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MEASURING WHAT IS MISSING IN MEGAPROJECTS

SOCIAL SUSTAINABILITY ASSESSMENT THROUGH
THE ANALYSIS OF SECONDARY STAKEHOLDERS'
SATISFACTION

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Abstract

Megaprojects are a major driver of economical, urban and social development of nations. The implementation of infrastructures has a huge potential of transforming economies and societies on a large scale. It plays an important role in solving the needs of people's livelihood, promoting economic and social development, and maintaining the sustainable development of economy and society. Megaprojects are not a magnified version of smaller projects: they are characterized by high cost, high organizational complexity and high impact on multiple primary and secondary stakeholders, traits that make them a unique kind of project to lead. Precisely because of this complexity, each megaproject makes its own story and the definition of "success" is vague. Over the years, the conception of megaprojects changed and academics started to value the impact of such ventures on local communities, society and secondary stakeholders, considering it as important as the economic aspects. This change in vision brought the need for a new framework of performance indicators and success factors for megaprojects, a framework that reflects these new values and the broad impact of such projects. The modern literature widely reports this need but remains vague about the implementation of a practical model to perform this holistic evaluation. This thesis aims at filling this gap by providing a framework for the holistic evaluation of megaprojects performance. Such framework introduces a practical model for assessing megaprojects social sustainability by measuring secondary stakeholders' satisfaction. Finally, the proposed model is validated through experts' opinion and the results are reported and analyzed.

Key-words: megaprojects, performance evaluation model, secondary stakeholders, social sustainability.

Abstract in italiano

I megaprogetti sono uno dei principali mezzi di sviluppo economico, urbano e sociale delle nazioni. Queste infrastrutture hanno un grande potenziale di trasformazione su larga scala e giocano un ruolo centrale nel risolvere le necessità delle persone, nel promuovere lo sviluppo economico e sociale, e nel mantenere una crescita sostenibile dell'economia e della società. I megaprogetti non sono versioni ingrandite dei progetti comuni: sono caratterizzati da un costo estremamente elevato, una grande complessità organizzativa e un forte impatto su molti stakeholder primari e secondari, caratteristiche che li rendono una categoria di progetti unica. Proprio a causa di questa complessità, ogni megaprogetto ha caratteristiche peculiari e la definizione di "successo" è vaga. Negli anni, il concetto di megaprogetto è cambiato e gli accademici hanno iniziato a dare valore all'impatto di queste opere sulle comunità locali, sulla società e sugli stakeholder secondari, al pari degli aspetti economici. Questo cambio di visione ha portato alla necessità di un nuovo framework di valutazione delle performance e del successo dei megaprogetti, un framework che rispecchi i nuovi valori e il grande impatto di queste opere. La letteratura moderna riporta ampiamente questa necessità, ma rimane vaga sul come implementare un modello pratico per effettuare questa valutazione globale. L'obiettivo di questa tesi è colmare questa mancanza con un framework per la valutazione olistica delle performance dei megaprogetti. Questo framework generale introduce un modello pratico per l'analisi della sostenibilità sociale dei megaprogetti tramite la valutazione della soddisfazione degli stakeholder secondari. Alla fine, il modello proposto è validato tramite l'opinione di esperti e i risultati sono riportati e analizzati.

Parole chiave: megaprogetti, valutazione delle performance, stakeholder secondari, sostenibilità sociale.

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Introduction

Megaprojects in today's world are becoming more and more central in the development process of countries, in fact, they are the principal driver of economic and social development around the world. It is possible to find megaprojects everywhere and megaprojects networks, such as railways networks, highways networks, energy systems and airport networks allow our world to be connected. They allow people to efficiently move and travel, they allow companies to deliver their products internationally and allow countries to maintain international relationships. Megaprojects have a huge potential of transforming economies and societies on a large scale, they play an important role in solving the needs of people's livelihood, promoting economic and social development, and maintaining the sustainable development of economy, society, and ecology [1]. Nations are continuously increasing investments in these infrastructures since their development is positively correlated with Gross Domestic Product (GDP) growth, population size, wellbeing and government revenue.

The meaning of the term "megaproject" evolved in time, and it is now used to describe unique and complicated, large-scale projects that require significant resources, time, and coordination to complete, and impact on multiple primary and secondary stakeholders. In fact, a new infrastructure development is about developing a site-specific prototype based on the evolving needs and claims of many autonomous organizations and individuals, many of which are non-users of the future asset. This extreme complexity makes megaprojects a unique and different kind of projects to lead, not just a magnified version of common project.

Today the world is changing at a faster pace than ever before, and this trend is continuously increasing its speed. This is evident just considering the events that happened in the last five years and how they changed our way of living and the global economy. This fast-changing environment is also forcing megaproject management to adapt and evolve towards a more dynamic approach. Moreover, in the last decades

there has been a change in cultural values, where social gains, social value and people's opinion are becoming more and more relevant. This means that, in the infrastructures world, public opinion and the value delivered to local communities are becoming more important, a contrasting environment with respect to the previous one, where organizations profit, governments profit and countries development where the main drivers for megaproject development, while social contribution was greatly overlooked. The satisfaction of secondary stakeholders (those who affect or are affected by the organization, but not directly involved in transactions with it [2]) and impacted local communities is growing in importance, since resistance of citizens, that may arise from the perception both in terms of cost and quality of life, could result in delays, cost overruns, or even abortion of the project. With the aim of reducing the risk of conflict and improving project performance, many studies suggest a change in the governance structure of megaprojects by involving local communities and ask for their opinion in the early phases of a project. Finally, this era is also characterized by a growing concern over climate change and environmental degradation, other themes that managers should take into consideration when realizing large projects. This cultural shift hugely influenced megaproject management, leading to new practices and also new parameters to assess their performance and their success. In fact, as the world and the cultures are evolving, megaproject evaluation models should also evolve with the aim of giving relevance to what public opinion considers important at a given time. Thus, nowadays, the central challenge of megaproject evaluation is to foster the adoption of more reflexive and learning-oriented evaluation approaches, while fully considering the socio-economic impacts of such large-scale projects. Greater attention to learning and improvement should not mean abandoning accountability as a major objective of evaluation. Rather, there should be a better balance between accountability, learning objectives and social value delivered. Even though current literature evidences the need for new evaluation techniques that match the new values, a real practical and quantitative method to assess megaprojects performance in a holistic sense is missing. The aim of this thesis is to reduce this gap by providing a practical performance evaluation model that expands the commonly used parameters with parameters that represents this value evolution. In particular, this research proposes a comprehensive framework to evaluates both quantitative and

qualitative aspects to assess the performances of megaprojects. Additionally, one of metrics described in this framework, which is secondary stakeholders’ satisfaction, is deeply analyzed and a specific model for its assessment is devised. Both the general evaluation framework and the practical model on secondary stakeholders’ satisfaction have been derived by studying and understanding the fundamental and the most modern literature on megaprojects published in western countries, mainly Europe and the United States. Together with the academic literature, also the European Commission guidelines on success criteria for infrastructures served as a basis for this work. Also the experts involved in model validation were people coming from Europe, mainly Italy, and the US, but with worldwide experience.

Structure of the work

This work is structured in four major blocks, as shown in the following picture.

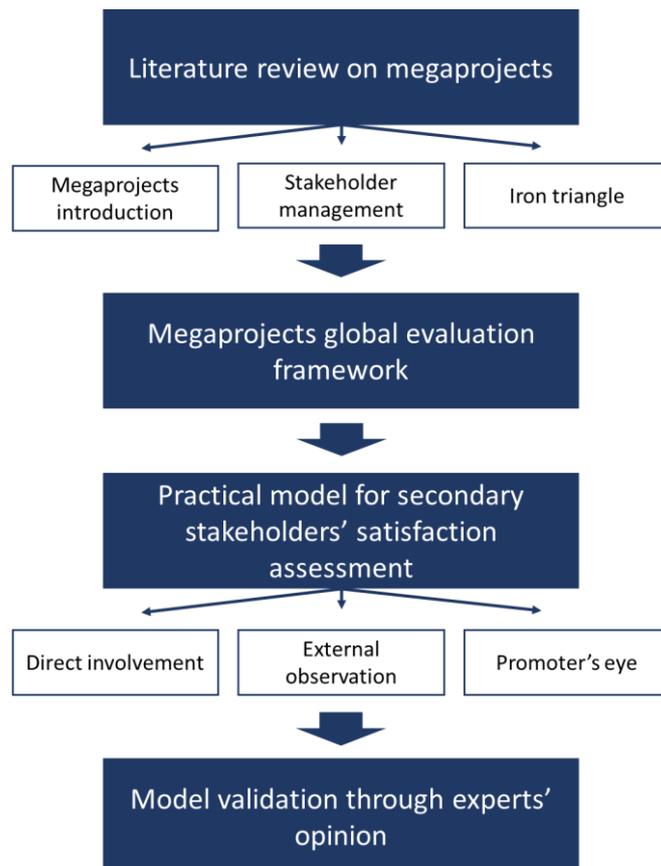


Figure 1 - Thesis structure

The first block, composed by the first three chapters, is an extended literature review about megaprojects. It starts with a general introduction about megaprojects where their definition is deeply analyzed and all their characteristics are displayed. In this introduction, there is a focus on how megaprojects impact society and economy, on how the world is evolving and how megaprojects should adapt to this change by means of objectives, governance structure and evaluation techniques. The second chapter is focused on stakeholder management: it starts with the history of stakeholders management and continues with a focus on stakeholder theory, where different stakeholders' management techniques are displayed. The chapter continues with the description of primary and secondary stakeholders, their definitions and some examples of both categories. Finally, it ends with the distinction of two ways of managing stakeholders: management of stakeholders and management for stakeholders. The last chapter of this block focuses on the iron triangle, the established mean for the evaluation of the management of megaprojects, which is composed by cost, time and scope. After an initial description, its limits are discussed and some statistics about megaprojects performances are presented, together with an analysis of the main reasons why megaprojects tend to perform badly under this metrics.

In the second block, the holistic evaluation framework is presented. This section starts with a focus on which is the existing gap in literature that this work aims at reducing. It is followed by an analysis of the advantages of a holistic performance evaluation model and it ends with the framework description. The framework is composed by nine key performance indicators (KPIs): cost, time, scope, value, stakeholders' satisfaction, quality, environmental impact, reputation and risk and safety. All inserted metrics are described and the aim of their measurement is explained. In this chapter, just a general framework is provided. In fact, a practical model to actually measure the performance of a megaproject have been developed only for secondary stakeholders' satisfaction and is presented in the third block.

The third block focuses on the development of a practical and applicable model for the assessment of secondary stakeholders' satisfaction. This metric aims at understanding which is the perception of secondary stakeholders about a specific project and which are the criticalities linked to it. The model is composed by three parallel approaches: direct involvement, where citizens' opinion is gathered through different techniques;

external observation, where various objective metrics are measured; and promoter's eye evaluation, where the analysis of several parameters is performed from the promoter's point of view. The final objective of this model is to end up with an overall score for the project, which is the average of the scores obtained in the three approaches. Moreover, it is a dynamic model, meaning it is designed to be applied during project development to timely understand criticalities and perform corrective actions.

Finally, the last block reports the results obtained from model validation. The chapter opens with a brief theoretical introduction to model validation techniques and it continues with the description of the one used in this case, meaning experts' opinion. The model was validated through ten semi-structured interviews performed to field experts. Each parameter was explained to them and they gave their opinion about it. The results of the analysis, together with the most important comments, observations and experts' personal experiences derived from the interviews are reported in the final part of the work.

1 Megaprojects

The concept of megaprojects may not be widely familiar; however, it is pervasive in modern society, and individuals interact with them, either directly or indirectly, on a daily basis. For instance, an individual can travel between cities via railway, which is an example of a megaproject. Similarly, when someone drives on a highway, crosses a major bridge, or passes through a tunnel, they are interacting with megaprojects. Even beyond the simple act of refueling a car there is a chain of megaprojects that allows oil to be extracted from the ground, transformed into car fuel, and arrive at the petrol station. These examples serve to highlight the all-encompassing nature of megaprojects in shaping our society and the world at large.

The following chapter aims at clarifying what megaprojects are and how they can be defined, what are their main characteristics, how they impact on our economy and society, how their governance is usually organized and how their conception is changing in today's world, a world that is moving with increasing speed and where multi-years programs cannot be done anymore.

1.1. What is a megaproject

Megaprojects in today's world are becoming more and more central in the development process of countries. Altogether, interest in the academic world has risen and once established management paradigms are evolving.

The term "megaproject" is now used to describe large-scale projects that require significant resources, time, and coordination to complete. [3] The definition of what a megaproject is has changed with time. At first, it was widely accepted as universal

threshold the total project cost: projects that costed more than 1 billion dollars. [4], [5] However, it is easy to understand how this definition cannot be applied in the whole world since it does not take into consideration the differences in the economies and countries. As a matter of fact, this definition was developed mainly by looking at projects realized in the United States and could only be applied to the richest and most advanced countries in the world. Different authors proposed other thresholds such as 500 million dollars [6]–[8] or even 100 million euros, as proposed by the International Project Management Association (IPMA) as a realistic cost for megaprojects in Europe. However, a more appropriate and universal economic reference to differentiate projects from megaprojects in every country would be the comparison of the project cost with the country GDP. As a rule of thumb, this ratio can be considered around 0,01% and 0,02%, as most megaprojects fall in this range [9].

Even though the economic reference can give a fast and easy definition of a megaproject, it does not highlight the wide variety of factors that characterizes these complicated projects. Many authors gave slightly different definitions that point out the different aspects of a megaproject: Hirschman refers to those projects as “privileged particles of the development process” [10], saying that they are “trait making”, meaning that they are designed to change the structure of our society; on the contrary, he refers to standard projects as “trait taking”, in a sense that they fit into existent macro structures without modifying them. [3] It is evident that megaprojects are not a magnified version of smaller projects, but a different kind of project to lead. [11], [12] Flyvbjerg, one of the most important and cited researchers in the field of project management, proposes his view of megaprojects as large-scale, complex ventures that typically cost 1 billion dollars or more, take many years to develop and build, involve multiple public and private stakeholders, are transformational, and impact millions of people. [3] Gil highlights another characteristic of megaprojects: specificity. As a matter of fact, a new infrastructure development is about developing a site-specific prototype based on the (evolving) needs and claims of many autonomous organizations and individuals, many of which are non-users of the future asset. [13] He adds that megaprojects are inter-organizational form of organizing capital production, meaning that they involve many participants and organizations in

the process of developing long-lived infrastructure resources that are shareable in use for an appreciable range of demand. [13]

The above definitions give a broad idea of the complexity that characterizes a megaproject: high cost, which is difficult to forecast at project beginning and usually exceeds the initial budget; long time to be realized, again, usually more than initially imagined; organizational complexity, since they involve both private and public stakeholders whose relationships has to be ruled by appropriate contractual agreements. In fact, the difficult and tangled interactions between public and private partners often generate delays and huge cost overruns, also because of conflicts and lack of cooperation. [14] Another important aspect is the impact that projects have on society and on the life of millions of people. Nowadays, the satisfaction of impacted people and local communities is growing in importance, since resistance of citizens, that may arise from the perception both in terms of cost and quality of life, could result in delays, cost overruns, or even abortion of the project. Especially when proposed within a specific political framework, they indeed draw attention from the media, that present the outcomes, costs and time under considerably different standpoints. [15], [16] With the aim of reducing the risk of conflict emergence and improving project performance, many studies suggest involving local communities and ask for their opinion in the early phases of a project, since they can have impact at different levels. [8]

Greiman [17] proposed a megaproject classification based on industry type and purpose of the megaproject. The author identifies 5 categories of megaprojects:

1. Infrastructure projects: such as roads, bridges, water security, tunnels, and dams
2. Extractive industries: such as oil and minerals
3. Production industries such as agriculture, rubber plantations, and exports
4. Research and development including software design, biotechnology, and aerospace innovation
5. Consumption such as travel and tourism, film festivals, Olympic stadiums, and entertainment complexes

For this thesis purpose Infrastructure and Consumption megaprojects are categorized under the same name of Construction megaprojects.

Construction megaprojects refer to permanent constructions, equipment, facilities, and the services they provide for people's living and social production. The primary purpose of this type of megaproject lies in improving people's lives and facilitating social development. [11], [18] Construction megaprojects can be found in many industries such as transport, energy and IT systems, social assets like hospitals and Olympic parks, and commercial assets like high-tech factories or oil and gas pipelines. [13]

1.2. Megaproject impact on economy and society

Megaprojects have a huge potential of transforming economies and societies on a large scale, they play an important role in solving the needs of people's livelihood, promoting economic and social development, and maintaining the sustainable development of economy, society, and ecology [1]. This paragraph provides an overview of the multifaceted effects of megaprojects on these two key domains.

Megaprojects are a major way to deliver social and economic value to the population and institutions are investing more and more money in those infrastructures. McKinsey estimates that the world needs to spend about \$57 trillion on infrastructure by 2030 to enable the anticipated levels of GDP growth globally. [19] As a matter of fact, megaproject development is highly positive correlated with GDP growth, population size, wellbeing and government revenue. [1]

Around the world there are many examples of how big infrastructures can transform the economy of a country: one is the Panama Canal, which accounts for a significant share of the country's GDP; another project that had a huge impact on the territory is Dubai's international airport, the world's busiest, which accounts for 21 percent of Dubai's employment and 27 percent of its GDP. [19] Apart from the airport, Dubai was built and became famous around the world thanks to the many ambitious and

eccentric megaprojects that were developed there: two examples can be the Palm Jumeirah and the World, two huge constructions of new island in the middle of the sea, shaped respectively as a palm and as the world. The two megaprojects cost respectively 12 and 13 billion dollars. These projects served the country as touristic attractions, bringing millions of people from every part of the globe to visit Dubai and boosting the city prestige and growth. Finally, Hong Kong's speedy and efficient subway system is what enabled the densely packed city to develop beyond the downtown district. [19]



Figure 2 - Panama Canal



Figure 3 - Dubai International Airport



Figure 4 - The Palm Jumeirah and the World, Dubai



Figure 5 - Hong Kong subway, MTR

However, the economy is not the only aspect affected by those kinds of projects. In fact, society benefits from megaprojects from many different perspectives: many infrastructures have enormous potential of bringing more values to their performing organization and to the surrounding environment. [4] Some of them can even be lifesaving and protect the environment: the North Sea Protection Works in the

Netherlands protects the low-lying country from the sea, otherwise much of it would be under water; or the sewages and water-supply systems keep fatal diseases such as cholera at bay. [19]



Figure 6 - North Sea Protection Works, Netherlands

Megaprojects can also be a vehicle for accelerating the process of funding and development of other projects that can be incorporated into the development of the bigger infrastructure and would be otherwise postponed or never done. One example is the regeneration of East London which was funded and realized thanks to the Olympics. In fact, for realizing the Olympic Park in London, a form of shared governance within different actors had been adopted, and the budget was increased from 1 billion to 2.5 billion pounds to incorporate other public works. In this case, the megaproject of the Olympics was used to achieve different objectives and bring social value to the citizens, as the London Mayor noted: “I bid for the Olympics because it’s the only way to get the billions of pounds out of the Government to develop an area neglected for 30 years”. [20], [21]

So, megaprojects have a huge impact on both the economy and society of countries where they’re developed, they can transform the economy, improve people’s life, attract tourism, improve transportation comfort and services. On the other hand, these projects can also negatively impact society. In fact, megaprojects often involve the

displacement and resettlement of local populations, leading to social disruption, loss of livelihood, community disintegration and social conflicts. [22], [23]

In the next pages all direct and indirect impacts of megaprojects on economy and society will be analyzed.

1.2.1. Job Creation

Megaprojects have a significant impact on job creation and economic growth, making them crucial drivers of employment growth and economic development. [7] They often generate substantial employment opportunities, leading to increased job creation in both the short and long term. [3], [24] These projects require diverse skills and expertise, fostering the development of local labor markets and contributing to economic growth. Moreover, job creation stimulates income generation, thereby boosting consumer spending and overall economic activity. [25] There are different ways in which jobs are created:

- **Direct Job Creation:** Megaprojects often require a large and diverse workforce to complete various stages of planning, design, construction, and operation. These projects typically employ a significant number of workers directly, including engineers, architects, construction workers, project managers, and support staff. [26] The scale and duration of megaprojects necessitate a substantial labor force, creating numerous job opportunities for local communities [3]. The employment generated by megaprojects can provide a boost to regional and national economies by reducing unemployment rates and increasing income levels. [24]
- **Indirect Job Creation:** Megaprojects have a cascading effect on job creation throughout the supply chain and related industries. These projects require a wide range of materials, equipment, and services, leading to increased demand for goods and services from various sectors. Suppliers, manufacturers, contractors, and subcontractors, and even legal firms and consultants experience increased business activity, leading to additional job opportunities.

