Megaprojects - Challenges and Lessons Learned

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Abstract

Projects have become popular work form in modern organizations. Megaprojects can be seen as the wild beasts in the project world, they are hard to tame, known for their complexity, vast size, expensive cost, and long time frame. These projects bring big changes in the geography of countries and life of people. Some of these megaprojects become landmarks for a country and bring significant prosperity, but some become unforgettable catastrophes. One of the definitions of megaprojects is that they are the projects in which the cost exceeds one billion US dollars. Examples of megaprojects include, "Channel tunnel", "London Olympics 2012" and "Ormen Lange offshore project". Though several pitfalls and challenges have been pointed out with respect to managing megaprojects, the relevance and the need of carrying out this kind of projects attract both the industries (practitioners) and academics. There are many significant issues that must be addressed in connection with managing megaprojects. This paper focuses on the different initiatives taken to date, presents them and tries to find the area of the missing expertise to understand the characteristics and the management of megaprojects.

Keywords: Megaprojects; initiatives

1. Introduction

According to Flyvbjerg (2003) megaprojects cost more and accumulate less revenue. Others express uncertainty and complexity in megaprojects due to their huge size and longtime duration. Because of these pitfalls and many others; this type of projects attracts more researchers from different fields within the project management area.
In this paper, the focus is on exploring the foundations of megaprojects and their characteristics based on the existing theory. There have been many initiatives to understand the management of these projects. However, most of the initiatives do not cover all the project management knowledge in managing them; the reason why we summarize most of the researches from the Norwegian and the international perspectives. We end up this paper by suggesting some focus area where more researches should be conducted in the future.

This paper contains five parts. They are:
1. Introduction
2. Research Methods
3. Megaprojects - A literature study
4. Reflections and Discussion: Megaprojects - What are the Characteristics
5. Recent Research Initiatives
6. Positioning the research initiatives
7. Conclusion

2. Research Methods

The method for this study is exclusively literature review and analysis. A preliminary review found that most of studies on megaprojects cover their characteristics. In addition to that, different approaches have been used by researchers to understand megaprojects in diverse knowledge areas of project management. Our study focuses at first on common megaprojects characteristics, then summarize the different initiatives and their areas of researches on managing megaprojects. The targeted literature sources are not limited to only academic journals; but also to some reports, books, which are published in English or Norwegian and dating before 2009.

3. Megaprojects - A literature study

Going through most of the definitions given to megaprojects, one can find that they are varying from one author. Also the label megaproject is not used by all authors and still the characteristics differ from definition to another. Grün (2004) calls them the “giants” among the projects; he puts the emphasis on the aspect of multi-organizational enterprises (MOEs) and characterizes these by (i) singularity, (ii) complexity, (iii) goal-orientation (technical, financial, time) and (vi) the nature and the number of project owners. Also called large scale engineering projects as described by Hassan et al. (1999) based on five attributes: (i) “high” capital cost, (ii) “long” duration but program urgency, (iii) technologically and logistically demanding, (vi) requiring multidisciplinary inputs from many organizations, and (v) leading to a “virtual enterprise” for the execution of the project. Miller & Lessard (2000) have researched sixty large scale engineering projects and in their sample the average capital cost is US$ 985 million, the average duration is six and a half years with a construction period of four years; this implies high capital cost and long duration. Fiori et al. (2005) define them as a large scale project with a price tag in excess of one billion dollar; or the “new animal” that have a strikingly poor performance in terms of economy, environment, and public support. Also, they lead to cost overruns and lower-than-predicted revenues that hinder economic growth instead of advancing it (Flyvbjerg et al., 2003). Ruuska et al. (2009) define megaprojects as significant undertakings which are characterized by multi-organizations, seeking success on different objectives; subject to socio-political impacts. The Federal High Way Administration (FAHWA) defines megaprojects as: “Major infrastructure projects that cost more than US$ 1 billion or projects of a significant cost that attract a high level of public attention or political interests because of substantial direct and indirect impacts on the community, environment, and state budgets”. Capka (2004)
describes megaprojects as expensive projects that require the management of numerous, concurrent, and complex activities while maintaining tough schedules and tight budgets. More elaborate definitions describe megaprojects as large scale complex projects that often fail to meet costs estimations, time schedules, and anticipated project outcomes. Brockmann (2009) defined Megaprojects as unique construction projects known for their complexity, vast size, expensive cost, and long time frame compared to conventional construction projects. The size and complexity are reflected by a price tag that exceeds one billion dollar and by a time frame that may exceed the five year limit. Marrewijk et al. (2008) describe megaprojects as projects that contain a large element of technological innovation associated with high risk and characterized by conflict, uncertainty, and poor cooperation between partners. All the definitions describe the megaprojects broadly. These definitions could apply to any project that may lack megaproject's characteristics. In other words, the definitions do not clearly define megaprojects and differentiate them from other projects.

