business and strategic management, throughput is defined as "the movement of inputs and outputs through a production process. Without access to and assurance of a supply of inputs, a successful business enterprise would not be possible" [61]. In system engineering, it is defined as "Material, energy, and/or information that enters the system in one form and leaves the system in another form" [62]. In our case, the system is the "Project". Therefore, "Throughputs" are continuous inputs and outputs during the block activities called "Project" (shown in Fig. 5).

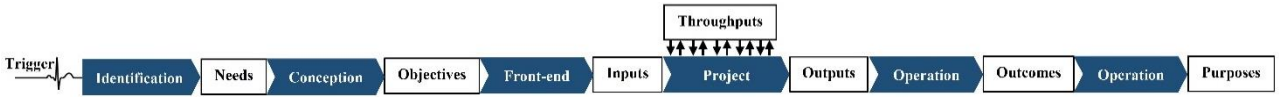

Fig. 5. The logic model combined with the project life cycle.

The evaluation criteria we use in the PESTOL model are relevance, effectiveness, efficiency, impact, and sustainability. The main difference between existing logic models and the model in Fig. 1 concerns "impact". In other models, impact it is the last element of the sequence, but here it is considered an evaluation criterion. "Purposes" is used as an element in the logic model instead of "Impact". This is presented in the model in such as way as to show that impacts will become apparent at the point when the decision is taken to put "Inputs" into the system. The magnitude of an "Impact" increases with time. The effects of the "Impact" may vary from positive to negative depending on, for example, perceptions.

4.2. Developing the project life cycle and its three levels

From our examination of the definitions of the project life cycle (presented in the theory section above) and by extracting the first phase's appellation, which differs from one author to another, the most repeated term we found was "Conception". Other authors have used the terms "Concept", "Conceptual", "General Conception", "Opportunity", "Objective Definitions", "Identification", "Idea", and "Analysis".

We start the project life cycle with "Identification". The reason is that before starting the second phase (i.e., "Conception") it is wise to first identify the "Needs", which is the logic behind the life cycle shown in Fig. 5. Hence, first, "Trigger" (e.g., opportunity, threat, problem, idea, society, or a parliament) triggers the "Identification" of "Needs". Those "Needs" will cause a decision to be made to start the next phase, which is "Conception". In this phase, "Objectives" are defined. Once the "Objectives" have been defined, the next decision will lead to the "Front-end" analysis phase. Once completed, the project is established with agreed "Inputs". Those "Inputs" become an input to the "Project". During the running of the system called "Project", there will be emergent "Throughputs" that nurture or undermine it. As soon as the system "Project" reaches its end, it will give "Outputs". The most important output is the delivered product. Once it has started functioning during the "Operation" phase, the product will give "Outcomes". The "Operation" phase will keep running because it has "Purposes". The system called "Project" consists of three sequential phases—"Plan and Design", "Construction", and "Closeout" - with a parallel phase called "Procurement". Most authors have regarded procurement as a work package or an activity, but for us it is more than that since it is the most important work package and since it feeds most of the other packages it is appropriate to upgrade it to a phase. In summary, the generic project life cycle will involve the following sequential phases: (1) "Identification"; (2) "Conception"; (3) "Front-end"; (4) "Plan and Design"; (5) "Construction"; (6) "Closeout"; (7) "Operation"; and (8) the "Procurement" phase in parallel with phases 4, 5 and 6.

The project life cycle can be divided into three levels (Fig. 6.) by setting boundaries for each subsystem. The *operational level*, which is the inner subsystem, the project itself, is where concerns are more about efficiency measured in terms of cost, time and scope [60]. The *tactical level* reveals the usefulness of the project, such as its relevance, effectiveness, and the achievement of its objectives [60]. The *strategic level* refers to the system or the whole life cycle from the moment when "Phenomenon" pushes the "Trigger" until the long-term impacts are felt. At this level, the most important aspects to address are the sustainability and the positive or negative economic impacts [60]. In the generic project life cycle model shown in Fig. 6, we have added an x-axis that represents the time line. At each time "T_n," a decision "D_n" is taken to start the next phase.