The American Public Transportation Association (APTA) estimated that for each billion dollars invested in public transportation, about 50,000 jobs are created or sustained across various sectors.[27] Similarly, a study by the Economic Policy Institute (EPI) found that investing 100 billion dollars in infrastructure would support approximately one million jobs in the first year across various sectors, beyond the immediate construction jobs. [28] This indirect job creation strengthens the overall economic ecosystem and stimulates economic growth.

- **Long-Term Employment and Skill Development:** Megaprojects often have extended timelines, spanning several years or even decades. This longer duration allows for sustained employment and stable income for individuals involved in the project. Moreover, once the project is completed and operational, it often continues to create jobs. This is particularly true for infrastructure megaprojects like transportation hubs, utility plants, or recreational facilities. These projects require personnel for their operation and maintenance, thereby providing sustained employment. On the other hand, if, at the end of the project, the workforce cannot transition into operations or maintenance, many of the jobs, if they are temporary and project specific, disappear. [29] In addition, megaprojects provide opportunities for workers to acquire and develop specialized skills, contributing to the growth of the local labor market. Construction workers and engineers gain expertise in advanced construction techniques, project management, and the use of new technologies. [25] These enhanced skills improve the employability of workers beyond the duration of the megaproject and foster economic diversification.

From all the above considerations it can be noted that it is not enough to talk about job creation in the context of a megaproject, but it is as important to consider the number of created jobs, as it is to consider the quality and the duration of those jobs. That is why measures to highlight the positive impacts on employment could include workforce training and development programs, social protection mechanisms for workers, and strategies for transitioning workers into permanent roles or new projects.

[30]

1.2.2. Economic Growth

The economic impact of megaprojects is multifaceted and extends beyond the immediate effects on the local and national economy. These projects often involve significant capital expenditure, which injects liquidity into various sectors of the economy, leading to both direct and indirect effects on economic growth. [3] Apart from generating employment opportunities, megaprojects can stimulate economic growth. [7] In fact, the economic impact of megaprojects extends beyond direct and indirect job creation. The influx of investment and increased economic activity associated with megaprojects creates multiplier effects that benefit various sectors of the economy.

- **Direct Economic Impact:** The direct economic impact of megaprojects primarily lies in the capital expenditure on construction and the resultant generation of jobs, as previously discussed. This expenditure also stimulates economic activity in industries directly involved in the project, such as construction, engineering, and project management [7]. Finally, the increased economic activity caused by this investment generates an increase in public revenues through taxes levied on the profits and wages associated with the project, [31] taxes that can be reinvested in social and economic development initiatives.
- **Indirect Economic Impact:** beyond the direct impact, megaprojects also create significant indirect effects in the economy. These are generated through the demand for goods and services by the industries directly involved in the project. For example, the construction industry might demand raw materials, machinery, and technical services, which stimulate activity in these supply industries. This multiplier effect can lead to further job creation and economic growth. [32] A study by the UK Department for Business, Innovation and Skills (2015) highlights the importance of this multiplier effect, demonstrating that for each job created in the high-value manufacturing sector, another four jobs are created elsewhere in the economy. [33] Another study that highlights the efficacy of the multiplier effect was conducted by the Political Economy

Research Institute (PERI), stating that for every 1 million dollars spent on clean energy and infrastructure development, approximately 16 jobs are created. [34]

- **Induced Economic Impact:** The economic impact of megaprojects also extends to induced effects, which result from the increased income of households and consumer spending of people benefitting directly or indirectly from the project. This can stimulate demand in various sectors, from retail and hospitality to education and healthcare, further driving economic growth. [35]
- **Long-term Economic Impact:** Megaprojects can also have long-term economic impacts by improving the infrastructure and technological capabilities of a region or a nation, thereby attracting investment and fostering economic development. [36] They can enhance connectivity, stimulate innovation, and improve the quality of life, making the region more attractive to businesses, skill workers and international investors. In fact, megaprojects, particularly those involving infrastructure development, can attract foreign investment and foster international trade. Improved transportation networks, ports, and logistics infrastructure enhance a region's connectivity and accessibility, making it an attractive destination for businesses and investors. Megaprojects that facilitate trade routes and reduce logistics costs can strengthen a country's competitiveness in the global market. Increased trade and foreign direct investment contribute to economic growth, job creation, and the transfer of knowledge and technology.[37]

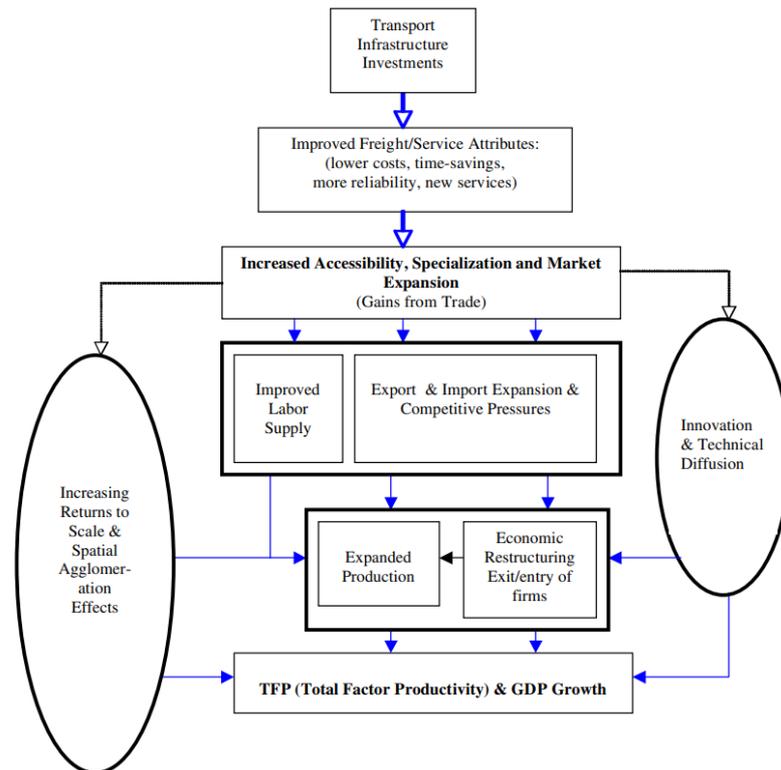


Figure 7 - Example of long-term economic impact in the realm of Transport infrastructure (from Lakshmanan [37])

1.2.3. Other impacts

Beside job creation and economic growth, megaprojects impact the area in which they are built in many other ways:

- **Infrastructure development:** megaprojects usually are developed to construct or enhance critical and strategic infrastructures such as transportation systems, energy networks and communication lines. Such infrastructural enhancements can amplify interconnectivity, expedite commercial exchange, and attract foreign investment. [38] Specifically, efficient transportation grids can mitigate logistical expenses and augment market reach, thus catalyzing regional and international commerce.
- **Innovation and technological advancement:** megaprojects frequently serve as stimulants for innovation and technological progress. [22] Given their complexity, these ventures necessitate the incorporation of state-of-the-art technologies with advanced and new solutions, leading to breakthroughs in

engineering, materials science, and construction methodologies. The quest for innovative resolutions not only amplifies the project's efficiency but also triggers knowledge dissemination, benefiting diverse economic sectors. [39]

- **Urban transformation and livability:** Megaprojects can induce dramatic transformations in urban topography, contributing to city revitalization and metamorphosis. [32] Investments in urban infrastructure, public spaces, and cultural amenities enhance the overall habitability and appeal of the area. [3] Moreover, improved access to educational, healthcare, and recreational facilities affiliated with megaprojects can elevate residents' life quality. On the other hand, the development of megaprojects that radically transform areas of the cities can also have a negative impact on the people living there. The renovation of such zones could increase house values and rental prices, forcing residents to live and find more affordable places. One example of this effect is the High Line in New York, a linear park constructed to renovate an area of the city that led to the increase of property values and forced lower income residents to leave.
- **Social integration and equity:** megaprojects possess the potential to rectify social inequalities and stimulate social integration. [29] Inclusive project planning and execution can offer opportunities to marginalized communities, advocate workforce diversity, and cultivate social cohesion. [30], [40] Nevertheless, it is critical to thoroughly contemplate potential adverse impacts, such as displacement and gentrification, to guarantee equitable distribution of project benefits.
- **Environmental sustainability:** megaprojects can exert both beneficial and detrimental environmental impacts. While certain projects embody sustainable design principles and eco-friendly technologies, others may lead to escalated carbon emissions, habitat obliteration, and resource exhaustion. Consequently, it is imperative to incorporate environmental considerations and implement suitable mitigation strategies to minimize deleterious effects. [40] In today's world, where people are becoming more and more concerned about

environment, megaproject are going toward the adoption of environmentally sustainable practices and scopes.

Type of Impact	Brief Description	Citation
Infrastructure Development	Enhances critical infrastructure like transportation, energy, and communication, attracting foreign investment.	Siemiatycki [38]
Innovation and Technological Advancement	Fuels technological progress and innovation, leading to advancements in multiple sectors.	Cernea [22], Gann et al. [39]
Urban Transformation and Livability	Contributes to city revitalization but can also cause property value increases, forcing out lower-income residents.	Moretti [32], Flyvbjerg [3]
Social Integration and Equity	Has potential to rectify social inequalities but may also lead to displacement and gentrification.	Ansar et al.[29] , International Labour Organization (ILO) [30], Flyvbjerg [40]
Environmental Sustainability	Can have both positive and negative environmental impacts; moving towards adopting more sustainable practices.	Flyvbjerg [40]

Table 1 - Summary of the other different types of impact caused by megaprojects

In summary, megaprojects play a huge role in job creation, economic growth, technological development, and social aspects. They generate employment opportunities directly and indirectly, provide long-term employment stability, contribute to skill development, and stimulate economic multiplier effects. Moreover, by attracting foreign investment and fostering trade, megaprojects can have a transformative impact on regional and national economies, leading to increased prosperity and development. Megaprojects can also spur technological innovation and

catalyze local and regional development. [36] It can be said that megaprojects impacts both economy and society in mayor ways and can be used as tools to shape countries and regions.

1.3. Megaprojects evolution in modern world

Today the world is changing at a faster pace than ever before, and this trend is continuously increasing its speed. Just in the last five years there have been many events that caused radical change in both the life of common people and in the industrial management of companies. The world passed from the usual life to being inside a pandemic where politics of lockdowns were adopted worldwide, and the world almost completely stopped for months. These lockdowns caused the interruption of the supply chain and led to shortages of raw materials such as steel or microchips in the following years [41], driving both prices and uncertainty about prices up, and this had huge impacts on everyday life and on the global supply chain, forcing people and companies to adapt with new solutions. To exacerbate this situation, once the world was reopening, China locked down Shanghai, including the naval traffic in its harbor, one of the largest in China, and this led to thousands of ships unable to load or unload material to transport it around the world. [42] This naval block caused another period of shortages and boosted the prices again. Moreover, another naval accident, the block of the Suez Canal due to the Evergrande ship that got stuck inside it, caused another huge problem for the naval traffic. Ships could not pass the Suez Canal for days [43] and they were forced to take alternative, longer and more expensive routes to deliver the material, making the shortages worse and the prices higher. On top of all this events, once the world really seemed to get back to a new normality, inflation hit record values in all developed countries, causing changes in monetary policies, bank failures and new difficulties for people and companies.

Given that just in the last five years all these events happened, and our world faced enormous changes, how can it be possible to forecast all aspects of a megaproject at the beginning, considering that its life span is at least five years? Obviously, it is not

possible anymore, and that is why the paradigm of how megaprojects are managed and evaluated must change. Firstly, it makes no sense anymore to establish a strict budget for the project before it starts. When prices can go up 10% every year, it is impossible for a budget established five years in advance to be accurate. This, together with the evolution of the financial systems and the increased uncertainties, is making project financing a critical aspect of megaproject management. The same is true for time constraints: with rapid changes in foreign policies and import/export policies by governments, together with supply chain uncertainties and increasing complexity, it is unrealistic to set a strict time constraint to a project that has millions of variables and complexities over a time span of several years. However, there are other aspects that have changed in the last decades and megaproject management should adapt to these too. One of the most important is the relevance that social gains, social value and people's opinion are gaining. As a matter of fact, in the last century, organizations profit, governments profit and countries development where the main drivers for megaproject development and social contribution has been greatly overlooked. Moreover, in previous practices, public opinions were often overlooked in the delivery framework of large infrastructure projects. [44], [45] Nowadays, public opinion and the value delivered to local communities are gaining more and more importance. For example, a manager involved in the construction of the Crossrail linking East and West London reported how the fact that the railway moved into construction right after the 2008 financial crisis increased the pressure to enlarge social gains, he said: "all of a sudden...we started to see that those things were very important... it wasn't a part of the core thinking in 2005 definitely". [20] The increasing centrality of local communities' needs also impacted the governance structure of megaprojects. As a matter of facts, public participation in the early decision-making process is increasing as it is seen as an important mechanism to foster justice, equity and collaboration and an effective tool to gather data and information from the public about their natural and social environment, as well as about the relations they have with their environment. [46] Moreover, public participation provides a better analysis of proposals, leading to more creative development, more sustainable intervention, and greater public satisfaction of the project. [47], [48]

Two salient facets dominating the contemporary discourse, particularly within the purview of megaproject management, pertain to environmental impact and workforce safety. In an epoch characterized by growing concerns over climate change and environmental degradation, the discourse on the environmental footprint of mega-infrastructure projects during construction and post-completion has come to the fore. Consequently, project managers are increasingly gravitating towards sustainable practices in the execution and management of these projects. Concurrently, workforce safety and the prevention of workplace accidents have emerged as pivotal concerns in megaproject management. Ensuring the safety of personnel across all project development phases is of great importance, given that incidents causing injury or loss of life can significantly tarnish the project's reputation and incur substantial socioeconomic costs. [49] As such, adopting rigorous safety protocols and instilling a culture of safety is not merely a regulatory obligation but also a strategic imperative for successful project execution. [50]

In conclusion, the rapidly changing global context is presenting both challenges and opportunities for megaprojects. By embracing innovative technologies, sustainable practices, and inclusive stakeholder engagement strategies, these projects are not just keeping pace with change, they are leading the way.

1.4. Megaproject governance

Megaprojects are complex venture that involve many actors in their development process [3], for this reason, their governance is a delicate and difficult process. As a matter of facts, in a megaproject, the organizational governance structure is responsible for the decisions that set the project performance targets for scope, cost, and end date, as well as that determine the focal organization's ability to stay within those targets. [20] Organizational governance relates to the rules and procedures that control resource accumulation, development, and allocation; the distribution of the organization's production; and the resolution of disputes. [51]

Governance in megaproject is not a fixed and defined entity, but it usually adapts to the project and to the context. Gil and Fu [20] highlighted how governance structure of megaprojects can get shaped in four different adaptations, which, together with the renegotiations of the value distribution, is responsible for cost hikes. The four adaptations are:

Shared Governance Core Formation: the megaproject's structure evolves from a single organizational actor with complete authority on governance matters into an alliance between legally independent actors under a shared form of governance. This adaptation is driven by the need for resource pooling to pursue the project's "grand idea". The members of the alliance must negotiate a unifying proposition for joint value creation and how this value is to be distributed. This shared decision leads to major increases in scope and to cost hikes.

Lead-role Governance Expansion: once a promoter, in a collective form, agrees to joint value creation, it becomes tempting to widen the participation on local governance matters to key stakeholder groups with which there is high task or outcome dependence or control local resources that are fundamental to value creation. As these nonmarket stakeholders agree to join local structures of decision-making, they gain rights to renegotiate the value distribution. Lead-role governance can be effective to encourage stakeholder cooperation but can also lead to collective action problems due to a tension between the individual self-interest and collective interest. [52]

Hub-and-Spoke Governance Expansion: the project governance adapts by adding many independent, bilateral agreements with stakeholders who were excluded from directly influencing project governance matters. The promoter does so to centralize governance decisions in the hands of its managers and enters into bilateral agreements with affected stakeholders to gain direct access to their valuable resources. But, in this way the stakeholders gain power and can them and to appropriate more value, thus the cost of contracting increases.

Supply Chain Expansion: the formation of a vast, capital-intensive supply chain governed by market transactions. Since in megaprojects there is high uncertainty, the buyer is forced to sign incomplete contracts that have to be completed during project execution. In this way, the supplier gain power since it may refuse to continue to

supply if its increases in demand are not met, especially if asset specificity is high. The opportunistic behavior of suppliers could lead to cost hikes. [20]

The four adaptations are represented in the figure below.

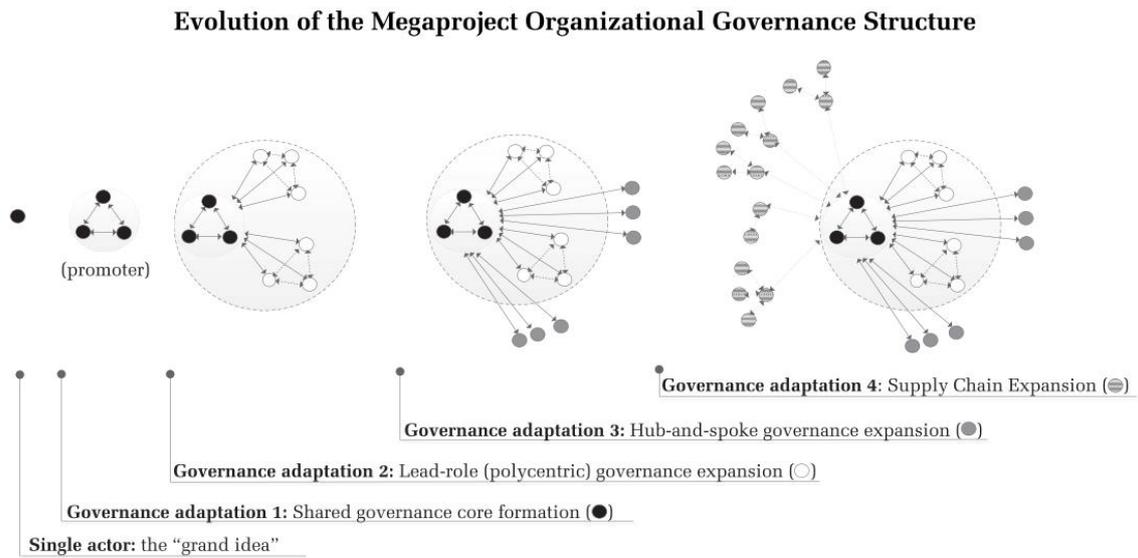


Figure 8 - Evolution of the megaproject organizational governance structure [20]

From the above discussion it is evident how megaproject governance is an incredibly complex process that includes many stakeholders, both market and non-market. The evolution of the governance structure to comply with the requests of all the actors that may have access to valuable resources or that have power or legitimacy to ask for additional interventions is what causes cost hikes, but also allows to generate a shared value for all the affected stakeholders.

2 Stakeholder management

2.1. History of stakeholder management

History of stakeholders can be traced back to 1963, when for the first time the word and the concept of “stakeholder” was used in an internal memorandum at the Stanford Research Institute.[53]. As defined by Freeman [54], Stakeholders are “those groups without whose support the organization would cease to exist.” Since then, the stakeholder concept has undergone significant development, resulting in a broad and complex field of study, diverging from the mere identification and categorization of stakeholders to a strategic management approach, called strategic management process [54]. It defined the stakeholder as “any group or individual who can affect or is affected by the achievement of the organization's objectives”, and it was divided in four main themes: (1) corporate planning, (2) systems theory, (3) corporate social responsibility and (4) organization theory. One aspect of stakeholder research that has received considerable attention is the “categorization of stakeholder theory”. According to Jones [55], stakeholder theory can be divided into three aspects: descriptive, instrumental, and normative. Descriptive stakeholder theory focuses on identifying stakeholders and understanding their relationships with the organization. Instrumental stakeholder theory emphasizes the role of stakeholders in achieving organizational goals, while normative stakeholder theory is concerned with ethical and moral issues related to stakeholder relationships. Another important aspect of stakeholder research is the concept of stakeholder salience and typology. Mitchell et al. [2] proposed a typology that includes primary stakeholders (those who have a direct relationship with the organization and whose interests are essential to its survival), secondary stakeholders (those who are affected by the organization but do

not have a direct relationship), and tertiary stakeholders (those who have an indirect or diffuse relationship with the organization).

