



The interest of an evolution of value management methodology in complex technical projects for improving project management

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ABSTRACT

Due to social, environmental and technical evolutions, complex technical projects (numerous stakeholders and several/high level expertises) need to evolve in their management practices. Many management and design methodologies exist to limit costs and resources used in a project. The proposed paper aims at identifying the challenges encountered in complex projects' management and determining how one of them, the Value Management, should be evolved. The research methodology combines a bibliographical analysis (on engineering methodologies for complex projects' management) and a demonstration of Value Management interest on a case study to address sustainable stakes.

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1. Introduction

An infrastructure project, such as transport infrastructure, water supply or nuclear plant dismantling, is by nature a complex project. These kinds of sociotechnical projects are often mixing public and private stakeholders, which requires strong engineering skills in a multiexpertises environment for system design. Expectations for positive social and environmental impact or value are as important as cost and quality of the project (Shen et al., 2011). Thus, project management has to embed social and ecological dimensions of sustainability requirements of such complex projects.

Sustainability has to be understood as the three pillars of sustainable development: economic, social and environmental aspects in a common and extended usage of this concept (Brown et al., 1987).

A French consulting company, Euro Contrôle Project (ECP), has initiated this research. Indeed, ECP is specialized in project consulting and part of their work consists in supporting companies in technical installations and infrastructure projects. These kind of projects are complex projects since they have many Stakeholders,

a long delivery time, many activities and require multiple skills to reach some performance (Yang et al., 2019; Bosch-Rekvelde, 2011). Therefore, main activities of Project Management (PM) deals with cost estimation, planning, cost control and risk management, quality control or even contract management... Before a project launch, opportunity and feasibility studies have to be done (Kostalova and Tetreva, 2014). In these specific steps that lead to project milestone, a sociotechnical approach have to be done to undertake the "best" solution to respond a need (build together needs and solution principles). However, numerous methodologies exist and the decision must not only be based on the achievement of technical objectives but by bringing the greatest value from an economic, social and environmental point of view. Thus, it seems to be difficult today to choose a global approach able to take into account sustainable approaches in early phases of design projects.

Indeed, stakeholders have to be analysed on the phase of use but also in construction or a dismantling phases. These works are consistent with heuristic perception of project management practitioners who consider that beyond technical requirements, human organization and environmental impacts are part of the characteristics of complexity of projects. Moreover, the "engagement and disengagement" of stakeholders in a project relate the importance of a systemic approach, in complex projects (Lehtinen et al., 2019). Indeed, stakeholders' involvement in a project is dependent of the Value perceived for and from the project. The polysemy of this

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concept of Value has to be taken into account (Ben Ahmed and Yannou, 2003). Indeed, it should be a system of integration of sustainability but also it could be the base of many confused interpretation. Practitioners highlight that even when they are identified social and ecological value of projects could sometimes are lost behind economic and technical rationality.

The aim of this paper is to understand how a complex project management methodology, through the Value Management example, should integrate social and ecological stakes in early design phase. The research methodology is firstly based on a state of the art of methodologies proposed and used to manage a project. Many methodologies seem to have important gap to support sustainable dimensions: they are not used all along the life cycle of a project with a stakeholders approach, they have a very technical or temporal one. Thus, Value Management methodology could be useful to integrate sustainable dimensions in PM. Practitioners as ECP company raised that the methodology they use are not perfect and there exist some limitations to take into account sustainable dimensions due to the fact that social or environmental parameters are not strongly measurable in an early phase project management. Thereafter, a simplified case study provided by ECP as representative to real project management context is presented to demonstrate that in practice, the same situation could be observed. Based on these two sections, authors show that management methodologies are not adapted to current social and environmental issues but also that Value Management should be able to fill this gap. Finally, limits of the study and required added research work are discussed.

2. Literature review

This first section will present what seems to be a “good” Project Management (PM). Later, some PM methodologies are characterized.

2.1. What is a “good” project management?

Two important definitions of PM are highlighted by (Kostalova and Tetrevova, 2014), that made a review of tools used for PM. The important elements of definitions are the steps that have to be managed: planning, organizing, monitoring and controlling; for the entire life cycle of a project. Thus, all dimensions of a project have to be taken into account to have an optimal one. It means that stakeholders' management is a key point. Indeed, they are actors of the project and contributors of the project quality. Moreover, projects' quality are linked to the global value of the project. In fact, not only cost or time are important for stakeholders of a complex project, but also social and environmental dimensions, which are crucial preoccupations today. Thus, Koke and Moehler (2019) enumerate many research works trying to incorporate sustainability in Earned Value Management, a cost-oriented management approach (Kostalova and Tetrevova, 2014), through water consumption for instance.