4.3. The complete PESTOL Model

By combining the logic model shown in Fig. 1, the illustration of the interaction between project life cycle phases and the logic model in Fig. 5, and the project life cycle model in Fig. 6, we generated the concept of the "Falling Star," shown in Fig. 7.

Samset [60] defines them as all unexpected positive and/or negative changes and effects of the project, both in the short term and the long term. In our case, "Impact" as evaluation criterion is divided into the following levels: during the project impact, the short-term and mid-term impact, and the long-term impact (Fig. 7).

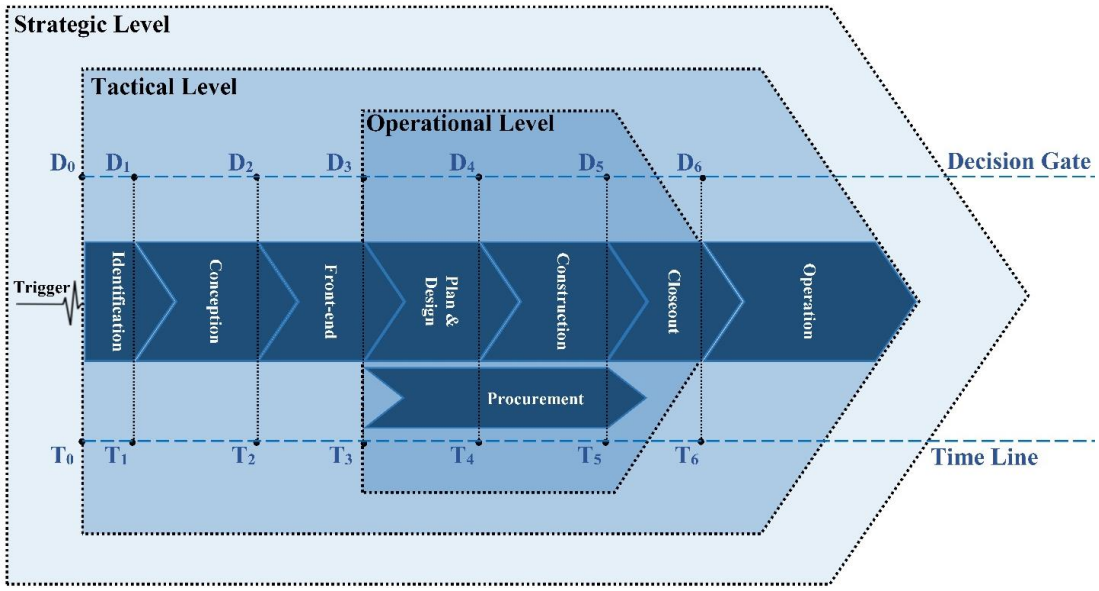

Fig. 6. Project life cycle and its three levels.