In recent years the focus has shifted, researchers got deep into understanding how organizations respond to stakeholder demands and how they can influence organizational decision-making. Savage et al. [56] (and later Aaltonen & Sivonen[57]) proposed a stakeholder response strategy that involves four stages: passive, defensive, accommodative, and proactive. According to Freeman [58], Hendry [59] and Aaltonen et al. [60] categorization, stakeholders can be classified based on their significance and impact on the organization, where key stakeholders are those with a notable level of influence and importance.

Stakeholder engagement has emerged as another important theme in stakeholder research. Greenwood [61] defined stakeholder engagement as a process by which organizations build relationships with stakeholders for mutual benefit. Also, Strand and Freeman [62] argued that stakeholder engagement is essential for creating value for stakeholders and achieving long- term organizational success.

2.2. Stakeholder theory

As it emerges from Freeman [63], the discussion surrounding the nature of "stakeholder theory" has been extensive in recent years. Some scholars have contested its classification as a "theory" due to the absence of a connected group of verifiable propositions. Others have argued that the term's central definition is too equivocal to qualify as a theory. There are also those who have posited it as an alternate "theory of the firm", as opposed to the shareholder model. Freeman [63] perceives "stakeholder theory" as a "framework," a collection of concepts that can generate numerous theories.

The core of stakeholder theory is the idea that organizations have responsibilities to multiple stakeholders, not just to their shareholders. This means that organizations must balance the interests of all stakeholders and consider their different needs and preferences [64]. Unlike the traditional shareholder-oriented approaches, which solely focuses on maximizing the profits for shareholders, stakeholder theory recognizes that

organizations have a broader set of responsibilities to society and the environment. In order to effectively apply the theory, it's important to understand which are its key components.

To apply stakeholder theory effectively, it is important to understand its key components. These include the identification of stakeholders, stakeholder salience [2], stakeholder management [65],[63] and corporate social responsibility [66].

2.2.1. Stakeholder Identification

Stakeholder identification is an ongoing process that requires companies to be proactive and responsive to the changing needs and concerns of their stakeholders [67]. Identifying stakeholders requires a process of "mapping" out the various individuals and groups who are connected to a company or a project and who can be affected by its actions. The three core elements of stakeholder analysis, as outlined by PMI [68] and Mok et al. [69], are identification, categorization, and evaluation. This involves a thorough collection and review of data to guide the project's lifecycle [68]. Stakeholder traits are discovered through this process.

Mitchell et al. [2] introduced the stakeholder salience model, which organizes stakeholders based on their claims' power, legitimacy, and urgency. This model guides managers in allocating attention to stakeholders [2]. It's beneficial in assessing stakeholder influence in complex global projects [60], as stakeholders exert different levels of control over project stages [70]. However, it doesn't account for stakeholder attitudes or support levels.

Stakeholders can also be grouped based on their project salience and interest. Savage et al. [56] developed a model that categorizes stakeholders into groups to assess potential threats or cooperation. Another model by McElroy and Mills [71] categorizes stakeholders based on their project attitude, presenting five levels [71]. However, these methods don't consider stakeholder salience.

The stakeholder matrix, a tool for categorizing and characterizing stakeholders, remains relevant in contemporary research [60], [72], [73]. It was initially based on the

power/dynamism matrix [74], which divided each axis into two sections. Stakeholders are categorized into one of these four quadrants [74].

Johnson and Scholes [75] adapted this model, resulting in a power/interest matrix.

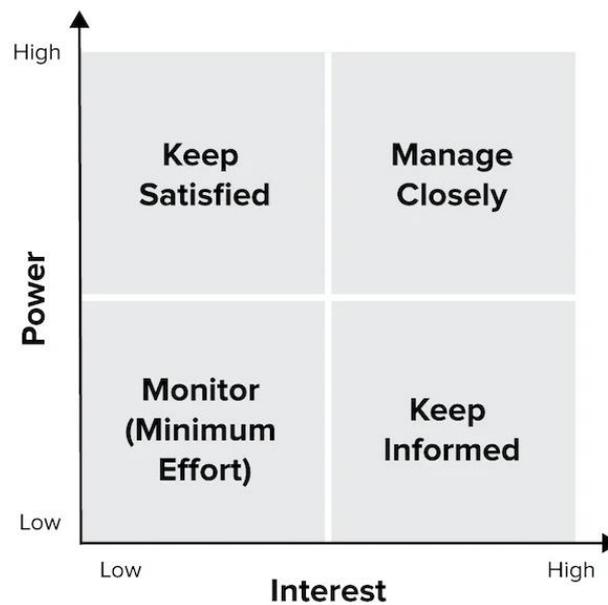


Figure 9 - Power interest matrix (Johnson and Scholes [75])

This matrix helps project managers understand how stakeholder communication and relationships influence the project [76]. Olander and Landin [76] further modified it by using a 0 to 10 scale to estimate relative power and stakeholder interest. Other matrices have been developed, such as the influence and interest matrix [77], and the power and urgency matrix [78]. However, these matrices do not indicate stakeholder attitudes.

To address these shortcomings, Aaltonen et al. [73] introduced a new matrix, the salience/position matrix. This model classifies stakeholders based on their salience and supportiveness. The application of this model enables a manager to grasp both the power and attitude of stakeholders, leading to a more comprehensive understanding of stakeholders and the creation of an effective Stakeholder Management strategy.

Stakeholder Model	Stakeholder Characteristics	Author(s)
Stakeholder Salience Model	Power, Legitimacy, Urgency	Mitchell et al. [2]
Stakeholder Classification Model	Supportive, Mixed-Blessing, Non-Supportive, Marginal	Savage et al.[56]
Stakeholder Attitude Model	Active Opposition, Passive Opposition, Noncommittal, Passive Support, Active Support	McElroy & Mills [71]
Power/Dynamism Matrix	High vs. Low Power, Dynamic vs. Static Dynamism	Mendelow [74]
Power/Interest matrix	Power, Interest	Johnson and Scholes [75]
Modified Power/Interest Matrix	Relative Power, Stakeholder Interest	Olander & Landin [76]
Influence and Interest Matrix	Influence, Interest	Ballejos & Montagna [77]
Power and Urgency Matrix	Power, Urgency	De Schepper et al. [78]
Salience/Position Matrix	Degree of Salience, Degree of Supportiveness	Aaltonen et al. [73]

Table 2 - Summary of stakeholders' models for identifying the different types of stakeholders

2.2.2. Stakeholder salience

Stakeholder Salience shows the degree to which the stakeholders are perceived as important to the organization. According to stakeholder theory, salience depends on three factors: power, legitimacy and urgency [2], [60].

2.2.2.1. Power

Power can be defined as ‘the ability of those who possess power to bring about the outcomes they desire’ [79]. In 1964, Etzioni proposed a classification of power into three types: coercive power, which relies on physical resources such as violence, force, and threats (e.g., the use of a weapon); utilitarian power, which is based on material or financial resources (e.g., ownership of property, shares, and cash); and normative/social power, which relies on symbolic resources (such as status, reputation, affection, and social approval). Further research from Leung and colleagues [80] identified five distinct types of power: reward power, coercive power, legitimate power, referent power, and expert power. Reward power is defined as the ability of stakeholders to incentivize desirable behavior (e.g., by offering recognition, guidance, and financial resources), implement successful change in a project (e.g., by providing resources and support), and offer approval, financial resources, and instructions. Legitimate power refers to the perception and capacity to legitimately induce others [81].

Leung et al. [80] reported that legitimate power refers to the perceived right and ability of individuals or groups to exert influence over others, such as those who hold positions of authority in organizations or institutions. For example, a CEO may have legitimate power over their subordinates due to their position in the company's hierarchy. Referent power, on the other hand, is based on a sense of identification and admiration for others, which can be associated with various sources such as celebrity figures, respected leaders, and popular icons [81]. Expert power, as described by Hinkin and Schriesheim [82], is derived from the possession of specialized knowledge, skills, and abilities acquired through advanced education, technical training, and professional experience, and can be seen in fields such as medicine, law, and engineering.

Type of Power	Description	Author(s)
Power (General Definition)	The ability of those who possess power to bring about the outcomes they desire.	Salancik & Pfeffer [79]
Coercive Power	Relies on physical resources such as violence, force, and threats.	Etzioni [83]; also referenced by Leung et al. [80]
Utilitarian Power	Based on material or financial resources such as ownership of property, shares, and cash.	Etzioni [83]
Normative/Social Power	Relies on symbolic resources such as status, reputation, affection, and social approval.	Etzioni [83]
Reward Power	Defined as the ability of stakeholders to incentivize desirable behavior by offering recognition, guidance, and financial resources, etc.	French & Raven [81]; also referenced by Leung et al. [80]
Legitimate Power	Refers to the perceived right and ability of individuals or groups to exert influence over others, such as those who hold positions of authority in organizations or institutions.	French & Raven [81]; also referenced by Leung et al. [80]
Referent Power	Based on a sense of identification and admiration for others, which can be associated with various sources such as celebrity figures, respected leaders, and popular icons.	French & Raven [81]; also referenced by Leung et al. [80]
Expert Power	Derived from the possession of specialized knowledge, skills, and abilities acquired through advanced education, technical training, and professional experience.	Hinkin and Schriesheim [82]; also referenced by Leung et al. [80]

Table 3 - Summary of different types and definitions of Power

2.2.2.2. Legitimacy

Stakeholder legitimacy is an important component of stakeholder theory, since it reflects the extent to which a stakeholder's claims or expectations are perceived as

valid or appropriate by the company or project, or, as defined by Suchman [84], "Legitimacy is a social construct that reflects stakeholders' assessment of the degree to which the organization's activities are desirable, proper, or appropriate within the context of their cultural and social norms, values, and beliefs". He also theorized that stakeholder legitimacy is based on three main factors: moral legitimacy, pragmatic legitimacy, and cognitive legitimacy.

- Moral legitimacy is based on whether the company or project is perceived as conforming to social norms and values, and whether it is seen as fulfilling its social responsibilities. This can include factors such as environmental sustainability, social justice, and ethical business practices. Companies that are perceived as acting in accordance with moral norms are more likely to be seen as legitimate by their stakeholders [85].
- Pragmatic legitimacy, on the other hand, is based on whether the company or project is seen as providing tangible benefits to its stakeholders, such as financial returns or job opportunities [84]. Companies that are seen as providing clear benefits to their stakeholders are more likely to be seen as legitimate, while companies that are seen as exploiting or neglecting their stakeholders are less likely to be seen as legitimate [86].
- Cognitive legitimacy is based on whether the company or project is perceived as having a valid and appropriate organizational identity or purpose. This can include factors such as the company's history, culture, and values. Companies that are seen as having a clear and consistent identity are more likely to be seen as legitimate by their stakeholders [84].

In addition to these three types of legitimacy, researchers have also identified other forms of legitimacy, such as environmental and social legitimacy. Environmental legitimacy refers to the perceived environmental impact of a company's activities and is becoming increasingly important as more stakeholders are becoming aware of the negative effects of business activities on the environment. Social legitimacy, on the other hand, refers to the perceived impact of a company's activities on society as a whole, including its contribution to social welfare and meeting the needs of various stakeholder groups.

Bansal and Clelland [87] argue that environmental legitimacy is becoming a critical aspect of corporate social responsibility, as companies are increasingly expected to minimize their negative impact on the environment and contribute to sustainability. Similarly, Deephouse and Carter [88] suggest that social legitimacy is becoming increasingly important, particularly in the context of emerging markets where companies are expected to play a significant role in addressing social issues such as poverty and inequality.

Type of Legitimacy	Definition	Citation
Cognitive Legitimacy	Perceived normative appropriateness of a company's actions	Suchman [84]
Pragmatic Legitimacy	Perceived usefulness or benefit of a company's actions	Suchman [84]
Moral Legitimacy	Perceived ethical or moral appropriateness of a company's actions	Suchman [84]
Environmental Legitimacy	Perceived impact of a company's activities on the environment	Bansal and Clelland [87]
Social Legitimacy	Perceived impact of a company's activities on society as a whole	Deephouse and Carter [88]

Table 4 - Summary of different types and definitions of Legitimacy

2.2.2.3. Urgency

The concept of urgency in stakeholder salience is a critical aspect that warrants thorough exploration. Urgency, as defined by Mitchell et al. [2], refers to the degree to which stakeholder claims call for immediate attention. It is characterized by time sensitivity and criticality of the stakeholder's relationship to the firm.

The urgency of stakeholder claims can significantly influence the strategic decisions of an organization. According to a study by Eesley and Lenox [89], firms are more likely to respond to stakeholder demands that are perceived as urgent. This urgency can be driven by various factors, including impending regulatory changes, imminent threats to the firm's reputation, or immediate financial implications. However, the perception of urgency is not solely determined by the objective characteristics of the stakeholder's claim. It is also influenced by the firm's interpretation of the claim and its strategic priorities. In this context, Bundy, Shropshire, and Buchholtz [90] argue that the firm's perception of urgency can be shaped by its cognitive frames, which are influenced by its past experiences, current context, and future expectations.

The urgency attribute in stakeholder salience is not static but dynamic. It can change over time due to shifts in the external environment or changes in the firm's strategic orientation. This dynamic nature of urgency underscores the need for firms to continuously monitor and reassess their stakeholder landscape. As noted by Parent and Deephouse [91], firms that fail to adapt to changes in stakeholder urgency may face significant strategic risks.

In conclusion, urgency in stakeholder salience plays a pivotal role in shaping the strategic decisions of firms. It underscores the need for firms to not only respond to immediate stakeholder demands but also anticipate future changes in stakeholder urgency. This requires a proactive and dynamic approach to stakeholder management, which is grounded in a deep understanding of the firm's stakeholder landscape and a willingness to adapt to changing stakeholder demands.

2.2.3. Managing Stakeholders

In the context of a megaproject, the importance of strategic stakeholder management following the identification and assessment of stakeholders' salience cannot be overstated. Turkulainen et al. [92] express that stakeholder management strategies encapsulate a range of actions primarily aimed at modifying stakeholder salience and

their relative positions within a project. This is a task typically assigned to the project management team.

These strategies are to be formulated with a deep understanding of the target stakeholders, underscoring the necessity of creating strategies that are nuanced, flexible, and individualized to the stakeholder [76]. During the initial phase of a project, a period generally marked by the continuing process of stakeholder identification and examination of their possible impacts, Savage et al. [56] identify four foundational strategies. These include engaging with supportive stakeholders, vigilance towards peripheral stakeholders, erecting defenses against antagonistic stakeholders, and cultivating collaboration with ambivalent stakeholders.

In order to address stakeholder pressures effectively and manage their expectations, the implementation of stakeholder response strategies becomes vital. These strategies, according to Aaltonen & Sivonen [57], are pivotal in defining the nature of stakeholder relationships and have a profound influence on project outcomes. They list five primary stakeholder response strategies as adaptation, compromise, avoidance, dismissal, and influence. The selection of an appropriate strategy hinges on several factors, including the stakeholder's position, power, and legitimacy within the project's framework. Taking a dynamic approach to stakeholder management bears significant implications in practice, especially concerning stakeholders who might initially appear antagonistic. Active dialogue and early engagement can potentially transform these stakeholders' stance from antagonism to neutrality [57]. The emphasis is placed on the pivotal role of effective stakeholder management techniques in reforming stakeholder perceptions and attitudes, thus ensuring smoother project progression. [93] However, the complexities of stakeholder management multiply in the context of public-private partnerships. These partnerships add an additional layer of complexity to the process of stakeholder management, requiring a deeper understanding of the overlapping interests, accountability measures, and potential conflicts in the stakeholder landscape [94]. Moreover, managing stakeholders in such a scenario might necessitate an increased emphasis on transparency and communication strategies, given the wider range of stakeholders involved and the need for public accountability [95]. Hence, in these situations, proactive stakeholder engagement becomes not only a strategic choice but a necessary mechanism for successful project execution [96].

Successful stakeholder management necessitates a thorough understanding of the stakeholder landscape, a clear strategy for managing differing stakeholder interests and saliences, and an adaptable approach to cater to the dynamic nature of stakeholder relationships and project environments [93]. Having thus laid the foundation of a well-strategized approach, we can smoothly transition to the equally important domain of stakeholder engagement, a process that deepens the rapport with stakeholders and further solidifies their commitment to the project's success. Stakeholder engagement plays a critical role in managing stakeholders in the context of complex projects. Stakeholder engagement plays a critical role in managing stakeholders in the context of complex projects. Numerous strategies exist for stakeholder engagement such as: encompassing listening, information provision, involvement, co-decisions, participation, consultation, collaboration and empowerment. These approaches have been implemented through various participatory techniques. Moreover, the extent of engagement within complex projects significantly influences the selection of participation techniques tailored to specific stakeholder groups.

In complex projects, researchers have devised numerous strategies to effectively engage stakeholders. Henriksen and Barlebo [97] proposed a 7-step approach that includes: defining the context, identifying factors, actions, and indicators, building pilot networks, collecting data, defining states, constructing conditional probability tables, and collecting feedback. Chung et al. [98] introduced a novel collaborative strategy aimed at fostering stakeholder engagement and enhancing the management of extensive stakeholder groups. Their approach involved harnessing the power of communication technology within a briefing framework, leading to notable improvements in both efficiency and effectiveness, this has shown to be particularly beneficial in handling the complexity associated with megaprojects. Luyet et al. [99] put forth a holistic framework outlining the successful integration of stakeholder participation within environmentally intricate projects. This framework encompassed various key steps, including the identification and characterization of stakeholders, determining the appropriate level of involvement, selecting suitable participatory techniques, implementing these techniques, and conducting evaluations. O'Toole et al. [100] introduced the concept of participatory logic tailored for coastal management projects involving complex ecological systems. This framework encompasses five key

concepts: institutionalization of stakeholder co-production and co-management processes, adaptability in making valuable decisions amidst changing conditions, inclusive involvement of all stakeholders, facilitation of local-level participation through flexible policies, and integration of diverse knowledge systems through capacity-building.

Stakeholder engagement serves as a platform for stakeholders to express their opinions, shape project plans, and remain updated on project decisions [24]. The ultimate aim of such engagement is to establish a transparent decision-making process that incorporates increased stakeholder input and fostering support for project decisions [101]. The engagement of stakeholders is crucial for the success of projects [24] and effective management of complex project networks [102]. The active involvement of both internal and external stakeholders during the early stages is particularly impactful. By engaging interested parties from the start, potential negative impacts arising from stakeholders can be minimized or even prevented. Emphasizing openness, dialogue, and active engagement, especially during project planning, mitigates the likelihood of conflicts arising in later project phases. [103] Notably, Henriksen and Barlebo [97] emphasized the importance of a stakeholder involvement plan and corresponding guidelines. Luyet et al. [99] thoroughly documented participatory techniques including various mediums such as newsletters, reports, presentations, public hearings, webpages, interviews, questionnaires, surveys, field visits, workshops, participatory mapping, focus groups, citizen juries, geospatial or decision support systems, cognitive maps, role-playing, multi-criteria analyses, scenario analyses, and consensus conferences. Furthermore, social media platforms have facilitated additional stakeholder engagement methods by using means like newsletters, project websites, hotlines, and community forums. Informal discussions and meetings have proven valuable in effectively communicating the potential project benefits.

Stakeholder engagement entails various aspects, including the extent of involvement in complex projects. This entails not only analyzing the stakeholders involved and how they are engaged but also assessing the level of their engagement within the project [104]. The degrees of involvement can vary, ranging from moderate levels such as treating stakeholders with respect, to intermediate levels such as incorporating

stakeholders' social impact in corporate governance, to demanding levels such as involving all stakeholders in decision-making processes [105]. Luyet et al. [99] identified and classified five levels of involvement: information, consultation, collaboration, co-decision, and empowerment. These levels provide a framework for comprehending the depth and scope of stakeholder engagement. Similarly, Cascetta et al. [101] proposed five levels of stakeholder engagement: identification, listening, providing information to the public, consultation, and participation. These levels aid in structuring and evaluating the engagement process with stakeholders. By considering these various levels of involvement, stakeholders can be appropriately engaged and empowered, fostering be more effective and their input be inclusive in decision-making processes.

In summary, the effective management of complex projects rely heavily on stakeholder engagement. It necessitates the implementation of diverse strategies such as empowerment, collaboration, co-decision, involvement, participation, identification, consultation, listening, and information provision. Researchers have proposed various frameworks and approaches to foster stakeholder engagement, and practical applications have utilized a broad array of participatory techniques. The selection of suitable strategies and the level of engagement are contingent upon the unique characteristics of the project and the stakeholders involved.

Stakeholders Engagement Strategy	Strategy Description	Author
Involvement	Engaging stakeholders in project activities and decision-making processes.	
Participation	Encouraging active involvement and contributions from stakeholders in project activities.	Cascetta et al. [101], Luyet et al. [99]
Collaboration	Promoting cooperation and joint efforts between stakeholders to achieve project goals.	