2.2. Project management methodologies commonly used

PM involves numerous tools and techniques as underlined by Kostalova and Tetrevova (2014). However, “it is not possible to provide an exhaustive list of project management tools, but it is possible to mention the best-known and most widespread ones”, according to (Kostalova and Tetrevova, 2014). Based on (Kostalova and Tetrevova, 2014; Seymour and Hussein, 2014), Table 1 shows majors of these methodologies and tools and what are their specifications.

It has to be noticed that this table relates with “+++” majors number of publications (more than 50%) about a dimension of sus-

tainability; with “++” between 25% and 50% publications and with “+”, less than 25% publications in the subject. This work was conducted with ScienceDirect database and a PM and design framework.

2.3. Value management specificities

With above analysis, we can show that VM have a high potential to introduce sustainable aspects in PM. Indeed, in early design phase, only this methodology seems to take partially into account social and environmental aspects. The fact that VM is an “open-dialogue exercise” (Maznan et al., 2012) with stakeholders seems to be crucial: other methodologies do not take into account stakeholders all along life cycle of the project. We do not have to forget that VM is “a proactive, problem solving or solution seeking process, which can be used to enhance the functional value of a project by managing its development from design concept to operational use”, according to (Fong et al., 2010). Thus, the concept of Value is crucial and should have to be defined with a systemic approach in a PM framework. However, main methodologies are centered on the economic aspect of this concept. VM, that seems to be the more systemic tool, should introduce more tools to “measure” social and environmental dimensions of Value.

2.4. Main findings on the literature review

The literature review suggests that sustainable dimensions are not entirely taken into account in none of the evoked methodologies. The “Triple Constraint of Project” present in each methodologies are: the project scope, time and cost, as described by Kostalova and Tetrevova (2014). We can notice that the economical aspect of sustainability is clearly present in a majority of PM approach. This is consistent with difficulties encountered by consultants and practitioners to identify and maintain social and ecological values all along project phases. It has to be noticed that VM methodology will be developed in herein case study to show how sustainability could be integrated in a management process.

3. Case study

With the literature review, we have seen that numerous PM methodologies exist. It seems that VM is able to integrate sustainable dimensions: ECP company used it to elicit stakeholders requirements and values.

In this section, a description is undertake before the application of this methodology. All characteristics are detailed to show how more of sustainable aspects are (not clearly for now) taken into account. The research had been driven in partnership with a company which allows us to lead a heuristic approach coming from practices observation and analysis to scientific assumptions. This analysis of practices is illustrated on a pedagogical case used in training sessions. This case study had been built up from ECP's experience to be representative.

3.1. Description

Let's take two cities A and B far from about twenty kilometers each other. The project's aim is to find some solutions to link up A to B globally more efficiently (issue 1). In fact, existing small roads between A and B are overload and a highway exists near to B from North to South without any exit to lay out B. Furthermore, some residential subdivisions were built on the outskirts of both cities; a river is situated at few hundred meters of A and B South's limits, and there is a mountain to the North. These topological constraints do not let think about an “easy” solution.

Table 1

Main project management tools and their characteristics.

Name	Economic dimension	Environ-mental dimension	Social dimension	Phase of the project
Triple Constraint of Project (Kostalova and Tetreova, 2014)	+++	++	++	Global management
Critical Chain Method (Kostalova and Tetreova, 2014)	++	++	++	Global management
Work Breakdown Structure[5]	++	++	++	Project planning
Formalized Structure (Kostalova and Tetreova, 2014)	+++	++	++	Pre-project study
Program Evaluation and Review Technique (Kostalova and Tetreova, 2014), (Seymour and Hussein, 2014)	++	++	++	Project planning
Value Management (Maznan et al., 2012)	+++	++	+++	Pre-project study; used all along the project
Logical Framework Approach (Kostalova and Tetreova, 2014)	+++	++	++	Pre-project planning; used all along the project
Agile PM (Kostalova and Tetreova, 2014)	+++	+	++	Global management
Formalized Risk Analysis (Kostalova and Tetreova, 2014)	++	+++	+++	Risk analysis
Internal Rate of Return (Kostalova and Tetreova, 2014)	++	+++	+++	Project implementa-tion phase
Net Present Value (Kostalova and Tetreova, 2014)	++	+++	+++	Project implementa-tion phase
Social Return of Investment (Kostalova and Tetreova, 2014)	+++	+++	+++	Project implementa-tion phase
Earned Value Management (Kostalova and Tetreova, 2014)	++	++	++	Project implementa-tion phase
Payback Period (Kostalova and Tetreova, 2014)	++	+++	+++	Project implementa-tion phase

The consulting company is solicited by Government to determine what is the project (management and Stakeholders) which would design the best solution. The case analysis follows the general Value Analysis method (issue 2).