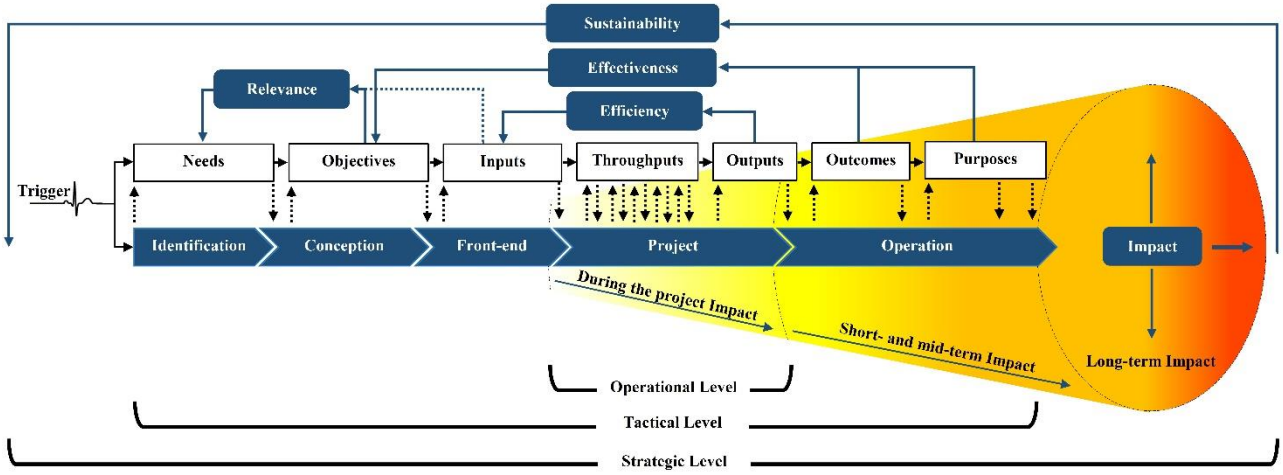

Fig. 7. The "Falling Star".

Efficiency is a measure of the ratio between the input and the output [6, 43, 46, 56-60]. In this paper efficiency is regarded as a question of doing things properly and producing project outputs in terms of the agreed scope, cost, time, and quality. An important point should be clarified here: Quality is not a constraint per se, but often a by-product of the other three factors (scope, time, and cost), and one that generally suffers when the others are not properly managed [18, 63, 64].

Effectiveness is a measure of the extent to which management attains its objectives [6, 7, 60].

Samset [60] defined relevance as "an overall assessment of whether a project is in harmony with the needs and priorities of the owners, the intended users and other attested parties. A change in policies or priorities could imply that a project is assigned lower priority, or that it loses some of its rationale. It becomes less relevant". In the present paper, relevance deals with the needed time (T_0 to T_3) to make the right decision (D_3) to start the implementation of the project (i.e., GO). If the decision is GO and the project becomes less relevant because of a change of policies or priorities, the assessment of relevance will instead be handled further by effectiveness, impact, and sustainability.

Sustainability concerns measuring whether the benefits of an activity are likely to continue after donor funding has been completed and/or withdrawn. Projects need to be environmentally sustainable as well as financially sustainable [6, 18, 60].

All of these factors contribute to formation of the PESTOL model shown in Fig. 8.