Co-decision	Involving stakeholders in the decision-making processes of the project.	
Empowerment	Granting stakeholders, the authority and resources to contribute meaningfully to the project.	
Listening	Actively seeking and considering the opinions and perspectives of stakeholders.	Cascetta et al. [101]
Information Provision	Providing stakeholders with relevant and accurate project-related information.	
Consultation	Seeking input and feedback from stakeholders to inform project decisions.	Cascetta et al. [101], Luyet et al. [99]
Identification	Identifying and recognizing relevant stakeholders in the project.	Cascetta et al. [101]

Table 5 - Summary of Stakeholders Engagement Strategies

2.2.4. Corporate Social Responsibility

The modern corporate world is marked by an unprecedented interest in Corporate Social Responsibility (CSR), a concept that incorporates various facets [54] such as corporate social performance [106], responsiveness [107], [108], citizenship ([109], governance [110], and accountability [111]. For businesses to be successful in the long run, they need to integrate the principles of CSR into their strategic decision-making processes.

At the heart of much empirical and theoretical CSR research is the examination of the relationship between Corporate Social Performance (CSP) and Corporate Financial Performance (CFP). Scholars have devoted considerable effort to exploring this connection [107], [112], [113]. However, according to a comprehensive analysis by Margolis and Walsh [114], the outcomes of these studies have been inconsistent, casting doubt on the asserted positive relationship between CSP and CFP. This inconsistency has sparked considerable debate on the role and scope of CSR within the business landscape. Traditional conceptions of CSR operate on a presumed dichotomy

between business and societal interests and, to an extent, a clear delineation between business and ethics [115]. These conceptualizations, however, have shown to be inadequate in addressing three fundamental problems that stakeholder theory attempts to resolve. The first of these is the issue of value creation, followed by the challenge of aligning capitalism with ethics and finally, the question of how corporations can effectively fulfil their obligations to stakeholders [110], [116].

Margolis and Walsh [117] raise an important point regarding CSR's silence on the topic of value creation, a problem that typically results in ethics being relegated to a secondary position or, conversely, being seen as a criterion that overrides profits. Their analysis suggests that the addition of social responsibility to the existing financial responsibilities of the firm could actually amplify the conflict between capitalism and ethics. This conflict, they argue, was laid bare in the recent financial crises, which exposed the limitations of traditional CSR frameworks. These authors present a compelling argument for a more nuanced analysis of the tensions between financial and normative/social demands placed upon the firm. They posit that stakeholder theory, with its focus on consequences—especially financial ones—risks overlooking non-salient stakeholders or those whose contributions or treatment is less apparent. Accordingly, they argue that normative reasons are necessary for firms to engage in socially responsible actions. Drawing upon their analysis, Margolis and Walsh [117] propose a paradigm shift in the approach to CSR. They suggest that instead of treating financial and social concerns as separate domains, these concerns should be seen as interconnected aspects of corporate operations. This proposal has significant implications for the way we understand and practice CSR, inviting a re-evaluation of the traditional dichotomy between instrumental and normative logic in CSR [118]. According to them, the role of CSR should be to enable corporations to balance a diverse range of objectives, duties, and concerns, as suggested by Richardson [119]. They call for a shift away from the 'one-size-fits-all' approach to a more nuanced, stakeholder-centric model. This new approach could signal the start of a new era in our understanding and application of CSR.

In order to implement CSR effectively, it is critical to strengthen regulatory frameworks, enhance transparency and accountability in CSR reporting, and promote active stakeholder engagement. Despite its inherent challenges, the development and

implementation of effective CSR strategies can provide long-term benefits for businesses, including improved financial performance, enhanced reputation, and increased stakeholder trust [120], [121]. While there are many directions that future research could take, the re-evaluation of the link between CSP and CFP in the light of this new CSR approach seems particularly promising. To reconcile the goals of value creation and societal welfare, businesses will need to find a balance between financial performance and the social and environmental impacts of their activities.

In summary, a shift in our understanding and approach to CSR is needed. By moving away from the traditional dichotomy of business versus societal interests, and instrumental versus normative logic, a more holistic and nuanced understanding of CSR can be achieved. This in turn could transform the way businesses operate, enabling them to fulfil their financial obligations while also contributing to societal wellbeing.

2.3. Primary and secondary stakeholders

Primary and secondary stakeholders are two distinct groups that have a vested interest in the outcomes of a project. Primary stakeholders are those who are directly involved in a project, such as project managers, employees, investors, and customers. They were defined by Freeman [54] as "those who can affect or are affected by the achievement of an organization's objectives". They have a direct economic relationship with the project and are typically the ones who control project resources. Secondary stakeholders, on the other hand, are those who are indirectly affected by the project or, as stated by Mitchell et al. [2], "those who affect or are affected by the organization, but not directly involved in transactions with it". These include local communities, advocacy groups, and other entities that do not have a formal contractual relationship with the project but are impacted by its outcomes.

In recent years, there has been a shift in the focus of megaprojects towards secondary stakeholders. This shift is driven by the recognition that these stakeholders, particularly local communities, can significantly influence the success of a project. The

NETLIPSE research [122], which studied large infrastructure projects in Europe, demonstrated the beneficial outcomes of involving stakeholders on an extended level in many megaprojects. These projects, such as the Øresund Crossing in Denmark and the West Coast Main Line in the UK, are clear examples of how organizations have seen local stakeholder involvement as valuable and considered them as an important issue in any project. The management of megaprojects needs to increase and enhance transparency, fairness, and participation by considering and balancing the project's stakeholders' economic, ecologic, and social interests [13], [123]. Project managers need to consider a long-term perspective for ethical and sustainable development which will take into account the global, regional, and local stakeholders. It is noted that scarce managerial attention has been given to the process of managing the social and political impact of megaprojects affecting the secondary stakeholders. However, the literature shows the ability of secondary stakeholders, especially the local community, in having a strong influence on the attitudes of the more powerful actors. In recent years project promoters have faced legitimate pressure to demonstrate greater ethical responsibility in their decision-making. While stakeholder theory recognizes the growing importance of communities as a new class of stakeholders, the issue of stakeholder identification and prioritization has never been fully resolved. [8]

In the stakeholder management literature, the concept of community has been left constantly unclear and undefined. A unique solution of solving this dilemma was given by Dunham et al. [124] whereby the authors raised 'the problem of community' as indicative of the definitional problems within stakeholder theory, enabling any number of entities to claim this role due to broad interpretation. Although many have explored the concept of 'community', defining its meaning is not an easy task. From the pioneering work of Hillery [125], over 90 conflicting definitions of the term 'community' emerged, and the only common characteristic among them was that they dealt with people. [126]

For Hillery [125] a community refers to a fluid group of people united by at least one common characteristic such as geography, shared interests, value, experiences, or traditions. Although Webber [127] was the first, from the perspective of a construction project, to set the stage for broadening the notion of community away from purely place-based definitions [128], community refers to a multitude of overlapping,

competing, and conflicting interests' groups, which shift over the project life cycle and whose interests are potentially affected by that project [129]. Similarly, Atkinson and Cope [130] state that the local community cannot be treated as a single homogeneous, easily identifiable group because, as mentioned by Skerratt and Steiner [131], they are characterized by a variety of different interests, needs, and expectations. Hence, it is not feasible to view the local community as a uniformly similar, readily distinguishable entity.

The importance of engaging with a broad spectrum of stakeholders, including secondary stakeholders, on project performance is a topic that has been increasingly explored in recent years. This is particularly true in the context of Public Infrastructure Construction (PIC) projects, where the social and political impact on secondary stakeholders necessitates a comprehensive analysis from both academics and practitioners. In light of the existing conceptual framework, it is proposed that by emphasizing benefits realization, the inclusion of a wider range of stakeholders in PIC projects can provide valuable insights to project managers, thereby facilitating more sustainable development of PICs at the local level and, consequently, enhancing the performance of these projects.[69],[132] Scope creep and benefits shortfall are among the key challenges of PIC, which can be considered even more significant than time and budget performance. For instance, understanding and minimizing the impact of megaprojects on people and places can aid in managing project benefits. This can be achieved by rethinking a tailored approach that integrates the perspectives of both primary and secondary stakeholders, which in turn, will assist project managers in improving accountability and transparency in their decision-making process for better benefits realization.

In conclusion, managing secondary stakeholders in megaprojects is a complex process that requires a nuanced understanding of the various interests, needs, and expectations of these stakeholders. When project managers integrate the perspectives of secondary stakeholders into their decision-making procedures, it can significantly boost the sustainability and overall success of their projects. This shift in focus towards secondary stakeholders represents a significant evolution in the field of project management, and further research is needed to fully understand and optimize this process [8], [123].

2.4. Management of stakeholders and Management for stakeholders

Project managers must strive for greater adaptability by striking a balance between the input of stakeholders and the acknowledgement of their significance in stakeholder management. These two strategies, encapsulated in Table 6, are referred to as "stakeholder management" and "management for stakeholders". A more comprehensive understanding of these management strategies, as proposed by Huemann et al. [133], is necessary to progress beyond outdated theories.

In the "management of stakeholders" approach, stakeholders are viewed as elements that both affect and are affected by the project. Each participant perceives the final outcome individually, and their decision to support future projects will be influenced by this perception. However, this approach has a significant drawback: as stakeholders are utilized to achieve goals, the ultimate aim becomes the generation of value for the organization. This can result in the neglect of stakeholders who are seen as less important in the value creation process during decision-making. On the other hand, the "management for stakeholders" approach is more comprehensive, suggesting that all stakeholders should be managed carefully, regardless of their actual influence. In contrast to the previous approach, transparency and integrity become essential elements here, aiming to achieve a trade-off that is acceptable to all stakeholders. However, this approach may not allow sufficient focus on stakeholders who provide greater value and contribution to the project, and it may increase the workload due to the need to consider every perspective and need. Moreover, while this approach has the potential to engage and satisfy stakeholders in a cooperative context, it could ultimately produce the opposite effect. Stakeholders might feel that their opinions are being considered, which could lead to an uncontrollable escalation in their expectations, potentially resulting in their ultimate dissatisfaction based on unrealistic assumptions. [134]

	Advantages	Disadvantages
Management of stakeholders	OF Fully concentrated on the end results, enhancing the organization's value substantially, and substantially streamlined.	Overlooking stakeholders considered to be of less importance, diminishing honesty and clarity.
	FOR Comprehensive method, enhanced openness and honesty, and a common goal	Increased task load, slower pace, decreased concentration, and the possibility of losing credibility and decreasing contentment

Table 6 - Management of stakeholders and Management for stakeholders

In the prevailing landscape of stakeholder management, stakeholders are often perceived as suppliers of resources, with most practices gravitating towards the "management of stakeholders" model. However, there's a growing call among scholars for a shift towards a more transparent and sustainable approach that enhances stakeholder engagement and ethical considerations, thereby striking a more balanced chord between the two models [8].

This shift is particularly crucial in the realm of public infrastructure and construction projects, which invariably exert a substantial impact on people and their communities [135]. It is, therefore, imperative to adopt a bespoke approach for each community, with the aim of better identifying and managing benefits, and fostering "community-inclusive" megaprojects [8], [136]. Given the finite nature of resources, it's impractical to consider the stance of every potential stakeholder. However, adopting a broader perspective that encompasses secondary actors is essential. Traditional methodologies have often acted as barriers to the inclusion and engagement of stakeholders, thereby diminishing their propensity to support public megaprojects as a collective community. Consequently, there's a pressing need to prioritize a more nuanced understanding of stakeholder management at the grassroots level in public infrastructure and construction megaprojects [8]. Di Maddaloni and Davis [8] have shown through a content analysis that stakeholder management research related to megaprojects has only recently begun to consider secondary stakeholders.

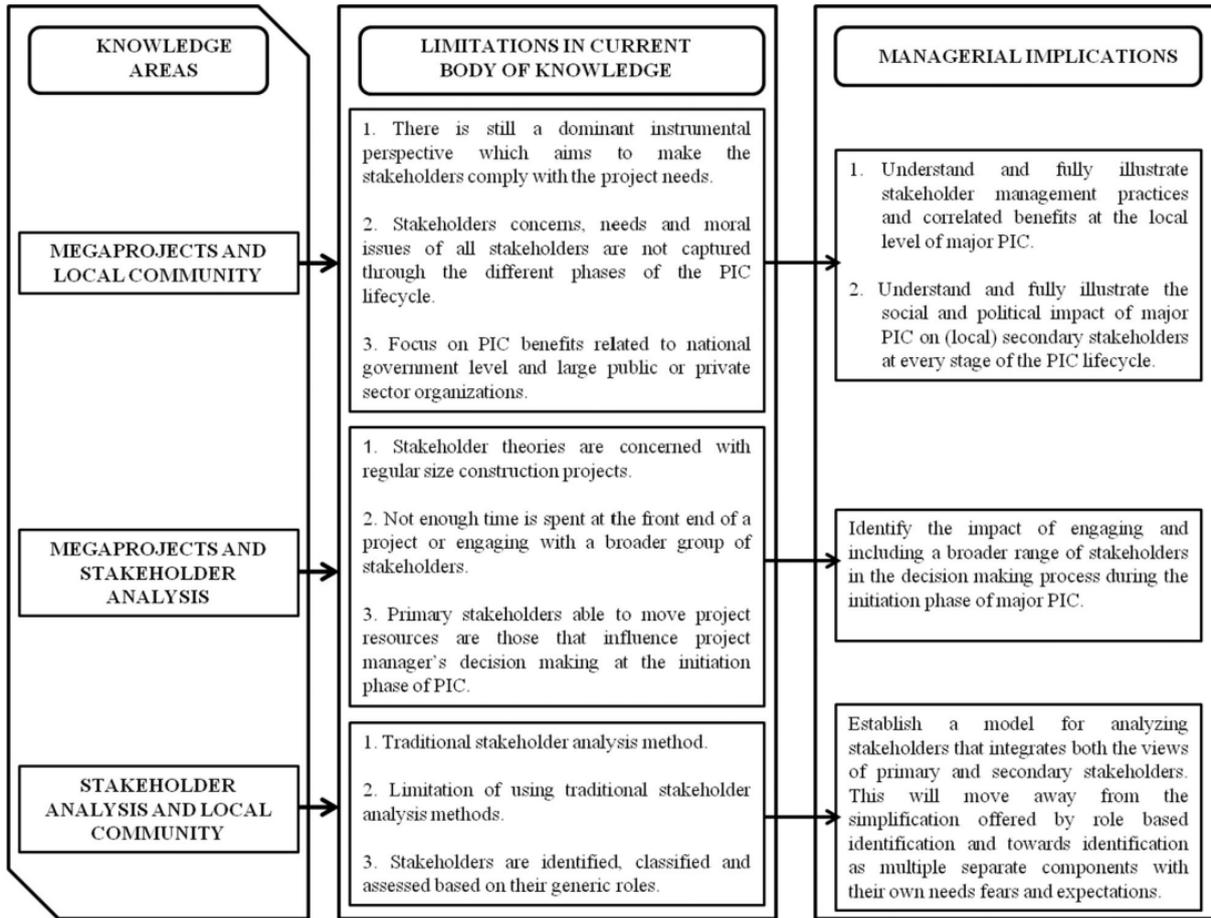


Figure 10 - The gaps in the current body of knowledge related to stakeholder management and its managerial implications.

In the realm of project management, there is a noticeable gap in the literature when it comes to comprehensive frameworks that clearly define the roles, relationships, and positions of both internal and external stakeholders within the context of an organization's governance structure. A summary of various governance theories and their respective attitudes towards stakeholders can be found in Table 7. Among these theories, Agency Theory, Transaction Cost Economics (TCE), and Stewardship Theory have been more frequently employed by researchers in the field of project governance, indicating the dominance of these theories in the literature.

These theories can be broadly categorized into two groups based on their approach towards stakeholders. The first group, comprising Agency Theory, Stewardship Theory, and Resource Dependence Theory, primarily focuses on the management of

transactions among internal stakeholders. The second group, which includes Transaction Cost Economics, Stakeholder Theory, and again, Resource Dependence Theory, extends its focus to include relationships among both internal and external stakeholders. Despite the prevalence of these theories in project governance literature, it is evident that their potential has not been fully realized. More specifically, there is ample room for further exploration in the application of these theories in stakeholder management across different organizational levels and in a variety of project contexts [4].

Theory	General Focus in the Theory	Main application of theory in project management	Theory's position towards stakeholders
Agency theory	Examining the interaction between agents and principals in self-driven organizations, contrasting risk appetites, and degrees of authority	Elucidating the connection between the project's proprietor and its manager, scrutinizing the manager's conduct based on a framework of trust, control, and penalty	Focusing on the dynamic between two key internal stakeholders, and the impact of this interaction on project outcomes, with a particular focus on trust
Transaction cost economics	Generating strategies to reduce financial burdens for organizations during procurement of goods and services	Making determinations regarding the choice of contractors and suppliers	Outlining the duties and obligations of project-related and external stakeholders, with particular attention to financial implications (contractors and suppliers)
Stewardship theory	Arguing that managers are more effectively driven by organizational goals rather than personal ones, and that the organization's long-	Intended for project and program managers, acting in the best interest of their principals (project sponsors)	Centering on the interaction between two internal stakeholders, highlighting the organization's long-term

	term success could elevate their status		success, trust cultivation, and mutual value generation
Resource dependence theory	Determining how to distribute organizational resources to attain corporate goals	Supplying instruments for decision-makers to prioritize resource allocation across distinct projects	Serves as a mechanism to actualize the organization's stakeholder preferences
Stakeholder theory	Underlining that besides shareholders, any party affecting or affected by the organization should be considered	Identifying the stakeholders whose interests should be incorporated in project stakeholder management	Illuminating the importance of external stakeholders and their significant role within organizational context

Table 7 - Summary of dominant governance theories, their application in project management and their position towards stakeholders (adapted from Derakhshan R., Turner R., Mancini M. [4])

Researchers are advocating for a more holistic methodology to incorporate individuals affected in their daily routines who have traditionally been somewhat neglected. The local community has often been considered as a homogeneous group, neglecting the diverse nature of their expectations and concerns. The most immediate and broadly accepted characterization of community refers to a social group that shares geographical proximity and additional internal connections [125]. However, this understanding merely acts as an initial step for a deeper conversation due to its lack of depth. Choudhury [15] comments that "one highly regarded research in this domain discovered that there exist more than ninety disparate interpretations of 'community,' with the single shared aspect being their focus on people", citing an influential study by Hillery [125]. Although this text won't delve further into the community concept, it is crucial to note that the idea cannot be accurately delineated. Some academics prefer to regard it as a framework encompassing shared interests, commitments, and values that require attention and evaluation [8], fostering a sense of belonging and a supportive structure. [15], [137] It is essential to recognize that communities frequently become stakeholders against their will, finding themselves unable to effectively negotiate their relationship with the other party. Also, it's worth noting that there are

situations where opposition from the community, for various reasons, can result in project abandonment, regardless of whether they are public or private initiatives. [15], [16]

The work of Di Maddaloni and Davis [8] reveals an insufficient comprehension of the participation of secondary actors in public infrastructure and construction ventures, which threatens the attainment of anticipated end benefits. Merely requesting stakeholder feedback is frequently insufficient. A deficiency of expertise among public decision-makers may create skepticism, making citizens feel marginalized. This is particularly true during public inquiries, which occur late in the process but before the final verdict. This implies that opportunities for changes are minimal, and the main objective is to persuade stakeholders of the project's merit, rather than soliciting public input to enhance the project. Moreover, the information accessible to the public is often challenging to comprehend due to technical jargon or other barriers that impede informed discussion. In such situations, resistance to the project can quickly escalate into violent opposition, undermining productive collaboration. [138] Hence, the project manager's communication approach is pivotal, as the language and presentation profoundly influence public perceptions [67]. For instance, the expansion of Heathrow airport triggered grievances among the local inhabitants affected by the project. Despite attempts by the project promoter to alleviate the impact of the project, residents felt aggrieved as the business could expand at the cost of their well-being. A careful scrutiny of spoken accounts of engagements between the senior project management team and local community representatives demonstrated that "denials" and "silence" were barely an option for the team in response to resident grievances. On the contrary, recognizing the concerns central to the grievances was almost an essential prerequisite during discussions with local residents, making them feel that the team was genuinely dedicated to minimizing the project's effect on their lives. This approach was consciously adopted by the managers even when they felt the grievance was of low legitimacy, appearing biased, incorrect, or opportunistic. [139]

3 Iron Triangle

3.1. What is the Iron Triangle

The Iron Triangle, a cornerstone concept in project management, encapsulates the intricate balance between three key elements: scope, cost, and time. This model is often employed as a benchmark for assessing project governance success. A project is typically deemed successful, from a governance point of view, if it adheres to the initially defined scope, is completed within the allocated budget, and is delivered within the stipulated timeframe.