3.2. Value management methodology used

3.2.1. Different steps

• Identification of Stakeholders

To treat this case, context is important (issue 3): **who are the different Stakeholders?** This first step of work, identification, is made with Government, which already know some of them through contact established and different early studies as topographical or socioeconomic ones. However, this is an iterative process to be comprehensive and to be able to evolve. Thus, Government that funds the project is the decision-maker also. Citizens of the zone concerned are implied as all companies (and workers) that will work on the project. Many Stakeholders could be identified: in this case study, around fifteen exist.

Numerous and varieties of Stakeholders (issue 4) are a key element: it requires to analyze the Value of them concerning the project in terms perception of “cost” and “benefits” (issue 5). It is made through a Function Approach described below.

• Identification of the needs and functions associated

After having identified all Stakeholders, it is crucial to know what they really need, and to characterise it. **Each Stakeholder needs are expressed through a Function Analysis approach..** Linking A and B corresponds e.g. to transport people and facilitate exchanges. It corresponds respectively to cities expectations and Government's one. For each step of life cycle, functions are characterized and ranked by “order of importance” for Stakeholders. In this case, a collective work is important because it permits Stakeholders involvement. The most important function is “to transport people” that is noted with 65% of the importance of the project while “to facilitate exchanges” have 35% of Stakeholders preferences.

Thus, Government wants to improve exchanges between two cities to enable the Economic Value creation, within a given budget (issue 6). Thus, the aim of the project is to perform functions within an optimized cost. Citizen's life is at stake also with traffic jams reduction, which is reported to Social Value (issue 7). Objectives of reducing pollution at the same time with public transports, refers to Environmental Value (issue 8). Moreover, inhabitants of both cities and peripheral ones, neighbouring ecosystem like river

and mountain, have to be taken into account also. Thus, a systematic life cycle step's approach has to be performed to elicit all needs of Stakeholders at each step of the project lifecycle. In this case, several needs are identified leading to about ten functions.

• Solutions finding

From functions ranked, solutions are explored and documented: they answer more or less each requirement, with a priority to the highest ranked functions. Many technical solutions can be imagined without speaking of details: a terrestrial one could be discussed through railway track, new roads or highways, bus... but also with fluvial or cycling systems, without forgetting mixed solutions.

Another aspect is the consideration of geographical location: where to set up the facilities and what could be the consequences. A channel with a highway would be acceptable for a kind of Stakeholders but might be too expensive; while a direct exit of the highway will lead to noise pollution for inhabitants, a local wildlife disturbance or land deforestation. Mountain could be removed also... or more reasonably, a tunnel could be built. At this step, real challenges exist to (1) find an agreement between most of Stakeholders with different viewpoints and (2) be able to explain to decision-makers how solutions have been thought.

At this step -again- a collective work is done, and all phases of the project and all Stakeholders have to be considered: temporary facilities could have to be implement as a citizen access to both cities.

• Establishing scenarios

To find scenarios able to respond a majority of Stakeholders' needs for all step of project life cycle, no limits of creativity exist but some constraints due to context: direct links between the two cities are not possible to avoid forced expropriation; it is a Government decision. Another limit is feasibility: five kinds of feasibility exists: technical realisation, answer to requirements, acceptable cost estimation, capability to realise or duration of the building step, level of risks (technical, contractual, planning, overcost...). Thus, budget cannot allow to remove mountain; this is not conceivable for this project.

Once the feasibility is explored, many solutions evoked earlier may be dismissed. With the ones that are possible, different scenarios are established. In fact, with an exit of the highway solution, with a North or a South bypass, these could be different: not same inhabitants could be concerned, not the same wildlife impacted. Thus, different values for different Stakeholders at different process stages of the project can be defined for each scenario.

Table 2
Value Management methodology.