Unfortunately, the researches on megaprojects seldom cover all aspects and challenges in managing these types of projects. most of the researches on megaproject's are focusing on poor managerial performance. In addition, no practical means were developed to improve their performance in order to meet time and cost constraints. The list of projects with cost overruns reads like a “who is who” in megaprojects (Flyvbjerg et al., 2003), between these are the Suez Canal (1,900%), the Sydney Opera House (1,600%) or more recently the Boston Artery Tunnel (196%), the Great Belt Rail Tunnel (110 %) and the Channel Tunnel (80%). On the other hand, some megaprojects should not exist; thus the importance to enlarge the research on this project to their effects, impacts, relevance and sustainability.

4. Reflections and Discussion: Megaproject – What are the Characteristics?

We start our discussion based on most definitions of megaprojects presented in the theory part of this paper. It is thinkable to realize that they converge to a common definition. The divergences between the different definitions come from the focus point of the researchers and from their approaches to analyze these projects. Based on all the characteristics taken from the definitions, a sum-up is made for those we think are most aim (Table 1).

Table 1. Megaproject Characteristics and Descriptions

| Element  | Characteristic and Description                                                                                                                                 |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Size     | Large scale project (huge scope)                                                                                                                               |
|          | Technologically and logistically demanding                                                                                                                   |
| Cost     | Exceeds one billion US dollar                                                                                                                                   |
| Time     | Exceeds 5 years Long” duration                                                                                                                                     |
|          | Program urgency                                                                                                                                               |
| Success  | Different objectives.                                                                                                                                           |
|          | Fail to meet costs estimations, time schedules, and anticipated project outcomes                                                                            |
|          | Goal-orientation (technical, financial, time)                                                                                                                   |
|          | Poor performance in terms of economy, environment, and public support.                                                                                           |
|          | Leads to cost overruns and lower-than-predicted revenues that hinder economic growth instead of advancing it.                                                    |
| Complexity | Requires the management of numerous, concurrent, and complex activities.                                                                                      |
|          | Contains a large elements of technological innovation                                                                                                         |
Table 1 represents the characteristics and elements describing megaprojects, but when trying to represent them as show in Figure 1 below, we may notice that the illustration cover all the types of project from smallest to mega one.

**Fig. 1. Megaprojects among projects**

The figure above represents general illustration of projects and among them megaprojects. This illustration includes the stakeholders, complexity, uncertainty, cost, time, size and the number of the organizations involved in the realization of the project.

5. Recent Research Initiatives

The last ten years there has been undertaken a key initiatives, both in research and education. The
literature focused on Norwegian and international initiatives, which are primarily intended as a basis for further Norwegian research work. A review of the literature shows that it was carried out numerous studies of megaprojects. These studies are mainly performed until 1990, after which fewer initiatives were taken. The initiatives are presented in chronological order (Figure 2). Among the eleven presented initiatives in this paper, the last six are not completed. This research presented in this paper was done in 2009, that is why the presented research papers here are till 2009.

| Initiative                                                                 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 |
|---------------------------------------------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|
| Norwegian Shelf Competitive Position (NORSOK)                             |    |    |    |    |    |    |    |    |    |    |    |    |
| International Program in the management of Engineering and Construction   |    |    |    |    |    |    |    |    |    |    |    |    |
| Auditor Review of the National Hospital                                  |    |    |    |    |    |    |    |    |    |    |    |    |
| An Anatomy of Ambition – Bent Flyvbjerg                                   |    |    |    |    |    |    |    |    |    |    |    |    |
| The federal Highway Administration (FHWA)                                  |    |    |    |    |    |    |    |    |    |    |    |    |
| Independent Project Analyst Institute (IPA)/UBIC                         |    |    |    |    |    |    |    |    |    |    |    |    |
| Research Program Concept                                                  |    |    |    |    |    |    |    |    |    |    |    |    |
| Optimal Management of Petroleum Resources (PETROMAKS)                     |    |    |    |    |    |    |    |    |    |    |    |    |
| Competency Standard for Complex Project Managers                         |    |    |    |    |    |    |    |    |    |    |    |    |
| Practical Management of Risk in an Ownership Perspective (PUS)             |    |    |    |    |    |    |    |    |    |    |    |    |
| BT Research Center on Oxford Business School                              |    |    |    |    |    |    |    |    |    |    |    |    |

Fig. 2. Initiatives over the last ten years

Here is some background information on the initiatives stated in Figure 2.