This model, also known as the Triple Constraint, represents the relationship between three primary performance criteria: time, cost, and quality. These have been the mainstay of project evaluation since the 1970s, serving as the primary reference points [140]. However, this model has not been without its critics. Some argue that the estimated cost and time are often unreliable, leading to project failures. These estimates are heavily influenced by the specific period in which they are calculated, a time when future project developments are largely unknown, making them more of a conjecture than a precise calculation [141].

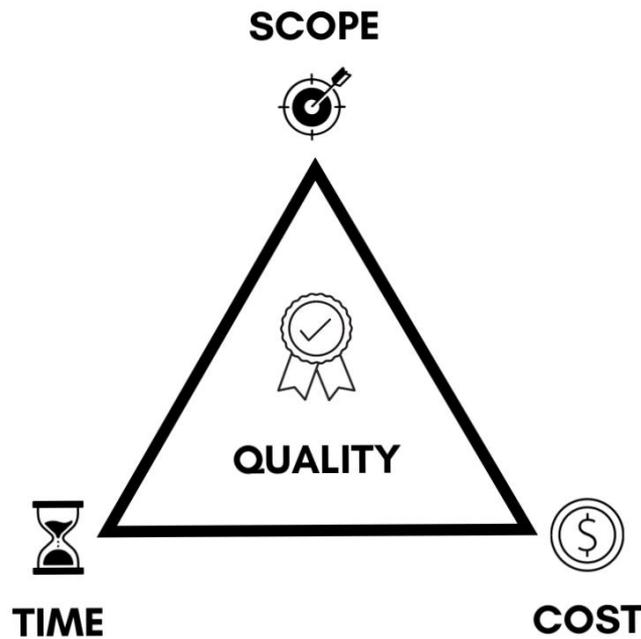


Figure 11 - The Iron Triangle in Project Management

Atkinson [141] provided a comprehensive overview of the 20th-century discourse on quality, cost, and time in project management. He noted that while many scholars agreed that cost, time, and quality should be used as success criteria, they should not be the only factors considered. In the context of megaprojects, defining lead time is not as simple as it might seem due to the long-term effects and externalities that these projects often generate during their development and after their completion [142]. The Iron Triangle's popularity can be attributed to its simplicity. It provides a clear and straightforward framework for declaring a project governance successful if it meets the defined criteria. The model effectively underscores the constant presence of trade-offs in the process, and that any alteration in one variable impacts the other interrelated criteria [143]. However, this simplicity also has its drawbacks. It often leads to many choices being viewed as "either/or" decisions, thus excluding negotiations among the constraints [143]. Furthermore, the inclusion of quality in the triangle has been criticized due to its subjective nature and complex definition [144]. Over time, scope has emerged as a preferred alternative as the third vertex of the triangle. Quality, due to its variability and subjectivity, is increasingly seen as a result of changes in the other three dimensions, rather than a dimension itself. This has led to a shift in the traditional representation of the Iron Triangle, with quality now positioned at its center [143],

[145], [146]. This evolution of the model reflects the ongoing efforts to adapt project management methodologies to the complexities and realities of real-world projects.

3.2. Limits of the Iron Triangle

However, the Iron Triangle model has its limitations, particularly when applied to large-scale projects. Megaprojects, due to their sheer scale and complexity, often face numerous challenges that can lead to cost overruns and delays. These challenges can range from technical difficulties and unforeseen environmental factors to stakeholder disputes and changes in regulatory frameworks [3]. Despite these challenges, the Iron Triangle model continues to be used as a measure of success for the governance of these projects. However, the use of the Iron Triangle model in the context of megaprojects has been criticized for its focus on control over flexibility and novelty. This focus often puts project managers in a difficult position. On one hand, they are pressured to commit to performance targets early on to reduce ambiguity in the project's value proposition. On the other hand, any deviations from these targets can lead to perceptions of underperformance, undermining the project's legitimacy [147]. However, the Iron Triangle model has its limitations, particularly when applied to large-scale projects. Megaprojects, due to their sheer scale and complexity, often face numerous challenges that can lead to cost overruns and delays. These challenges can range from technical difficulties and unforeseen environmental factors to stakeholder disputes and changes in regulatory frameworks [3]. Despite these challenges, the Iron Triangle model continues to be used as a measure of success for the governance of these projects. However, the use of the Iron Triangle model in the context of megaprojects has been criticized for its focus on control over flexibility and novelty. This focus often puts project managers in a difficult position. On one hand, they are pressured to commit to performance targets early on to reduce ambiguity in the project's value proposition. On the other hand, any deviations from these targets can lead to perceptions of underperformance, undermining the project's legitimacy [147]. In addition to these challenges, the budgeting process for megaprojects often involves a split between the actual cost forecast and a contingency fund. This contingency fund

serves as a buffer of resources that can be used to cover unexpected costs. However, until this fund is depleted, cost overruns can be hidden, leading to a perception that the project is still on budget [20]

The discourse surrounding the persistent issue of cost escalation in megaprojects has predominantly occurred within the realm of project management literature. Consequently, it has been deeply anchored in the project's 'golden triangle,' where the success of a capital project is measured against its initial goals for budget, timeline, and scope. Even in the face of constant critiques for prioritizing control over adaptability and innovation, this professional standard remains deeply rooted. [147], [148].

In the realm of megaprojects, cost escalation has been attributed to a variety of factors. Some scholars have pointed to managerial incompetence, failures to control for optimism bias, escalation of commitment, and inadequate buyer-supplier contractual arrangements [25], [149]–[152]. Others have controversially suggested that cost escalation may be due to the dishonesty of the project's top management team, who deliberately underestimate expected costs to increase the chances of the project plans being sanctioned. [25], [153]. However, a different group of studies has suggested that cost escalation is rooted in the shared decision-making authority between the project's managers and key nonmarket stakeholders [154], [155]. When decision rights are shared, the project's managers become accountable to stakeholders, and their leadership is only secure if they facilitate a collective agreement on a value distribution that all perceive to be fair. This leads to protracted consensus-oriented talks on scope, which put pressure on the project managers to relax the cost target [20]. Given these conditions, three distinct lines of inquiry have been identified in the literature on megaprojects, viewed from an organizational governance perspective.

1. The first strand assumes that the promoter is the ultimate decision-maker on governance matters, following a "hub-and-spoke model" [156]. This perspective attributes cost overruns to the promoter's lack of managerial capabilities [149] and unfettered optimism [25].
2. A second research strand, while also assuming that the promoter's managerial authority is the primary mechanism for obtaining cooperation from project

participants, focuses on escalations in project supplier costs [152], [157]. The research points out that cost overruns from suppliers can be attributed to a promoter's inclination towards an arms-length strategy, orchestrating supplier interactions based on disparities in power, irrespective of the inherent uncertainties that characterizes buyer-supplier relations [158], [159].

3. The third research strand challenges the assumption that megaproject promoters have complete managerial authority. Instead, it suggests that the promoter is held "hostage" to interrelationships and obligations to stakeholders who are not suppliers [7]. This perspective resonates with the idea that planning a megaproject is a "wicked" problem, determined by a plurality of objectives held by a plurality of politics [160]. This line of research adopts a more benevolent stance, presuming that the promoter plays a "lead role" [156] in local endeavors for achieving mutually agreed solutions. It suggests that the promoter's role is to facilitate the achievement of a collective agreement on the project's value distribution, which all stakeholders perceive as fair. The process frequently necessitates prolonged dialogues oriented towards consensus about the project's scope, potentially pressuring project managers to loosen their grip on the cost objectives [20]

Factors contributing to cost escalation in megaprojects are multifaceted and complex. They range from technical and environmental challenges to stakeholder disputes and changes in regulatory frameworks. The governance of these projects also plays a crucial role, with the project's managers often being held accountable to a variety of stakeholders. This complex interplay of factors makes the management of megaprojects a challenging task, and further research is needed to develop more effective strategies for managing these projects and mitigating cost escalation.

3.3. Megaprojects' statistics under the Iron Triangle

The performance of megaprojects, when assessed using the Iron Triangle measure, consistently reveals a pattern of cost and time overruns. A multitude of studies,

including those by [3]) and [19], have demonstrated that a significant majority of these projects, around 90%, exceed their initial budget. This is particularly pronounced in rail projects, which overshoot their budget by an average of 44.7%, and their demand is often overestimated by 51.4%. This trend extends to other infrastructure projects as well, with bridges and tunnels incurring an average cost overrun of 35%, and roads at 20%.

Project	Cost Overrun (%)
Suez Canal, Egypt	1,900
Scottish Parliament Building, Scotland	1,600
Sydney Opera House, Australia	1,400
Montreal Summer Olympics, Canada	1,300
Concorde Supersonic Aeroplane, UK, France	1,100
Troy and Greenfield Railroad, USA	900
Excalibur Smart Projectile, USA, Sweden	650
Canadian Firearms Registry, Canada	590
Lake Placid Winter Olympics, USA	560
Medicare transaction system, USA	560
Bank of Norway headquarters, Norway	440
Furka Base Tunnel, Switzerland	300
Verrazano Narrow Bridge, USA	280
Boston's Big Dig Artery/Tunnel project, USA	220
Denver International Airport, USA	200
Panama Canal, Panama	200
Minneapolis Hiawatha light rail line, USA	190
Humber Bridge, UK	180
Dublin Port Tunnel, Ireland	160
Montreal Metro Laval extension, Canada	160
Copenhagen Metro, Denmark	150
Boston–New York–Washington Railway, USA	130
Great Belt Rail Tunnel, Denmark	120
London Limehouse Road Tunnel, UK	110
Brooklyn Bridge, USA	100
Shinkansen Joetsu high-speed rail line, Japan	100
Channel Tunnel, UK, France	80
Karlsruhe–Bretten light rail, Germany	80
London Jubilee Line extension, UK	80
Bangkok Metro, Thailand	70
Mexico City Metroline, Mexico	60
High-speed Rail Line South, The Netherlands	60
Great Belt East Bridge, Denmark	50

Figure 12 - Cost overrun in the history of megaprojects [3]

Time overruns are another persistent issue. For instance, the metro system in Salvador, Brazil, took more than a dozen years for the first passengers to ride it, despite construction commencing in 2000. Similarly, the initiation of the \$3.9 billion project to rebuild the 59-year-old Tappan Zee Bridge in New York took a decade [19].

Despite the surge in investment and construction of megaprojects, the performance of project management and delivery often falls short of expectations. This is evident in the findings of Flyvbjerg [12], who refers to this as the 'megaprojects paradox'. This issue is not confined to a particular region; it is a universally international phenomenon, more pronounced in developing countries than in developed ones. For instance, an analysis of China's 95 railroad and railway projects between 1984 and 2008 showed an average cost overrun rate of 30.6%, and a delay rate of 25% [29].

These findings collectively highlight the limitations of the Iron Triangle as a performance measurement method for megaprojects. It underscores the need for more comprehensive and nuanced evaluation frameworks that can better account for the complex dynamics of these projects. For instance, Brookes and Locatelli [161] found that large-scale power plant megaprojects often face time delays and cost escalation during the construction phase, which can undermine their overall economic viability. They found that modular technologies, project governance, and external stakeholder involvement were critical factors affecting schedule and cost performance. Furthermore, Ansar et al. [162] analysis of 245 large dams built between 1934 and 2007 found that actual costs were on average 96% higher than estimated costs, and the actual implementation schedule was on average 44% higher than the estimate. Similarly, a study on the Olympics, a type of megaproject, revealed that these events have the highest average cost overrun of any type of megaproject, at 172% in real terms [132]. These findings underscore the pervasive issue of cost and time overruns in megaprojects across various sectors and regions, highlighting the need for further research and innovative solutions to improve project management and delivery.

3.4. Why projects go bad

Megaprojects, by their very nature, are fraught with challenges and risks that often lead to less than satisfactory outcomes. Common issues such as budget overruns, missed deadlines, and inadequate organizational capabilities are frequently encountered throughout the lifecycle of these large-scale projects. The genesis of these failures can be traced back to the inherent complexities and uncertainties associated with megaprojects. The task of harmonizing the unpredictable elements of long-term planning, non-standard technologies, and the intricate web of stakeholder interests presents a formidable challenge.[163] From inception to operation, megaprojects are invariably accompanied by the twin specters of uncertainty and complexity, rendering them susceptible to failure at any stage. Flyvbjerg's research [164] provides a comprehensive analysis of the primary failures that occur in the policy and planning stages of large infrastructure projects. Large-scale projects typically exhibit certain characteristics:

1. They are inherently risky due to long-term planning horizons and intricate interfaces.
2. The technology involved is often non-standard.
3. Decision-making and planning processes frequently involve multiple stakeholders with divergent interests.
4. The project's scope or ambition level tends to change significantly over time.
5. Statistical data indicates that unplanned events are often overlooked, leading to substantial budget deficits.
6. Misinformation about costs, benefits, and risks is a common occurrence.
7. The result is usually cost overruns and/or revenue losses for most projects.

These cost overruns and benefit shortfalls are indicative of failure and can lead to a host of problems, including inefficient resource allocation, further delays, and additional cost overruns and benefit shortfalls. They can also undermine the project's

policy, planning, implementation, and operation. The large scale of these projects means that any problems that arise are magnified. [163]

The implications of these findings are clear: lawmakers, investors, and the public cannot rely on the cost, benefit, and risk information provided by large infrastructure project sponsors and planners. This necessitates a reevaluation and adaptation of megaproject planning and policy.

Understanding the causes of cost overruns and benefit shortfalls, which originate in the planning phase, is crucial. Flyvbjerg identifies three primary causes of failure that lead to inaccurate cost-benefit forecasts: technical, psychological, and policy explanations [164]. Technical explanations attribute cost overruns and benefit shortfalls to imperfect forecasting techniques, inherent difficulties in predicting the future, honest mistakes, lack of data and inexperienced forecasters. Improving predictive models, data quality, and forecaster experience can help mitigate these technical errors. Psychological explanations, as proposed by Lovallo and Kahneman [165], attribute cost overruns and benefit shortfalls to planning fallacy and optimism bias. Planners and project sponsors often make decisions based on overly optimistic assumptions rather than a balanced assessment of gains, losses, and probabilities. They tend to overestimate benefits and underestimate costs, leading to unrealistic success scenarios and the pursuit of initiatives that are unlikely to deliver the expected returns on budget or on time. Cognitive biases, or incorrect information processing by the brain, are thought to be pervasive, but their effects can be mitigated with reality checks [164]. Policy explanations suggest that planners and project sponsors deliberately overestimate benefits and underestimate costs to increase the chances of their project being approved and funded. This strategic misrepresentation can lead to the pursuit of projects that are less likely to deliver on-budget, on-time, or deliver on promised benefits. Such inaccuracies can be attributed to political and organizational pressures, such as competition for scarce resources or positions [166]. These causes of failure, including overestimations and optimism biases, are common throughout all stages of a megaproject's lifecycle. Therefore, it is crucial to understand the overall scenario and the various types of failures and their causes that affect most megaprojects.

A comprehensive analysis of numerous articles and papers suggests a classification of potential failures and causes of poor megaproject performance into themes. A literature review by Juliano Denicol, Andrew Davies, and Ilias Krystallis [167], which analyzed over 6000 titles and 86 full papers, proposed six themes in their paper "What Are the Causes and Cures of Poor Megaproject Performance? A Systematic Literature Review and Research Agenda":

1. Decision-making behavior
2. Strategy, governance, and procurement
3. Risk and uncertainty
4. Leadership and capable teams
5. Stakeholder engagement and management
6. Supply chain integration and coordination

These themes encompass all the causes of poor management performance. It is important to note that these themes often intersect, and one can be the cause of another.

Megaprojects, with their vast scale and complexity, are subject to a multitude of potential failures. These failures are often rooted in various aspects of project management, decision-making behavior, and the inherent uncertainties that accompany such large-scale endeavors. The following sections delve into these themes, exploring the concepts and causes of poor performance in each area.

1. Decision-Making Behavior: This theme focuses on the psychological and behavioral aspects that influence decision-making and contribute to poor project performance. The three primary concepts associated with failures in this area include:

- **Optimism Bias (Delusion):** This concept refers to the tendency of project executives to overestimate benefits and underestimate costs due to excessive optimism. This bias can result in unrealistic project plans and expectations.

- **Strategic Misrepresentation (Deception):** This concept involves leaders intentionally distorting facts to serve their self-interest. This deceptive behavior can lead to misinformation, misguided decisions, and ultimately, project failures.
- **Escalating Commitment:** This concept occurs when leaders continue to follow patterns of behavior that lead to unsuccessful outcomes, rather than pursuing alternative courses of action. This can result in the continuous investment in failing projects, leading to significant losses.

The first theme, closely tied to Flyvbjerg's classification, highlights issues in decision-making during both planning and execution phases of projects. Underperformance often stems from optimism bias, where biased expert advice and judgments lead to overly optimistic scenarios, underestimating costs and overlooking risks. This is known as the planning fallacy. Strategic misrepresentation, another root cause, involves decision-makers manipulating situations due to various pressures, leading to underestimated costs and ignored risks. Lastly, escalating commitment arises from the belief that large projects, once started, cannot fail or be halted. This belief often leads to further resource allocation, even when evaluations suggest a different course of action due to diminishing returns on investment.

2. Strategy, Governance, and Procurement: This theme encompasses the processes in the initiation and planning stages of large projects. The three main areas of poor performance include:

- **Roles and Responsibilities:** Poorly defined roles and responsibilities throughout the project lifecycle can lead to confusion and miscommunication.
- **Governance:** Inadequate attention to the design of governance structures can result in ineffective decision-making processes and poor project outcomes.
- **Implementation Model Strategy:** A poor understanding of the balance between internal capabilities and those outsourced to the market can lead to inefficiencies.

Poor performance in the roles of sponsors, clients, owners, and operators in projects is primarily due to unclear role definitions and responsibilities throughout the project

lifecycle. This lack of clarity, coupled with an absence of long-term vision, often leads to risk-shifting to the supply chain. In terms of governance, performance issues arise from inadequate focus on the design and evolution of governance structures, including the balance between formal and informal structures. Lastly, issues with the delivery model strategy stem from a lack of understanding of the balance between internal capabilities and those outsourced or allocated to partners, leading to adversarial rather than collaborative relationships with supply chains.

3. Risk and Uncertainty: This theme addresses the risks associated with the use of new and untested technologies and the strategic decisions made during the project lifecycle. The three main concepts include:

- **Technological Novelty:** The implementation of new technologies in large projects is associated with risks that must be properly managed.
- **Flexibility:** A lack of flexibility can limit a project's ability to adapt to changing and uncertain environment.
- **Complexity:** The presence of many components and their reciprocal relationship to the external environment can add to the complexity of a project.

The introduction of new and uncertain technologies in projects often extends design and development phases, leading to increased costs and delays. Performance issues related to flexibility are primarily due to early decisions that restrict adaptability in complex and uncertain environments, with factors such as centralized decision-making and regulatory frameworks playing a role. Complexity in large projects arises from the uncertain interactions among numerous moving parts within the project system and their relationship with the external environment, with regulatory, informational, technical, and organizational aspects influencing the system.

4. Leadership and Capable Teams: This theme addresses the relationship between project team members, individual competencies, required skills, and organizational skills. The three main areas of poor performance include:

- **Project Leadership:** Inappropriate definition of project culture and sense of purpose can result in inconsistencies within and between organizations.

- **Competencies and Skills:** Poor definition, recruitment, and maintenance of the right team can lead to high employee turnover and lack of necessary expertise.
- **Capability:** The inability to integrate organizational skills to handle the needs of different phases of a project and its transitions can lead to inefficiencies.

Project leadership performance issues often stem from a misalignment in defining the project's culture and purpose, leading to organizational inconsistencies and fostering counterproductive behaviors. Performance problems related to competency arise from inadequate team definition, recruitment, and retention, leading to high turnover and a lack of necessary expertise. Furthermore, the inability to merge organizational skills to manage various project phases and transitions contributes to deficiencies in competencies and skills.

5. Stakeholder Engagement and Management: This theme deals with stakeholder engagement and governance. The three main concepts include:

- **Institutional Context:** A collection of formal organizational structures, rules, and informal norms can influence the project's success.
- **Stakeholder Fragmentation:** The high number of parties involved often leads to frequent interactions and discussions among relevant stakeholders.
- **Community Participation:** Poor engagement, communication, and transparency with external parties during the project life cycle can lead to opposition from local communities, leading to project delays or failures.