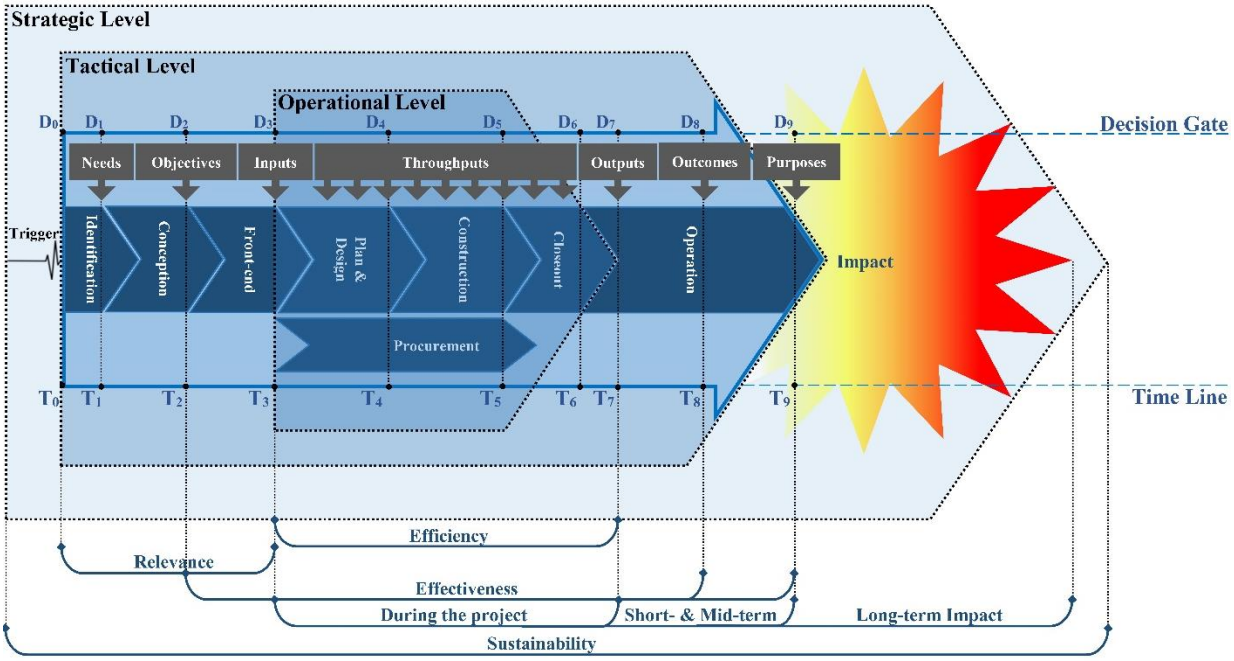

Fig. 8. The PESTOL model.

5. The megaproject case

To date, the cost of the Algerian East–West Highway megaproject has been more than USD 11.2 billion [16], and the project is considered Algeria's most important road project and the largest public works project worldwide. It was due for completion in the fourth quarter of 2009 but was delivered behind schedule. The megaproject has generated over 100,000 jobs. The road was intended to cut travel times and provide better and safer access to the north of Algeria, stimulating economic development there [16]. The megaproject was part of the 7000 km "AutoRoute Transmaghrébine Programme", which is being developed in many stages. The first stage was the East–West Highway, which involved the construction of a 1216 km section linking Annaba in the east to Tlemcen in the west, passing through 24 Algerian departments (out of a total of 48 departments). The East–West Highway is a six-lane toll highway. It connects most of northern big cities of the country. The development was planned to have 12 tunnels, 70 viaducts, and 60 interchanges. It included provisions for building truck stops, service stations, and maintenance facilities [16].

6. Evaluation of the Algerian megaproject based on the developed framework

The evaluation of the megaproject was based on the stakeholders' perceptions, by asking the interviewees to grade each criterion on a scale ranging from 1 to 6, corresponding to very bad, bad, fair, good, very good, to excellent. After completing the interviews, averages were calculated and compared to the planned and realized objectives to check for inconsistencies [19]. The planned and realized objectives and the interviewees' reflections on the five measures are summarized in Table 1. The lowest score was for the operational level (efficiency), but there were higher scores for the tactical and strategic levels. In the following subsections we explain each evaluation separately and lastly explain their dependencies. The evaluation is subjective in nature, since the respondents perceived and interpreted their work subjectively, and the researchers who gathered the qualitative data from the sources interpreted the data with a degree of subjectivity.

Table 1. Planned versus realized objectives of the Algerian megaproject [16, 18].

Measures	Planned objectives	Realized objectives	Score/ 6
Efficiency	1 – Estimated project cost: < USD 7 billion	1 – Final project cost: > USD 11.2 billion – Project cost overrun: > USD 4.2 billion	1
	2 – Starting implementation: late 2006 – Planned implementation finish date: late 2009	2 – Implementation finish date: late 2014 – Project delivery behind schedule: > 5 years	
	3 – Deliver the whole scope	3 – Operational but still not completely delivered	
Effectiveness	1 – Reduce traffic and shorten travel time	1 – Objective met 2 – Reduce carbon dioxide emission 3 – Fewer accidents compared to on previously used road	6
Relevance	1 – Time-saving and increase the fluidity in traffic	1 – Objective met	6
Impact	1 – Create temporary employment	1 – Creation of more than 100,000 jobs 2 – Destruction of houses and trees standing in the way of the project	3
Sustainability	1 – Cover the maintenance of the highway from its income in the operational phase 2 – Enlarging the transportation network by other highways	1 – The highway will not generate any income since its usage will be free until 2017 2 – The highway has highlighted the gaps in the existing transportation network, which has made the government consider further expansions	4

6.1. Efficiency (score: 1 out of 6)

The efficiency was a tragedy for the project. The project was completed more than five years behind schedule. The initial plan was to finish the project within three years, but because of the complexity of the project and many technical obstacles (including thousands of internal stakeholders), it was impossible to achieve the target date of completion. In addition, there was a cost overrun of more than USD 4.2 billion compared to the initial estimate. The time and cost estimations were based on incorrect assumptions; for example, by supposing that the land is flat and that the project would need minor modifications. This was not the case for the project because most of the land mountainous or hilly; hence billions of tons of soil needed to be removed from or to the highway. In additional to the delays, there were extra costs relating to external stakeholders (e.g., NGOs, landowners, and the habitants affected by the construction of the road) [19, 65].