1999 - NORSOK: was a project intended to reduce completion time and costs for construction and operation of petroleum installations on the Norwegian shelf. NORSOK established a new implementation model based on new work processes between the actors and the changing framework conditions. The goal was to reduce resource usage by 40-50%, and maintain a high level of security.

1999 - IMEC: The research program "International Program in the Management of Engineering and Construction" was launched in 1995 at the University of Quebec and Montréal. The program was eventually supported by many organizations, including the Norwegian contribution from the Norwegian Hydro and PM 2000. The mandate of IMEC grew out from projects experienced challenges in the eighties and nineties. The program had as a main purpose to facilitate the exchange of information between industry, government and research on large-scale engineering projects. IMEC defined, in 1995, large-scale projects as projects with a budget of 500 million dollars or more.

2000 - Office of the General Auditor of Norway for the examination of the leading university hospital of Norway (Rikshospitalet Oslo): General Auditor was created in 1816. It is through the audit, control and supervision ensure that community assets and values are used and managed as Parliament has decided. General Auditor reviewed the project "New National Hospital" several times in the period between 1996 and 2000. The project experienced many changes, including the increase in cost by 89%. The audit went through many large government projects each year and thus has great expertise in review of such projects. The projects are mainly examined by analysis of project documents, but it is supplemented with interviews.

2003 - Bent Flyvbjerg has devoted much time to research the phenomenon of megaprojects and he published the book "An Anatomy of Ambition ", together with Nils Bruzelius and Werner Rothengatter. The book presents a study based on major projects around the globe. The study is conducted by extensive investigations of some megaprojects, like tunnel under the English Channel, Great Belt Railway Bridge and the bridge over Øresund. In addition, 113 projects analyzed using quantitative method.

2004 - The Federal Highway Administration (FHWA): In 2000, FHWA sent a description of a concept
for project office about megaprojects. The project office was established as headquarter and would ensure that megaprojects will no longer attain low achievement as before. From this concept description in 2000 until 2004, a number of megaprojects reviewed and megaprojects were an area of increase attention.

IPA / UBIC: One of the largest studies conducted by major projects carried out by Independent Project Analyst Institute (IPA). IPA is an organization that offers both consulting and training in project management. IPA developed in 1977 a tool for analysis and evaluation of project. This tool is called the Project Evaluation System (PES). In the years 1999 to 2007 the tool had been used to analyze 10 000 large projects with a total budget of 500 billion dollars, by benchmarking of 362 upstream oil and gas projects. The results of this benchmarking were published in 2007 under the title of "Upstream Industry Benchmarking Consortium" (UBIC 2007).

2002 - CONCEPT, NTNU: The program conducted a research to monitor large public investment projects. The purpose behind the creation of the research is to develop knowledge that ensures better resource utilization and effectiveness of major public investments. The research program CONCEPT has its primary goal to develop knowledge and expertise on projects in the early phases. The approach of the research program is that projects are initiated on the wrong or inadequate foundation. This may be because the projects may not be able to stay within the cost framework, or that the projects are initiated with the wrong goals. Another challenge that it is pointed out in the program is the difference between a project results and benefits. The project can achieve the internal goals, but be a failure as a whole, if it did not achieves the desired effects. The program is still going on

2004 - PETROMAKS: Optimal Management of Petroleum Resources is a research program for petroleum industry that is supported by the Research Council. The program covers both long-term basic and more applied practical and technical research. PETROMAKS is the largest research program supported by the Research Council and it has an annual budget in excess of 30 million euros. The mission of this program was both in research and to assist in the implementation of government strategies in petroleum matters. The program optimizes the management of petroleum projects to increase competitiveness and awareness, safety and security. PETROMAKS focuses on large projects in challenging and environmentally sensitive areas, mainly in the Barents Sea, projects in Snøhvit field on the Norwegian continental shelf and the Shtokman field on the Russian shelf.