Negotiations with government agencies and regulatory compliance can lead to disputes, inefficiencies, and postponements. Stakeholder fragmentation, a result of the inability to synchronize the diverse and often conflicting objectives of numerous project participants, is a primary cause of discord. Additionally, inadequate interaction and openness with external entities during the project's lifespan can result in subpar performance. Affected local communities frequently rallied to protect their interests, using media platforms to promote their objectives.

6. Supply Chain Integration and Coordination: This theme deals with the mechanisms that different types of organizations use to coordinate and integrate large supplier networks. The three main concepts in this topic are:

- **Project Management:** The inability to gain the information and visibility into the project scope needed to coordinate projects and sub-projects at the right time at different stages of the project life cycle can lead to inefficiencies and project failures.
- **Business Relationship:** Limited systematic understanding of the interdependencies affecting different levels of the project life cycle can lead to misalignment.
- **System Integration:** Poor understanding of front-end system architecture design can lead to integration issues.

Poor project management performance often stems from a lack of necessary information and visibility into the project's scope, hindering the timely coordination of projects and sub-projects throughout the project lifecycle. Commercial relationships suffer due to a limited understanding of the interdependencies across various levels of the project lifecycle, including intra-organizational, inter-organizational, and external environments. System integration issues arise from a lack of understanding of the front-end system architecture design, crucial for integrating different levels of large projects. An effective systems integrator organization should possess the required traits to coordinate and integrate supplier coalitions effectively.

As explained, the complexity of megaprojects often leads to a multitude of potential failures. These failures are rooted in various aspects of project management, decision-making behavior, and the inherent uncertainties that accompany such large-scale endeavors. Understanding these themes, concepts, and causes is crucial for improving the performance of megaprojects. By addressing these issues proactively, project managers can increase the likelihood of project success, leading to better outcomes for all stakeholders involved.

The table below summarizes the themes, concepts, and causes of poor performance in megaprojects:

Themes	Concepts	Causes
Theme 1 Decision-Making Behaviour	Optimism bias	Expert advice often leans towards optimism, overlooking potential risks and uncertainties, leading to a phenomenon known as the planning fallacy
	Strategic misrepresentation	Various pressures (political, organizational, personal) can lead to manipulation of situations, often resulting in underestimated costs and overlooked risks
	Escalating commitment	The belief that a megaproject, once initiated, cannot fail or be halted due to its size and cost
Theme 2 Strategy, Governance, and Procurement	Sponsor, client, owner, operator	Lack of clear role definitions and long-term vision often results in risk being shifted to the supply chain
	Governance	Insufficient focus on the evolution and design of governance structures over time
	Delivery model strategy	Inadequate understanding and definition of the balance between internal capabilities of the client and those outsourced to partners and contractors
Theme 3 Risk and Uncertainty	Technological novelty	Implementation of unproven technology can lead to increased costs and delays
	Flexibility	Various factors such as centralized decision-making, financing, and regulatory frameworks can limit project flexibility
	Complexity	Uncertain interactions among numerous moving parts within the project system and their relationship with the external environment
Theme 4 Leadership and Capable Teams	Project leadership	Misalignment in defining project culture and purpose can lead to inconsistencies within and between organizations
	Competencies	Inadequate team definition, recruitment, and retention can lead to high turnover and lack of necessary expertise

	Capabilities	Inability to assemble the organizational capabilities to address the requirements of different phases of the project and its transitions
Theme 5	Institutional context	Misunderstanding of the parties, interests, and power relationships surrounding the project can lead to conflicts, inefficiencies, and delays
	Stakeholder Engagement and Management	<p>Stakeholder fragmentation Difficulty in aligning the competing and often conflicting priorities, goals, and interests</p> <p>Community engagement Inadequate engagement, communication, and transparency with external parties affected by the project during its life cycle</p>
Theme 6	Program management	Difficulty in obtaining the necessary information and visibility required to coordinate projects and subprojects at the right time during various phases of the project life cycle
	Supply Chain Integration and Coordination	<p>Commercial relationships Limited understanding of interdependencies during the life cycle, which impact the project at different levels: intra-organizational, inter-organizational, and external environments</p> <p>Systems integration Lack of understanding of the design of the systems architecture at the front-end, which provides a structure for integration across different megaproject levels including projects, the program, and system</p>

Table 8 - Summary of themes, concepts, and causes of poor performance in megaprojects (by Juliano Denicol, Andrew Davies, and Ilias Krystallis [167])

4 Megaprojects dynamic evaluation framework

4.1. What is missing in literature

Over the past few decades, stakeholder management has gained increasing prominence within the literature on megaprojects, emphasizing the importance of measuring and maximizing stakeholder satisfaction for overall project success [3], [168]. To this end, considerable academic attention has been directed towards primary stakeholders, those entities with a direct financial, contractual, or regulatory stake in the project [2], [54]. These entities typically include investors, clients, regulators, and sometimes even local governments. However, current scholarship shows a marked deficiency in one critical area: the evaluation of secondary stakeholders in the realm of megaprojects, real concern only showed in the latest works of Di Maddaloni et al. [8], [123], [169] and few others. While primary stakeholders are undoubtedly crucial, secondary stakeholders—such as local communities, NGOs, and future users—also play a substantial, indirect, role in shaping the project's long-term viability and social license to operate [65], [84]. This glaring gap in the academic discourse undermines the potential for a more holistic understanding of the stakeholder environment in which megaprojects operate. Further, existing literature often lacks a nuanced approach to secondary stakeholders, reducing them to peripheral entities rather than active agents capable of shaping project outcomes [170], [171].

Ignoring secondary stakeholders is not merely an academic oversight but presents practical consequences as well. Failure to adequately consider these groups can lead to negative public opinion, political interference, and even organized resistance that

could jeopardize the project [84]. Considering the magnitude and impact of megaprojects, the ripple effects of such consequences could be enormous, reaching far beyond the project itself and affecting broader social and economic contexts.

In light of these shortcomings, some scholars have cursorily acknowledged the need for a more integrative model that includes secondary stakeholders [8], environmental impact and other metrics that will be described in the following paragraphs. Such calls have largely remained unheeded, tucked away in the "future research" sections of academic papers.

This thesis aims to address this noteworthy gap by proposing a comprehensive model explicitly designed to evaluate a broader set of parameters among which a specific focus will be dedicated to secondary stakeholder satisfaction when a megaproject takes place. By doing so, this research seeks to provide both practitioners and academics with a more balanced, nuanced, and ultimately effective framework for comprehensive evaluation in the realm of megaprojects.

4.2. Advantages of a comprehensive evaluation model

Since in literature and practice it is hard to find performance evaluation strategies that take into account the broader complexity of a megaproject in addition to the iron triangle, megaprojects performance assessment is still done through the lenses of cost, time, and scope. However, as greatly exposed in the previous chapters of this thesis, this approach is limited since it does not consider how these projects impact society in a broader way: how they impact secondary stakeholders and local communities, the environment, the reputation of the actors involved and all this aspect that go beyond pure accountability. Another limit of this approach is the fact that it conceptualizes megaprojects as static structures that can be completely defined at project beginning, however, given their complexity and their time duration, megaprojects can be better conceived as dynamic and evolving networks. This shift in consideration would provide a useful basis for the design of an evaluation approach better able to address

the socio-economic aspects of megaprojects and to promote learning. [172] Moreover, megaprojects are usually unique and case specific and despite their common characteristics, they represent a partly heterogeneous group of entities that can usually better be described as networks or programs of projects [135] than as discrete projects with clearly circumscribed boundaries. [172] So, given the complexity and uniqueness of megaprojects, the governance evaluation model based on the pure iron triangle is limited and it does not allow a constructive type of evaluation, usually resulting in reputational disruption and no lesson learned. That is why, as the world and the cultures are evolving, megaproject evaluation models should also evolve with the aim of giving relevance to what public opinion considers important at a given time. Thus, nowadays the central challenge of megaproject evaluation is to foster the adoption of more reflexive and learning-oriented evaluation approaches, while fully considering especially the socio-economic impacts of such large-scale projects. Greater attention to learning and improvement should not mean abandoning accountability as a major objective of evaluation. Rather, there should be a better balance between accountability, learning objectives and social value delivered. [172]

A global and more comprehensive evaluation model can bring several advantages to the management practices for large projects:

- **Comprehensive evaluation:** a global evaluation model would consider a broader range of factors including social, environmental, reputational, and economic impacts. This holistic approach aligns with the complex and multifaceted nature of megaprojects and can provide a more comprehensive evaluation of project success. [173]
- **Stakeholder engagement:** incorporating a wider set of parameters in the evaluation model facilitates the inclusion of diverse stakeholder perspectives. This can lead to improved stakeholder engagement and satisfaction, which is crucial for the success of megaprojects. [76]
- **Risk management:** A broader evaluation framework can help identify and manage a wider array of project risks. This is particularly important in

megaprojects, which are typically characterized by high levels of uncertainty and complexity. [174]

- **Sustainability:** a global evaluation model can provide a structured approach to incorporating sustainability considerations into project planning and execution. This is particularly important in today's context where the environmental and social sustainability of projects is gaining increasing attention.
- **Long-term value:** traditional project evaluation models focus on short-term project outcomes. A global model can help assess the long-term value and impact of a project, ensuring that it contributes positively to societal, economic, and environmental goals.
- **Adaptability:** given the dynamism inherent in the global environment, a broader evaluation model enables the flexibility to adapt to evolving societal values, economic conditions, and technological advancements. [24] In fact, measuring performances throughout project development can help managers to adjust the trajectory of the project.
- **Learning orientation:** by having an evaluation model that considers many parameters, it is possible to analyze the success or failure of single aspects of the project. Thanks to this analysis, managers can recognize actions that brought to success or failure in any aspect and implement them or eliminate them in future projects. Without this deep analysis practices would be repeated in the same way and improvement would be slower.

Advantages of a comprehensive evaluation model	
Comprehensive evaluation	Inclusion of many aspects (social, economic, environmental, reputational impacts) aligns with multifaceted nature of megaprojects.
Stakeholder Engagement	Stakeholder consideration in the evaluation model can boost stakeholder engagement.
Risk management	Broder evaluation model helps to identify and manage a wider array of risks.
Sustainability	Evaluation of environmental impact can help to incorporate sustainable practices in project management and construction.
Long-term value	Global evaluation model help assess both short and long-term effects on society.
Adaptability	A broader evaluation model enables the flexibility to adapt to changing values and conditions throughout the life of the project.
Learning orientation	Wider set of KPI helps understand which actions brought to success or failures in different project aspects, leading to advancement in management practices for future projects.

Table 9 - Advantages of a comprehensive evaluation model

The evaluation of megaprojects from a wider and holistic perspective has many advantages and it can lead to greater improvements in both management practices and projects reputation. As a matter of fact, the evaluation limited to the iron triangle is an extreme simplification of those infrastructure projects, where their multifaceted nature is completely ignored. Using this evaluation method, most projects result in a failure in terms of both budget and timeline compliance, causing negative public opinion. A broader evaluation model can help to justify and explain these slippages, that for example can be due to an increase in social value delivered during the project execution which is not reported by the mere analyses of cost, time, and scope. On the other hand, such a model would require an increased effort in the evaluation process by keeping track of different data during project execution. However, since megaprojects are incredibly complex and require an enormous amount of resources,

assigning a small portion of that resources to the evaluation process could have huge impacts on management practices and can show strengths and weaknesses of those practices, contributing to their continuous improvement.

4.3. Holistic evaluation framework concept

Given the limits of the iron triangle and the little progresses made in literature on how to overcome this evaluation model, this research proposes a comprehensive framework to evaluates both quantitative and qualitative aspects to assess the performances of megaprojects.

The iron triangle triad has served as the bedrock for project management evaluation for decades. However, as the world's expectations from megaprojects have evolved, the simple trifold iron triangle no longer suffices. Increasingly, researchers and practitioners recognize the need for a more holistic and multifaceted model that accounts for an array of additional critical elements such as value, stakeholder satisfaction, quality, environmental impact, reputation, and risk. [175] In the context of the 21st century, the parameters for assessing the success of megaprojects are changing. Megaprojects today are not just marvels of engineering; they are instruments of societal transformation, playing a pivotal role in shaping economies, societies, and the environment. [3] As such, there is a pressing need for an evaluation framework that can capture this multifaceted nature of megaprojects and provide a balanced and comprehensive assessment of their success.

This chapter is dedicated to the exploration and development of a new, global model for the evaluation of megaprojects that incorporates the traditional iron triangle and extends it to integrate several other key dimensions. In the following paragraphs, the global framework will be presented, and all the evaluation fields will be introduced. Later, in the following chapter, the field of secondary stakeholder satisfaction will be deeply analyzed with the development of the specific evaluation model for this

parameter. The expansion of all the other fields of the global model is left to future developments.

The model is an integration of the iron triangle with other evaluation parameters that are seen as important in modern society, however, this shift of attention should not mean abandoning accountability as the core aim of the evaluation but should lead to more balanced relation between accountability and social value delivered. [172] It is also true that performance evaluation of complex projects needs to look at both efficiency and effectiveness, as well as to a diagnosis of political expectations in terms of justice and fairness, and to a calculation of what is operationally feasible. [20] The proposed evaluation framework must also be used at different stages of the project development: first, it has to be used as a dynamic tool to measure performance during project execution. In fact, megaprojects usually lack adequate control, particularly, they lack robust risk-analysis or risk-management protocols and do not provide timely reporting on progress relative to budgets and timelines. The data used to report on project progress are typically outdated, as they generally rely on payments to contractors rather than on actual work performed and are not aligned with the true progress of the project. A more sophisticated approach is to use real-time data that measures activity in the field [19]. The continue assessment of projects performances during its development is fundamental to understand where practices are producing good results and where they're failing, giving managers the opportunity to adjust the direction of their work to minimize negative performances. Moreover, the model should be adapted with new and different KPIs if, during the project development, there are perceived changes in what is valued by stakeholders. By doing so, managers can stay up to date with what is important for stakeholders and can shift parts of their resources to delivering those things, remaining compliant with the main project goals. When the project comes to completion, the evaluation model has to be used for final project evaluation. In this case, an evaluation is performed to assess whether or not the project has achieved its intended goals, if it is compliant with contract terms [47], if it has satisfied all initial criteria and how it has been perceived by stakeholders. At this time, the long-term impacts of the megaproject are not visible yet, that's why another analysis of performance has to be done years after project completion. This analysis is

called ex-post evaluation, a highly valuable tool for determining not only how successful a large infrastructure project may have been after the completion, but rather the long-term performance of the outcomes for the economy, society, and the environment. [176] Different from final project evaluation, an ex-post evaluation is conducted in the years after a project's official end date to assess relatively long-term effects [177]. It is a systematic assessment framework and can be conducted from different perspectives [178]: the socio-economic evaluation is the most common content of ex post project evaluation and has been reported in several previous studies. [179], [180] Originally, the socio-economic evaluation only focused on direct benefits for users and costs of the project, which can be easily calculated as economic values. [181] However, with the growing importance of the concept of sustainability in recent project development [182], economic evaluation based on narrowly scoped cost-benefit analysis is now insufficient for ex-post evaluation of large infrastructure projects. [47], [183] The presented evaluation model aims at expanding the classic evaluation based on cost-benefit analysis with a broader range of KPI to assess the success of megaprojects in all valuable aspects.

The model considers both economic and non-economic effects, some of which are objective, such as environmental effects, economic promotion or additional public services, and others not. Subjective factors, including participants' satisfaction, user satisfaction and public satisfaction are still difficult to quantitatively measure within the socio-economic evaluation framework, but are also important in the evaluation of large infrastructure projects. [184] These subjective factors are not only individual evaluation indicators, but also important references for determining the relative weights of objective factors in the evaluation framework. [47] Given their importance, subjective factors must be included inside a holistic evaluation framework, and they should be reported to a quantitative scale to enable a fast screening of project results and the extraction of statistical values.

The model includes nine evaluation fields: the three coming from the iron triangle model and six that have been selected as representative of the change in megaproject perception in recent years. The nine success factors are representative of economical values, societal impact, environmental impact, and project perception. In particular,

they are cost, time, scope, value, stakeholder satisfaction, quality, environmental impact, reputation and risk. The evaluation of megaprojects under all these parameters would give a clear and complete picture of the impact of such infrastructures on people’s lives, on participating organizations, on society and on the environment. The evaluation fields have been selected by looking at the most recent literature about megaprojects evaluation and at secondary sources such as guidelines and studies from the European Union, the Ministry of Infrastructure, and other governmental sources.

The figure below shows a schematic representation of the aforementioned megaproject success factors. In the following pages, each category will be briefly introduced and explained, while only for secondary stakeholder satisfaction a specific framework will be developed. The following chapter will be entirely dedicated to the development of such a model, expanding the concept of stakeholders’ satisfaction, and identifying the qualitative or quantitative factors that can contribute to the evaluation of such a complex field. The deepening of the other five aspects is left to future developments.

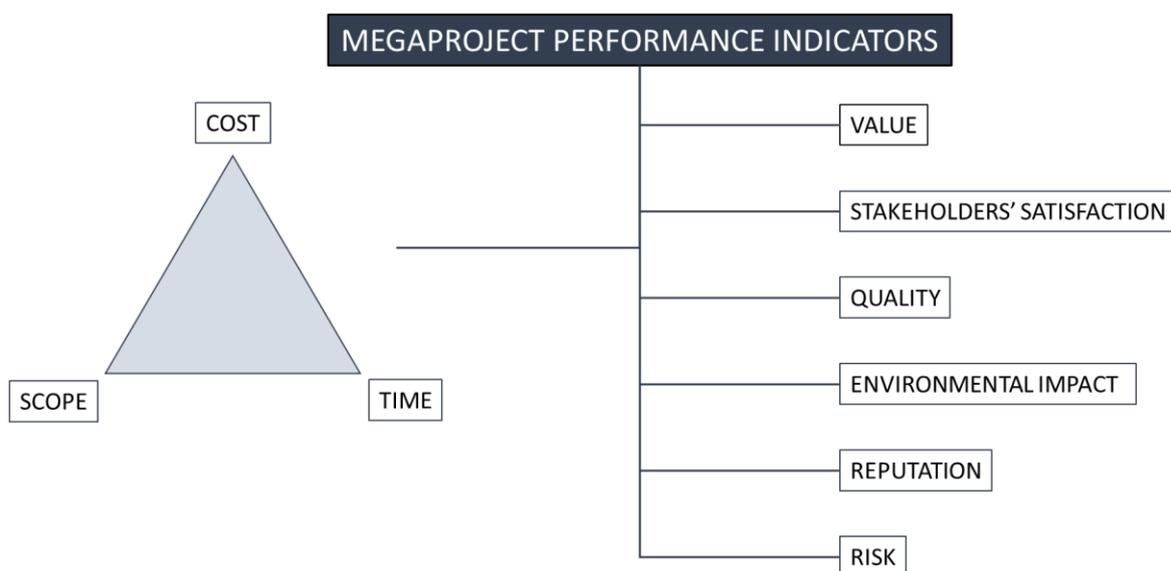


Figure 13 - Megaproject holistic evaluation framework

4.3.1. Cost

Cost, one of the vertices of the 'iron triangle,' holds paramount importance in the evaluation of megaprojects. Conventionally, it refers to the total monetary resources that are required to complete a megaproject, from the inception and design phase to the execution and post-completion phase. [141] In essence, it encapsulates all capital expenditures, operating costs, and incidentals that are directly and indirectly associated with the project.

In the realm of megaproject evaluation, measuring cost is a multidimensional task. The fundamental aspect is the financial tracking of project expenditures against the estimated budget. This measurement provides an indicator of the project's financial performance and cost-efficiency. A cost overrun, i.e., exceeding the budget, is a common issue in megaprojects, and hence, cost control measures and budget adherence are closely monitored. [40] Even though cost has been the primary concern in megaproject evaluation, just looking at this data can be limiting for various reasons. First, it is hard to understand what the real performance in terms of cost has been. To understand this concept, the difference between the budget and the cost forecast has to be clear: the budget is the total amount of resources that are allocated to the development of a specific infrastructure (for example resources that a government publicly announces to dedicate to the construction of a bridge), while the cost forecast is the actual forecast of the real cost of the infrastructure made at project beginning. The budget of a megaproject is often made public, but promoters rarely disclose how that budget is split between the actual cost forecast and the contingency fund. The latter is a form of financial slack that gives the promoter a buffer of utilizable resources bigger than the minimum necessary to produce a specified level of output. Budget data reveal little of the inner workings of a megaproject because until slack runs out, the promoter can draw down from the contingency to hide cost hikes while claiming the project is on budget. [20] The following figure shows the evolution of the cost forecast and budget for the construction of the Crossrail in London during its development.