6.2. Effectiveness (6 out of 6)

There has been a significant and important reduction in travel time and travel costs. The objective of the project was to reduce the number of traffic jams, shorten travel time for the users, and reduce the numbers of accidents. In addition, it was anticipated that linking Tunisia to Morocco would increase the number of tourists using the route. Some studies

have shown that the carbon dioxide emissions on the new highway have been reduced by 40% compared to on the narrow road that it replaced [16]. The traffic jams on the former road were mainly caused by a high number of accidents (registered). The number of accidents has since been reduced by half and the explanation for this is very simple. People have various reasons for travelling and they drive at different speeds according to their sense of urgency; the provision of six lanes instead of two lanes has improved the road authorities' ability to organize traffic and drivers' priorities.

6.3. Relevance (6 out of 6)

The project idea emerged in the late 1970s and has remained relevant since then, yet it seems that the identification and conception phases took more than 40 years to make the decision to start the front-end analysis for the project. Since time-saving and increasing the flow of the traffic were the main reasons for the project and for linking the different infrastructures (airports, seaports), and the big cities, the investment is considered relevant. Increased traffic volume and reduced travel time does not in itself increase the benefits for the community. Rather, the benefits also depend on the purpose of the journeys. Much of the time, the highway is used by heavy vehicles that boost industry and provide factories with primary materials.

6.4. Impact (3 out of 6)

Table 2 lists all of the impacts from the start of the project until the evaluation.

Table 2. Positive and negative impacts.

Occurrence	Positive impacts	Negative impacts
During the project impacts	1 – Creation of more than 100,000 new jobs 2 – Creation of many start-up companies in the field 3 – Knowledge and experience transfer	1 – CO_2 emissions (during construction phase—thousands of engines operating day and night) 2 – Demolished houses, felled trees, destroyed lakes, loss of wild animals (i.e., anything that stood in the way of the highway) 3 – Fatal work accidents (e.g., use of explosives to speed up progress caused the loss of lives and many injuries) 4 – Traffic jams increased during construction
Short- and mid-term impacts	1 – Better planning for future similar projects (for better outputs) 2 – The number of accidents have reduced compared to on the former road 3 – CO_2 emissions have decreased compared to the former road (during the operation phase) 4 – Shorter travel times	1 – Increase in illegal merchandise trafficking with neighboring countries 2 – Accidents on the highway are generally fatal due to the high speeds involved 3 – Some youths use the highway for illegal rallies
Long-term impacts	1 – Improvements in the national industries 2 –Flow of tourists from neighboring countries 3 – Good vision for the extension projects	1 – Migration of thousands of birds, especially from the destroyed lakes 2 – Higher taxes since the use of the highway will be free for several years (at least until the end of 2017)

There were significant positive impacts on employment during the project, as it created more than 100,000 new jobs. Furthermore, the knowledge and experience that were transferred to local companies should result in increases productivity levels in future similar projects. Other positive short-term and mid-term impacts are as listed above under "Effectiveness": reductions in the numbers of accidents, decreased CO_2 emissions, improved traffic flows on the road, and improvements in the national industries. There were also negative impacts during the project. For example, the

highway crosses an international nature reserve - Lac des Oiseaux - many houses were demolished to make space for the highway, fatal accidents were caused by one of the contractors when explosives were used to speed up the work, and many trees were felled in the forest that highway passes through. Another negative impact has been the increase in illegal merchandise trafficking with neighboring countries.