Economic dimension	Environmental dimension	Social dimension
The cost of the project: what is the amount of each technical solutions	Through stakeholders' consideration: they have to speak about their ambitions. For instance, ecological association are involved in this kind of process	Through stakeholders' consideration: they have to speak about their ambitions. For instance, some companies have constraint: how to deal with local employment?

• Decision-making

All the process leads to decision making. A diagram representing the classification of global “value creation” for each scenario is constructed that helps in making a justified decision. Herein this case study, Government will decide what seems to be the best scenario, based on diagrams, or which scenario requires more studies to take a final decision.

3.2.2. The observations

Case's study based approach permits us to draw characteristics link to sustainability (see Table 2) of VM in early stage of complex project conception.

3.3. Main findings of the case study

With a VM approach, many of sustainable aspects are taken into account through the concept of “Value”, that relates not only economical aspect but also social and environmental ones.

Moreover, a stakeholder approach seems to be great to a better integration of the Value, according this example: they are involved into the project so they “co-create” the Value.

4. Discussions

Firstly, we showed that main existent methodologies to manage projects lack to address sustainability issues in complex projects. Secondly, the case study illustrates that many dimensions of the concept of sustainability are (more or less) taken into account contrary to the supposed methodology of VM. Thus, in this part, we will try to make hypothesis of what should be undertake to a complete integration of sustainability in a PM framework.

4.1. Project management

Many tools are used to manage a project. However, a lot of them are very specific in term of scope (time and cost are the more represented) or usefulness in each step of a project.

Pre-Project Study with Formalized Structure, consisting of an opportunity study and a feasibility study. It is one of the mains step before starting a project, according to Kostalova and Tetreva (2014). However, this early design consideration does not permit to know if the project have a real utility for stakeholders. This is a point that should be raised and represent a major limitation of this work: stakeholders have to be more studied.

Main preoccupations of Humans being are related to sustainability: climate change, pollution problem of disappearance of many species... These aspects are not taken into account in PM methodologies today. Thus, to manage a project, sustainability dimensions should have to be driven today. As seen above, the three principal constraints (time, cost and scope) are mainly related to economic preoccupations. This seems to be problematic when some Humans are present into a project: social and environmental should have to be treated also and integrated to early design phases of a project. A second limitation a this work appears: dynamic aspect, through evolution of the project, should be studied later.

4.2. Value management

VM is flexible and can be used in all steps of a project, as suggested by the literature review. However, as many PM methodology, it is not clearly a methodology able to take into account sustainable dimensions today. In practice, ECP used “Value” concept to incorporate these dimensions to PM. This type of management is able to support a stakeholder-based approach which seems to be interesting. Therefore, VM despite of some limitations, seems to be one of the most usefulness methodology to incorporate a part of sustainable dimensions in PM, through the concept of “Value”. It have to be noticed that this concept should be more studied in a complex project management framework to have a strong definition, with not only a theoretical but also a practical approach.

Some gaps exist as no dynamic aspects and the existence of some parameters able to measure social and environmental dimensions in early phases of a complex project.

The concept of “co-creation” of Value, in a complex projects framework should be explored in future works. It corresponds to a “value that is more than the sum of the parts that individual organizations can create on their own and in-house” (Liu et al., 2014). It seems to correspond exactly at the process used in a VM approach. It should permit to incorporate many aspects of sustainability in PM.

5. Conclusion and future work

Through this article, we demonstrate that VM seems to be a strong methodology to support a sustainable integration in PM despite some gaps. Value is a polymorphic concept and it should be a manner to integrate all dimensions of sustainability in PM. As (Seymour and Hussein, 2014) highlight, “it's not clear exactly what the future holds for project management, but with challenges such as globalization, diminishing resources, and increasing population there is no more fitting vehicle for managing such issues than project management”. Thus, this research work is a strategical one for the future of PM and more exactly for early integration of sustainability dimensions in early phases of complex projects conception.

Future works will be conducted to identify and characterise what are parameters able to measure and how to treat information for a more systematic methodology of VM. Others will be conducted on the temporal aspect: complex projects are dynamic and as stakeholders, they should have to be managed “in real time”.

The two aspects will finally lead to take better decisions in a complex project framework.

CRedit authorship contribution statement

Alexis Lalevée: Writing - original draft, Methodology, Conceptualization, Investigation, Writing - review & editing. **Nadège Troussier:** Supervision, Writing - review & editing. **Éric Blanco:** Visualization, Investigation, Writing - review & editing. **Marion Berlioz:** Supervision, Writing - review & editing.

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