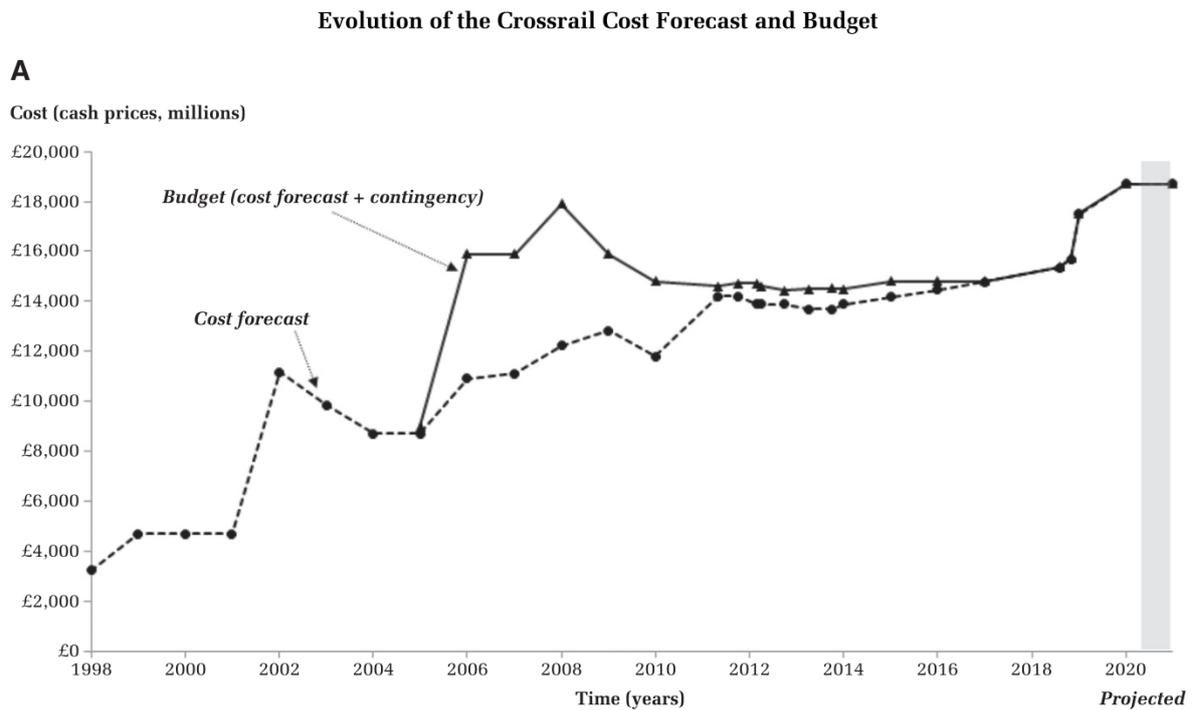


Figure 14 - Evolution of the London Crossrail cost forecast and budget [20]

It is easy to understand how this utilization of contingencies can be useful from the reputational perspective of megaprojects and from the political point of view since it can partially cover bad management practices or cost hikes by stating that the project is still on budget. However, if the aim of a project evaluation is transparency and learning, this analysis can be counterproductive because the project can be on budget but strongly over its forecast and if no further evaluation is done, the reason for this excess can be lost. On the other hand, going over budget is not necessarily a sign of management failure. In fact, some projects go over budget because, during their development, the scope is changed or more requests are added and realized. If these added features increase the social value delivered by the project, it can be a success even though the budget is not respected.

All the above reasons indicate how the concept of cost control should be expanded: it is not enough to make a mere comparison of the initial budget and the final cost, but additional considerations must be made. Managers, for performance analyses, should keep track of additional stakeholders' requests and their costs, so that if the project goes over budget, the extra expense could be attributed to additional value created or

actually bad management practices. Moreover, since supply chain, raw materials prices and inflation are unpredictable in today's world, analysts should keep these factors into consideration given the huge temporal extent of megaprojects development. Cost evaluation still remains one of the most important aspects of megaprojects evaluation, but the focus should shift towards the reasons for cost hikes rather than stopping at the pure comparison between cost and budget.

4.3.2. Time

Time is another critical vertex of the classic 'iron triangle' of megaproject evaluation. Generally, time refers to the temporal aspect of the project lifecycle, spanning from the initial conception to the ultimate completion of the project. [141] It includes the scheduling and timely completion of all individual tasks and milestones that are integral to the project.

In the evaluation of megaprojects, the measurement of time primarily concerns the tracking of the project schedule and the degree to which project activities adhere to the planned timeline. It's a key performance indicator that sheds light on the project's efficiency and effectiveness in terms of time management. Timely project delivery is often a vital requirement for stakeholders, as delays can lead to escalating costs, missed opportunities, and eroded trust. Therefore, the management of 'project time' and prevention of time overrun - the situation where the project exceeds its estimated completion time - is a crucial aspect of megaproject management. [185] It's noteworthy that the concept of 'time' in modern megaproject evaluation can encompass broader aspects such as the speed of response to changing project conditions, and the time to market in cases where the project output is a product or service. Thus, the same considerations made for cost evaluation can be extended to overtime. It is important to consider the context and the geopolitical condition of the time span in which the project is developed. Moreover, a central and constructive part of the evaluation is the investigation of the causes of time overruns. Hence, a nuanced understanding and

measurement of time can contribute to a more comprehensive evaluation of megaproject performance. [186]

4.3.3. Scope

Scope, the third vertex of the iron triangle, typically refers to the sum total of all the work, services, and deliverables that the project is intended to produce. [141] It encompasses the project's objectives, deliverables, functions, features, tasks, and requirements necessary to achieve the desired outcome.

In megaproject evaluation, the measurement of scope primarily involves assessing whether the project's deliverables align with the initially defined project objectives and requirements. Scope verification and control procedures are applied to ensure that the project remains within its defined boundaries and that any changes to the scope are adequately managed. However, to fit within a more holistic model of megaproject evaluation, the understanding and measurement of 'scope' should transcend the traditional boundaries. As megaprojects are inherently complex and susceptible to changes in requirements and objectives over time, dynamic and adaptive scope management becomes crucial. A more progressive interpretation of scope can consider the adaptability to evolving stakeholder needs, the project's alignment with broader societal and environmental objectives, and its long-term impact. [186] Moreover, scope measurement should consider scope creep - uncontrolled changes or continuous growth in the project's scope - which can lead to cost overrun and time delays. Effective management of scope creep necessitates a balance between delivering the project within the defined parameters and remaining flexible to accommodate necessary changes. [185]

4.3.4. Value

The concept of value is usually underemphasized in megaproject performance evaluation, in fact, with the iron triangle model, the attention is focused on the concept of costs, but not much on the value delivered by the project. Value can be defined as the sum of the economic benefits and wider social gains to be accrued from a new large-scale technology development minus the capital costs to be incurred. [20]

Economic value and social value constitute the two primary components of total value creation. Economic value primarily refers to the direct and indirect economic benefits delivered by the project. These benefits could include job creation, increased local productivity, induced investments, improved competitiveness, industrialization, and long-term economic growth. Evaluation of economic value generally employs techniques like cost-benefit analysis, economic impact analysis, and return on investment analysis. Conversely, social value encompasses wider societal benefits, including improvements in quality of life, social equity, public health, mobility, and cultural enrichment. Evaluating social value is often challenging due to the intangible nature of these benefits and the difficulty in quantifying them. However, methods such as Social Return on Investment (SROI) and multicriteria decision analysis can provide structured frameworks for assessing these impacts. [187]

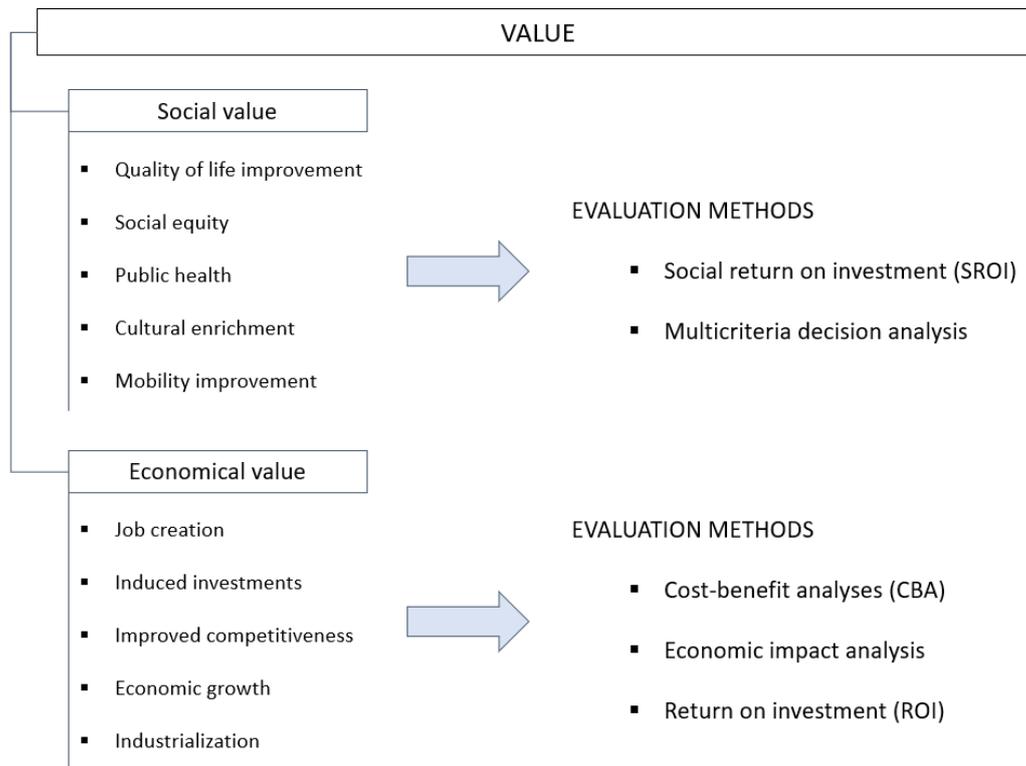


Figure 15 - Value in megaproject evaluation

Inclusion of value as an evaluation criterion in the megaproject context encourages a more balanced and comprehensive assessment of project outcomes, considering both tangible and intangible impacts, and transcending the conventional cost-focused perspective.

4.3.5. Stakeholders' satisfaction

Megaprojects are infrastructures made to foster the economic development of a country or a region and to improve the quality of life of the people living there. With increasing public awareness on environmental protection [188], [189] and progressive democratic deliberation in public policy making, large infrastructure projects will attract more attention from the public and meanwhile the public satisfaction will be more important in ex post evaluation of large infrastructure projects. [47], [188], [190] For this reason, an assessment of how satisfied all stakeholders are from a given project

is central in a global evaluation framework. Stakeholders' satisfaction must be focused on both primary and secondary stakeholders: primary stakeholders were defined by Freeman [54] as "those who can affect or are affected by the achievement of an organization's objectives". They are those who are directly involved in a project, such as project managers, employees, investors, and customers, they have a direct economic relationship with the project, and they typically control project resources. On the other hand, secondary stakeholders are those who are indirectly affected by the project or, as stated by Mitchell et al. [2], "those who affect or are affected by the organization, but not directly involved in transactions with It". These include local communities, advocacy groups, and other entities that do not have a formal contractual relationship with the project but are impacted by its outcomes.

Evaluation of primary stakeholder satisfaction is typically executed through surveys, interviews, or qualitative analysis to discern their level of contentment with project outcomes, financial returns, project management performance, communication, and their involvement in decision-making processes. [191] Thus, evaluation of secondary stakeholder satisfaction demands a broader, more inclusive approach. Public hearings, community surveys, hearings with representatives of different categories, or social impact assessments could be employed to gauge their satisfaction, covering aspects like environmental impacts, changes in community infrastructure, perceived benefits, and potential disruptions. [192]

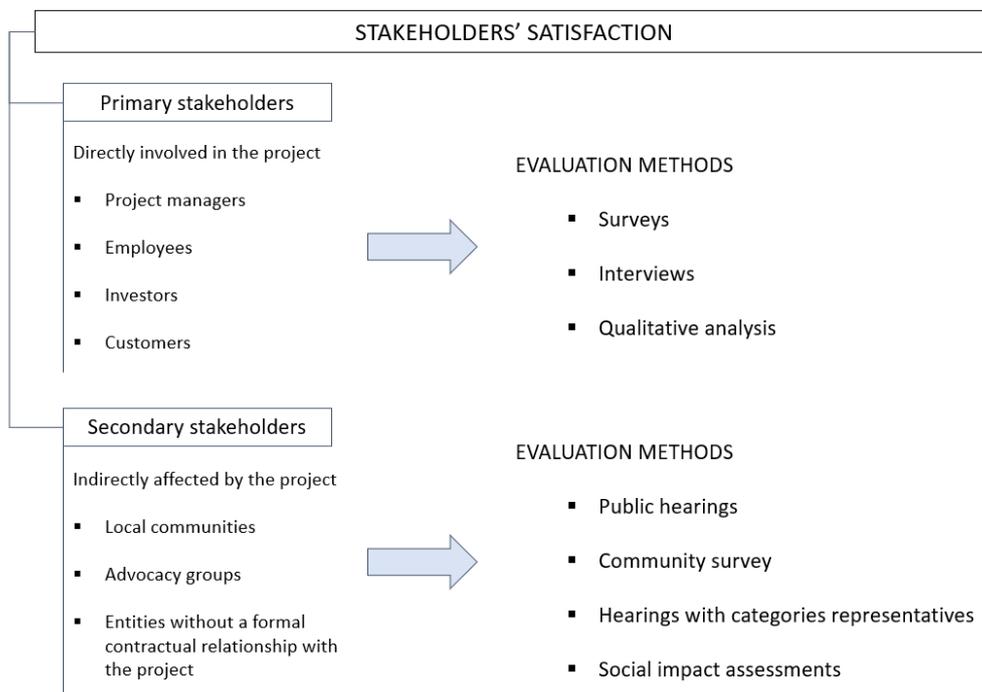


Figure 16 - Stakeholders' satisfaction

In conclusion, adopting stakeholder satisfaction as a central evaluative measure facilitates a more inclusive, human-centric perspective of megaproject performance, ensuring that the project's effects on the socio-economic landscape are truly recognized and appreciated. In the following chapter, a dynamic model for the assessment of secondary stakeholders' satisfaction will be developed considering three different perspectives: direct involvement of stakeholders with surveys and hearings, external observation of elements that indicate content or discontents throughout the population and evaluation of benefits and results from the promoter's point of view.

4.3.6. Quality

Quality has gained more importance as an evaluation parameter in megaprojects' performance and can be bifurcated into two primary categories: quality of practices and quality of outcomes.

Quality of practices refers to the procedural aspects of the project, including planning, execution, and management. It encompasses adherence to established standards, guidelines, and best practices in the field. The evaluation of the quality of practices can be conducted through audits, peer reviews, and benchmarking against industry standards. Quality of outcomes, on the other hand, pertains to the tangible results of the project. It includes factors such as the project's adherence to stated objectives, to norms and normative, to expectancies, even the duration and degradation of the infrastructure over time, the needed intervention during its lifecycle and durability. The quality of outcomes can be evaluated through performance metrics, post-implementation reviews, and stakeholder satisfaction surveys.

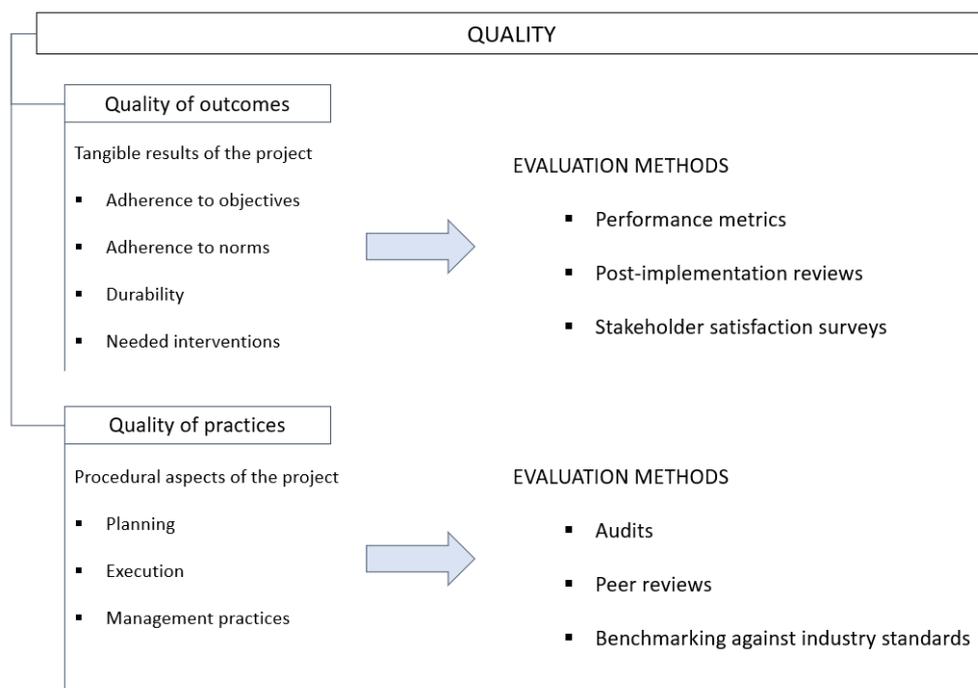


Figure 17 - Quality

It is important to note that these two categories are interdependent. High-quality practices often lead to high-quality outcomes, and vice versa. Therefore, a comprehensive quality evaluation framework for megaprojects should encompass both these aspects.

4.3.7. Environmental impact

Given the increasing importance of environment-related themes in modern society, environmental impact evaluation in megaprojects is a critical component to be inserted into a broader evaluation framework. In this context, the evaluation of environmental impact is a multifaceted process that extends beyond the project's development phase and into its post-completion period. It has to be recognized that the environmental footprint of a project is not confined to the construction period but persists long after the project's completion. According to Flyvbjerg, the environmental impact of a megaproject is a significant factor that influences its overall performance and success. [3]

As indicated by the European Union Environmental Impact Assessment [193], the environmental impact can be measured and evaluated in various ways, including using environmental indicators, monitoring programs, and modeling techniques. These methods can help to identify potential environmental impacts and evaluate the effectiveness of mitigation measures. To perform the evaluation correctly, it must be done for both the project development phase and after its completion. The evaluation of environmental impact during the project's development phase involves assessing the potential environmental consequences of the construction activities. This typically includes the analysis of factors such as air and water pollution, noise levels, waste generation, and disruption of natural habitats. Furthermore, the evaluation process should be iterative, with repeated assessments conducted throughout the project's lifecycle. This allows for the timely identification and mitigation of adverse environmental impacts, contributing to the project's overall sustainability. On the other hand, the evaluation after project completion focuses on the long-term environmental footprint of the project. This involves monitoring the ongoing environmental effects of the project's operation, such as energy consumption, emissions, waste management, impact on landscape, impacts on local ecosystems, and cultural heritage.

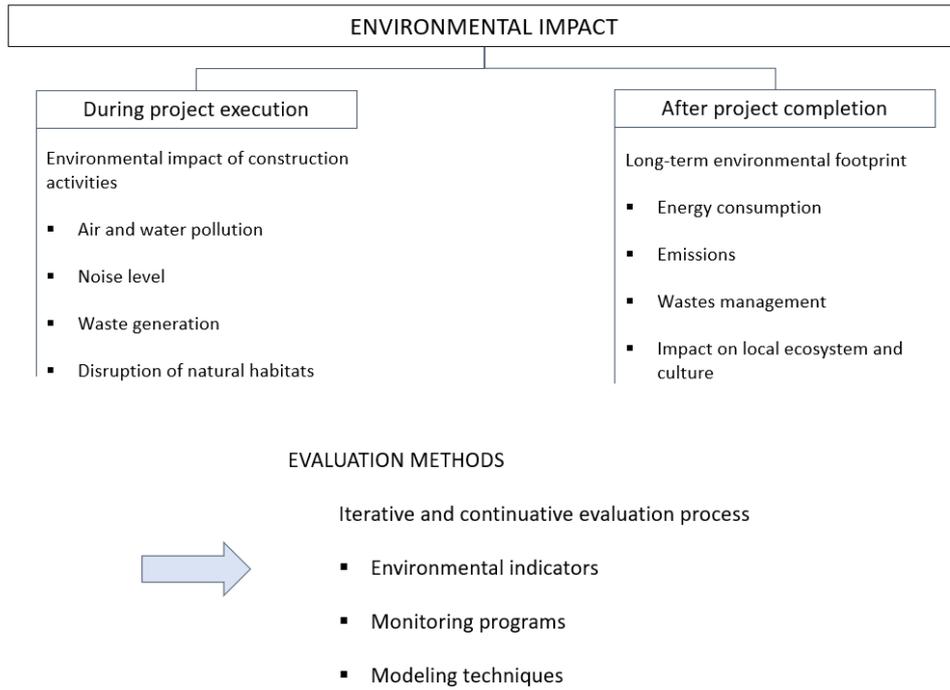


Figure 18 - Environmental impact

In conclusion, environmental impact evaluation in megaprojects is a complex process that requires a comprehensive approach, considering various environmental aspects and using multiple evaluation methods.