6.5. Sustainability (4 out of 6)

The long-term effects of the project are probably greater than the short-term and medium-term effects. The further expansion of the highway to the high hills (in the middle north of the country) and to the south as far as the border between Algeria and Niger will reinforce the transportation network. The immediate effect of the highway is the shorter travel times, while medium-term effects will begin to show as changes in industries and in all different sectors and services. In the longer term, one could initially expect to see changes in the structure of industry and in demographics. The long-term effect will probably be a balanced distribution of the population along the highway since people would no longer have to worry about their means of transportation. This redistribution would probably include industries that rely heavily on the highway.

In any project there is a proportional relationship between relevance and effectiveness. The measure of relevance at some stage is handled further by the effectiveness, as shown in Figure 9. The Algerian megaproject was relevant with regard to satisfying the needs. The effective way was that the outcome is produced and that the purpose of the project satisfies the goals and the objectives of the project. By contrast, the desire for a high degree of effectiveness will adversely affect efficiency; the more we want to be effective (by shaping the desired outcome with respect to emerging changes), the more efficiency will suffer. The impact of the megaproject (especially the positive short-term and mid-term impacts) has to some extent related to effectiveness with regard to the positive effects and the opportunities. However, a project of this size may have negative impacts. The sustainability of such a project will initially depend on success at the tactical level and once all the impacts of the project have been identified the sustainability will become clearer. However, in cases of general success, the sustainability of the project will depend on a good plan for maintaining the positive effects of the outcome of the project.

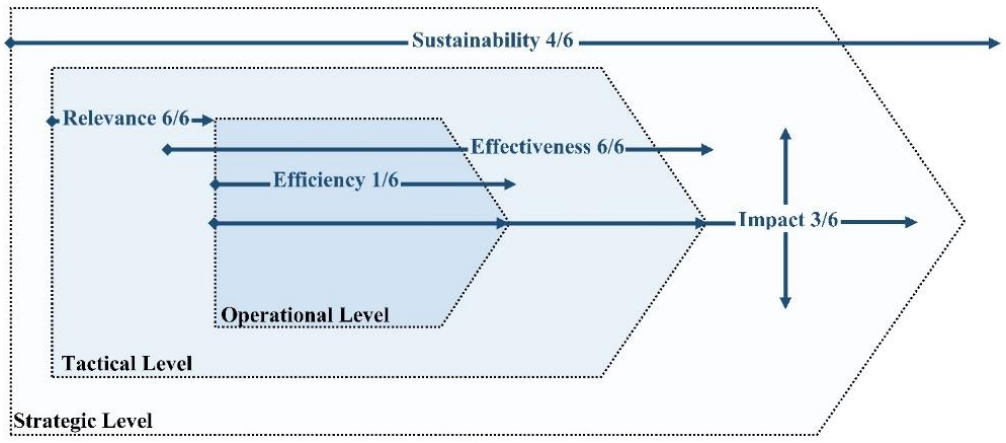

Fig. 9. The five measures' dependencies

7. Conclusions

In this paper we have described the development of an ex-post project evaluation framework. Following a review of a large body of literature, we found gaps in the extant evaluation models. We combined elements from existing evaluation models to form an improved framework, the Project Evaluation on Strategic, Tactical and Operational Levels (the PESTOL model). We applied the model to a case project to verify its applicability. The evaluated megaproject showed the relevance of the model, how it covers the whole project life cycle, and how it handles the links between different measures.

We do not claim that the model presented in this paper is the "ultimate" evaluation model, but rather that it can be used as a reference guide to ex-post evaluations. Nevertheless, there are some limitations within the model, such as the subjectivity in the scores that rather reflects stakeholders' perceptions, and that often there will be partiality in the judgments. Where necessary, for further research to develop a systematic method based on the model in order to reflect the evaluation measures and their rationality.

Another issue concerns how to link the ex-post evaluation model presented in this paper to ex-ante, monitoring, mid-term, terminal evaluations. That can be done by developing "mirror" models that reflect the PESTOL model. In such cases, there would be continuous evaluation of a program or project from the trigger until the purpose that it is going to serve is fulfilled. That would also serve to improve management and decision-making during the whole life cycle of the project.

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