2004 - Competency Standard for Complex Project Managers: The Australian defense experienced consistently large excess of costs. In addition, it attained low achievement in other parameters in the most complex investment projects. This resulted in a growing focus on complex projects and a development template to competence needs was prepared. The document was developed by the Australian Government Department of Defense and is called Competency Standard for Complex Project Managers. However, the document has generally a common approach to project management and it says little about the additional challenges that entail complex projects.

2006 - Practical Uncertainty management in owner perspective (The PUS project) at the Norwegian Center for Project Management (NSP) is a research project that looks at how the external uncertainty can be handled. Behind the project PUS stands companies like Statoil, Telenor, Norwegian Directorate of Public Construction and Property Management (Statsbygg), the Armed Forces, the Public Roads Administration and the National Rail Administration, which together manage a project portfolio of approximately yearly annually project cost of more than 10 billion euros.

2009 - BT Research Center at Oxford Business School: The new center for research on megaprojects at Oxford Business School is said to be the first research center for research on the phenomenon of megaprojects. In addition to research, the center will provide teaching and study programs about megaprojects.

These eleven research initiatives would give us an understanding of what has been looked at when it comes to managing megaprojects. The number of initiatives may be considered as small. Bu, the
initiatives present a picture of the resent studies on the topic of managing megaproject.

6. Positioning the Research Initiatives

We suggest in Figure 3, four phases from the lifecycle of a megaproject.
1. Idea and conceptual phase
2. Planning phase
3. Execution phase
4. Operation phase and impacts
Also in Figure 3, the eleven research initiatives are positioned based on their focus area.

The initiatives taken in the past decade pretty well scattered depending on the focus area. The Figure 3 shows the main focus area for each initiative; still, it was necessary to distinguish the work of NORSOK and CONCEPT (initiative 1 and 7, respectively), their focus is on two areas. It can be seen right away that
there are very many of the initiatives dealing with the projects results. Three out of the eleven initiatives have this as their main their research area (Initiative 1, 3 and 4). Four initiatives have their research area the early project phase. For research about the realization of social goals, CONCEPT is the only one positioned in that area in Figure 3. The most important initiative so far is the IMEC (initiative 2), but the project PUS (initiative 10) has covered three phases (but in a specific area of project management which is uncertainty management). In the future it will be exciting to follow the development of the research going-on at Oxford. The center is developing a master in management of megaprojects, thus probably most knowledgeable will be developed in the near future. It is necessary to complete the existing knowledge about the management of megaprojects to form a more complete picture.

7. Conclusion

We think that there are three trends that will drive the project management field forward in the future. We believe that in the future they will be more Megaprojects - The trend in Norway shows that those projects are becoming larger and more complex over the last decade. This trend will drive the development of the project management field. It means that we have to develop theory that covers this kind of projects. The second trend is that the project owners will expect more flexible solutions that give a high delivered functionality. They will demand that the projects should be delivered as effective as possible. This means that in the future it will not be acceptable to just deliver the result within the time, cost and quality - project managers must also understand the business case and deliver the required effects and functionality. The third trend is that we will see more rapidly changing demands from project owners - not one, but many owners in the megaproject. Also there will be more global competition - not one company but many companies deliver inputs and share responsibilities to achieve the objectives from and of megaprojects.

We have stated in Figure 3 that the different previous research initiatives do not cover all the important areas that need new project management approach and Figure 2 shows some of the aspect that needs further focus.

We suggest some knowledge areas which need to be developed more as listed below:

- The project owner role - how do multiple-owners influence the management of a megaproject?
- The project management role in megaproject - what kind of skills and knowledge do they need?
- How to deal with culture differences - a lot of cultures are involved, with different skills, knowledge and training in project management.
- Contact and legal issues - with the involvement of different countries and with different legislations and institutions.
- Stakeholder management.
- Change management - external and internal changes of megaprojects, how to control them?
- Uncertainty management - how to focus on opportunities in megaproject.

Megaproject will always exist, and we need to provide theory that reflects the challenges that they may face. The history tells us that they were not always successful, but they have always huge impacts on the society and therefore we should be interested in how to make them successful in the future.

Megaprojects can be considered as wild beasts in the sense that they are unpredictable and complex. However, there are ways to deal with the challenges that megaprojects present. In this paper, we positioned megaprojects with respect to other projects, and described research work that has been done within the field of managing megaprojects. By doing this, we tried to obtain some understanding on possible knowledge areas that could be considered in order to deal with the challenges of megaprojects.

We do not claim that the study presented in this paper is the final one. But we call it a start of a journey; a journey that can shed more light on the field of managing megaprojects.
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