4.3.8. Reputation

In megaprojects, the reputation parameter is multifaceted and can be considered from three perspectives: the reputation of the project itself, the reputation of the participating organizations, and the reputation of the society involved. Each of these reputation aspects plays an important role in the overall success and acceptance of a megaproject. As a matter of fact, megaprojects usually suffer from bad reputation given their poor performances on adherence to budget and timeline, quality of outputs, and environmental impacts. Bad reputation then translates into citizens' opposition and mistrust in infrastructure projects. In fact, a project that is seen as successful can enhance the reputation of the participating organizations and the

society in which it is implemented, while a project deemed a failure can have the opposite effect. [123]

The reputation of the project itself is tied to its perception of success or failure. Usually, perception tends to be negative since media coverage amplifies and gives resonance to bad news with respect to good ones. Reputation can also be influenced by the discomfort, both its duration and entity, that the project brings to society during its development and by the perceived benefits or damages that such project brings to society in terms of immaterial benefits, material benefits and employment opportunities.[194] Moreover, project reputation can also be affected by the level of community engagement in the project, and the project's alignment with societal values and norms. [195]

The reputation of the participating organizations can be influenced by their track record in similar projects, their financial stability, and their ethical standards. Organizations with a strong reputation are more likely to be trusted by stakeholders and the public, which can contribute to the success of the project. [195] On the other hand, organizations with bad reputation for corruption, poor quality or bad management practices can lead to opposition a priori with people finding them untrustworthy.

Finally, the reputation of society refers to the level of pride and identity that the project gives to a country's population. In fact, megaprojects work as monumental structures and cultural icons to acquire the status of a global city. They can also incorporate cultural capital, creating new cultural urban spaces that share national and city identities. [196] Fame, aesthetics, or the symbolic meanings of iconic megaprojects are stressed as crucial to give identity to a particular area. [197] One example of this type of impact can be the city of Dubai, which gained international fame thanks to its ambitious megaproject; or the Twin Petronas Towers in Malaysia, which were designed to elevate national pride and identity through a symbolic and material role in postcolonial nation-building. [194], [198]

Assessing and measuring these aspects of reputation can be complex, as they involve both objective and subjective elements. Objective measures can include financial

indicators, project outcomes, and compliance with regulations, while subjective measures can involve stakeholder perceptions, public opinion surveys, media analysis of both social media and traditional media such as newspapers, online journals, television, and radio programs. It's important to note that the relationship between performance and reputation is not always straightforward, as reputation can be influenced by factors beyond the actual performance of the project, or the organizations involved. [195]

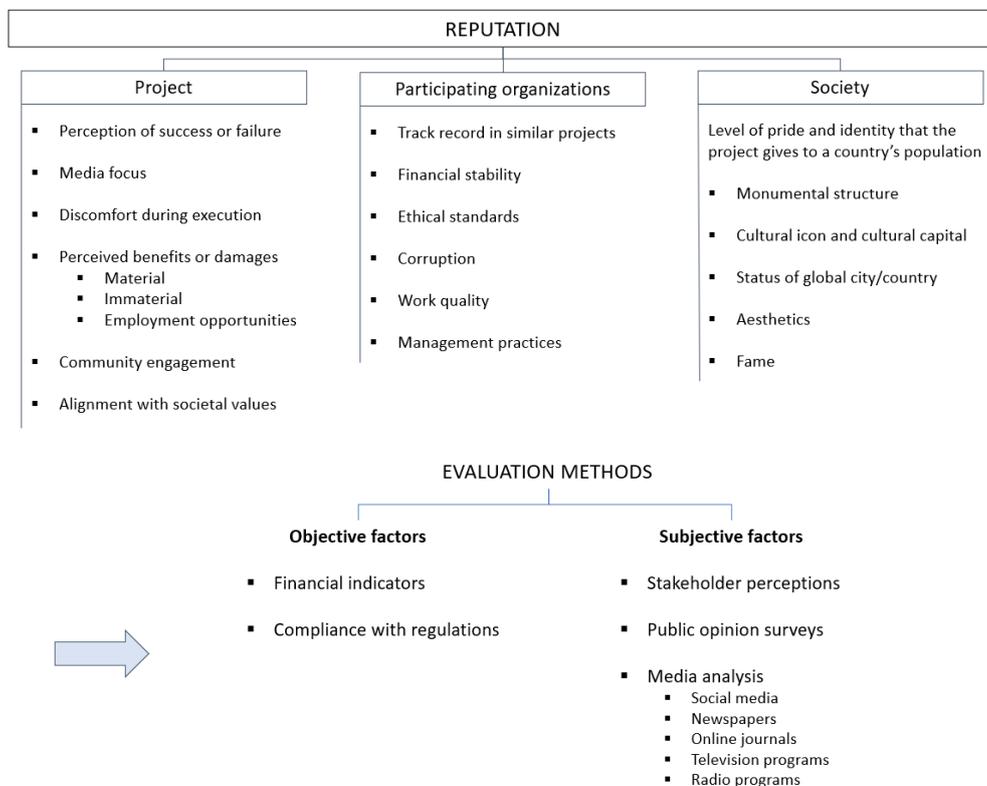


Figure 19 - Reputation

4.3.9. Risk and safety

Risk management is a crucial aspect of megaprojects development, in fact, many potential risks events with undesirable results may occur in megaproject lifecycle and affect the project's success. Risks can strongly influence each stage: from the project

conceptual design phase through to the handover phase and that's why it would be quasi-impossible to draw up a general list of all risks appearing on such large and complex projects. Generally, risk management is a vital, on-going, and iterative process used to identify possible risks sources during different phases of the projects under development. It allows parties involved in the project development to recognize the existence and impact of uncertainties in the project and hence, to consider appropriate strategies to mitigate their effects in the project. Due to complexities, large resource requirements, long time horizons, and exposure to interrelated and pervasive drivers of risk, megaprojects are faced with unique risks and tend to stretch available resources to the limit and sometimes beyond during their development. [199], [200] Evidence suggests that large and complex projects such as highways, bridges, and airport expansion are usually money pits where funds are simply 'swallowed up' without delivering sufficient returns because of unbalanced subjective beliefs and information in assessing risks and uncertainties and taking corrective actions to control and manage the identified risks. [201] Flyvbjerg et al. (2002) therefore regarded the main reason for cost and time overruns in megaprojects as simply the marginalization of risks during feasibility studies and by assuming what the World Bank calls the "Everything Goes According to Plan" (EGAP) principle. [202], [203]

Boateng et al. (2012) identified risk sources in literature, from experts' opinions, source documents of past and existing megaprojects under construction and they categorized them in five groups:

- **Social risks:** risks related to society and citizens, including potential for the project to cause harm or disruption to local communities and stakeholders. This can include issues such as displacement of communities, disruption to local economies, and negative impacts on cultural heritage sites. Moreover, risks for the project success can be protests, legal actions or disputes.
- **Technical risks:** risks associated with all technical aspects of a project, from its engineering to complexity analyses or supply chain challenges.
- **Economic risks:** risks associated with the economic environment in which the project is developed and pertains to the potential for cost overruns, delays, and

other factors that could negatively impact the financial viability of the project. These risks can include changes in taxation, inflation increases, foreign exchange rates and price changes.

- **Environmental risks:** risks referred to the potential for the project to cause harm to the environment, either through its operations or because of accidents or unforeseen events. On the other hand, adverse environmental conditions for project development are also included.
- **Political risks:** risks related to the political environment where the project is developed. These risks can be linked to political uncertainties and changes in policies, political opposition and government changes, all factors that can undermine project success.

The figure below, taken from Boateng et al. (2012) [200], shows all the identified risks for every listed category.

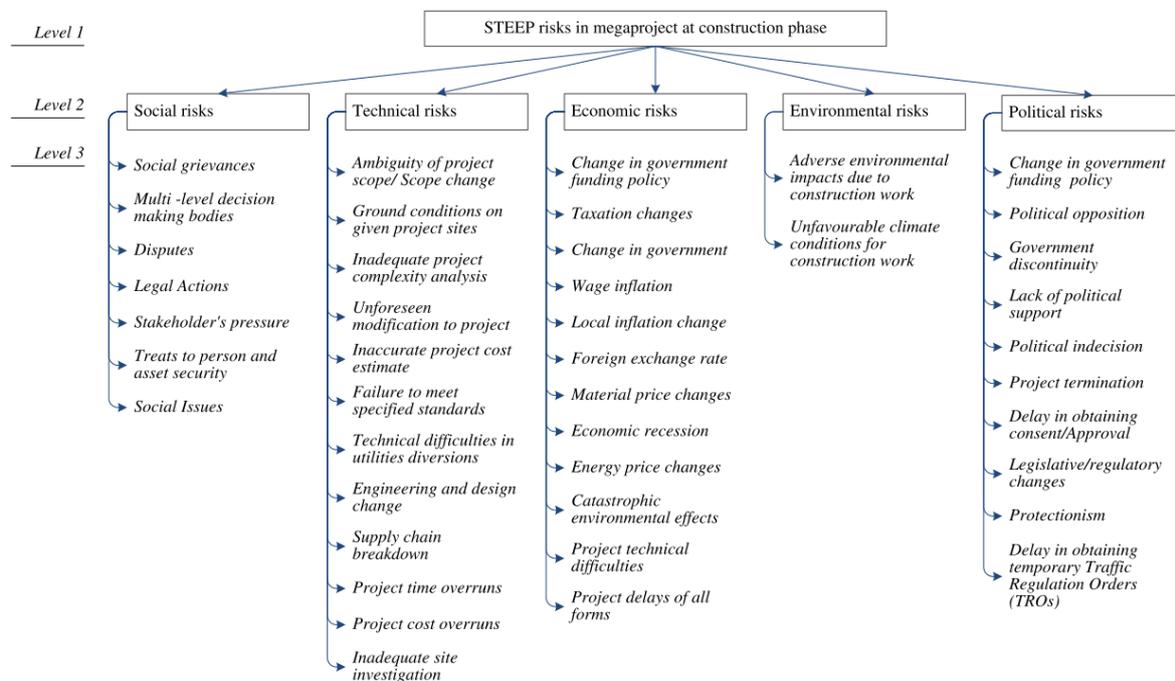


Figure 20 - A hierarchy of STEEP risk in the ETN project [201]

Given the importance of risk management for the success of megaprojects, inserting its evaluation in a global evaluation framework is crucial. With the proper evaluation of risk management practices, managers could keep record of which are the good and bad practices, applying or avoiding them in future projects.

Worker's safety is a paramount concern in any project, any company and any practice that involves human work, especially in today's world where concerns about injuries and fatalities on the workplace have huge importance and can undermine a project or company reputation. Thus, the importance of worker's safety is a central concern in the context of megaprojects due to the scale and complexity of operations. Ensuring the safety of workers involves a comprehensive approach that includes rigorous training, the implementation of robust safety protocols, and the use of appropriate protective equipment. The evaluation of worker's safety can be achieved through regular safety audits, incident reporting, and continuous monitoring of safety indicators. [123]

The framework presented above groups all the parameters that should be assessed for a global and complete evaluation of megaprojects' performance. In such a way, managers can have a full overview of the key success factors of a project, and they can assess where the used practices led to successes or failures. In the next chapter, the evaluation of secondary stakeholders' satisfaction will be studied in detail with the development of a practical model to assess that parameter. The development of the same detailed model for all the other factors is left to future developments.

5 Secondary stakeholders' satisfaction

In the last decade, literature has shown a growing interest for more ethical and sustainable projects and a conscious endeavor for fairness and engagement of all stakeholders through a 'management-for-stakeholders' approach. [8] With this shift in focus, also performance evaluation of megaprojects should evolve and include the satisfaction of local communities and non-market stakeholders. Understanding how secondary stakeholders perceive a megaproject during its development and after its completion can help managers to understand and minimize the effect of megaprojects on people and places, to improve project benefits and to rethink a tailored approach for the local community, which will lead to improved project accountability and transparency in the decision-making process, generating more 'community inclusive' megaprojects.[8]

In literature there is not a comprehensive method to evaluate secondary stakeholders' satisfaction even though it would be a central parameter in a holistic approach. In fact, megaproject evaluation is still done mainly through the lenses of the Iron Triangle, overlooking all other aspects that are impacted by such projects. This chapter is dedicated to the development of an evaluation model for secondary stakeholders' satisfaction. All listed parameters and approaches were taken from literature sources and secondary sources such as European Union guidelines or evaluations, Governmental documents, and journals.

The model for secondary stakeholders' satisfaction assessment articulates in three different evaluation methods: direct involvement of secondary stakeholders, external observation of several factors, and an evaluation with the project promoter.

- **Direct involvement of stakeholders:** in this part, the evaluation is carried out through the direct involvement of population through community surveys or

consultation with the representatives of category associations. The aim of this part is to understand how the project is perceived by people, how it is impacting their life and if there can be any corrective action to improve its performance.

- **External observation:** this section is dedicated to the analyses and observation of different objective factors, such as media reputation or corruption, from an external and unbiased point of view.
- **Analysis with promoter's eyes:** in this part the analysis is carried out with the project promoter to understand if the project has produced the desired benefits for society or not.

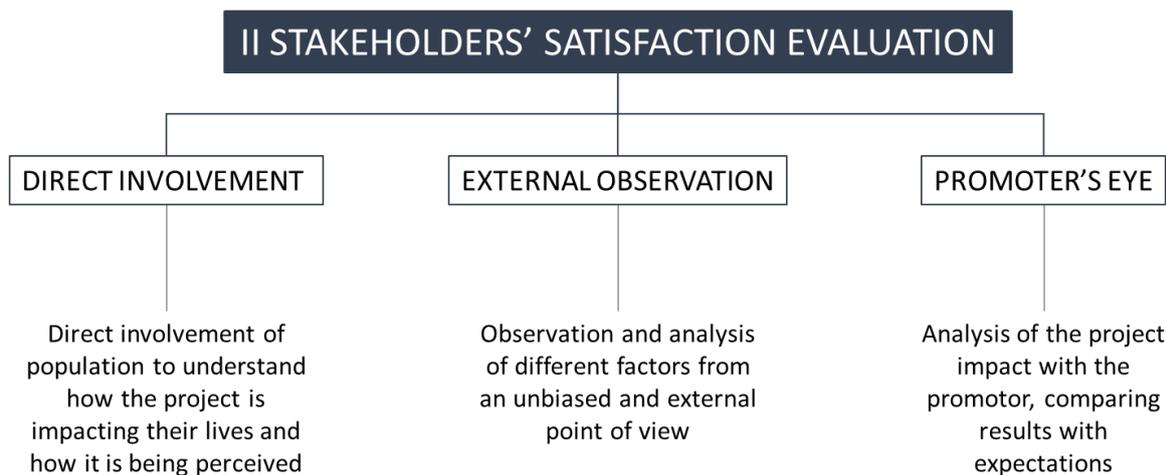


Figure 21 - The three evaluation approaches for secondary stakeholders' satisfaction assessment

Every aspect listed above then develops into a set of measurable KPIs that has to be evaluated and compared to expected values or reference valued and market to be quantified. The list of all KPIs is shown in the figure below.

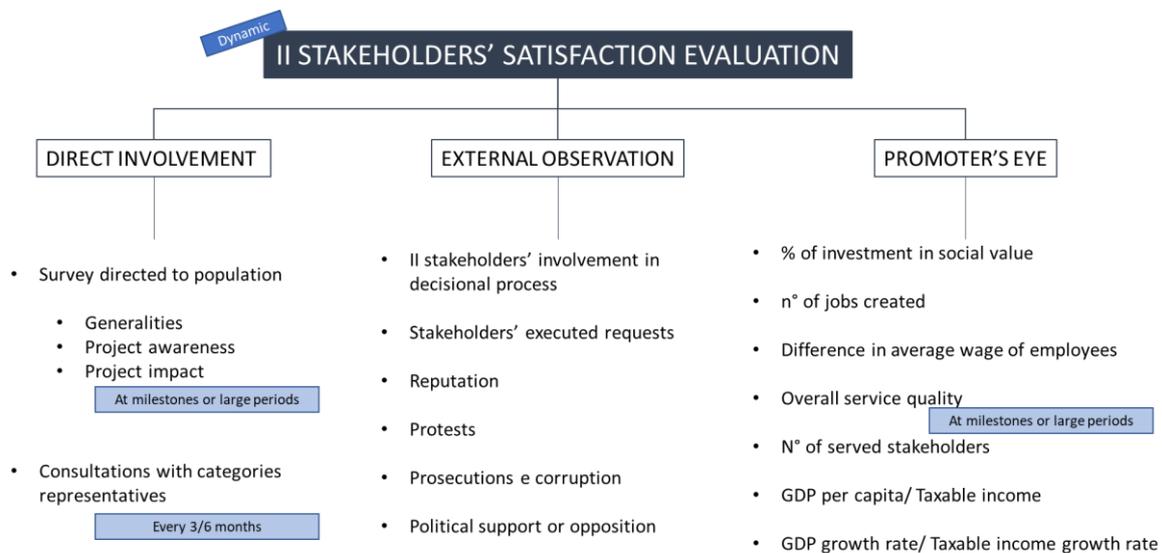


Figure 22 - Secondary stakeholders' satisfaction evaluation model

An evaluation that covers the three aspects listed above should give an overall view of how the project is impacting secondary stakeholders. As a matter of fact, limiting the analysis to direct involvement of population would be too biased since data gathering would be based on a subjective method and it is known that megaprojects are usually not well seen by citizens, especially in the first development phases. In fact, as Di Maddaloni and Davis underlined [123], when a new megaproject is initiated, local communities pass through different phases of acceptance:

- 1. Shocking phase:** when the project becomes real, local communities enter a phase of shock desperation and incredulity which leads towards an oppositional phase, due the unknown effects of the project and its perceived changes to the local area.
- 2. Oppositional phase:** phase when the local communities try to influence the decision making before project approval. This leads to tension dialogues and can result in well-organized oppositions causing major delays. This phase characterizes the 'unconditional opponents' groups and it is mainly strong in the preapproval stage, as the local communities' groups have more influence on project decision making.

3. **Acceptance phase:** this phase starts when the project gains approval and the level of influence of secondary stakeholders drops. The oppositional attitude ends, and the local communities are resignedly entering into a state of acceptance.
4. **Understanding phase:** as time passes, emotional reactions of local communities weaken, and they start to rationalize the purpose and objectives of the project. Moreover, they got used to the project and its disruption.
5. **Vision for opportunities phase:** as the project progresses and first results become tangible, the local communities start to have a vision for future benefits.
6. **Recognition of benefits phase:** in this phase the tangible asset has been delivered. The local communities fully recognize the benefits brought by the project.

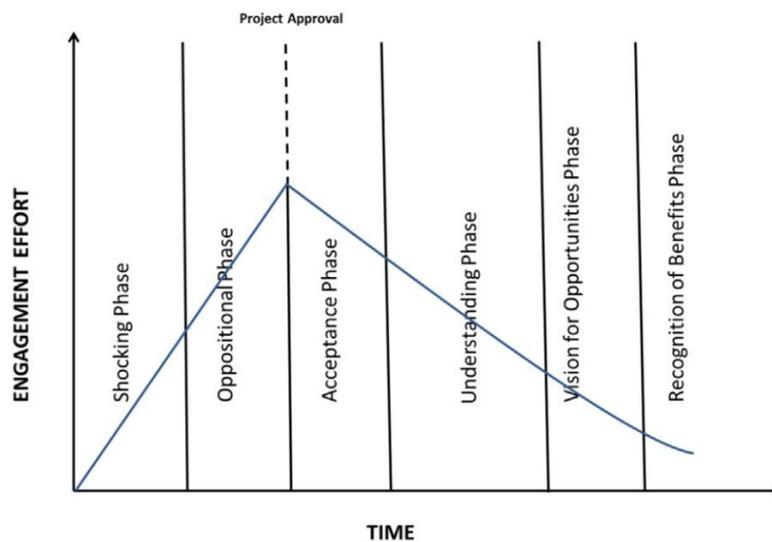


Figure 23 - Engagement effort at the local level through the major public infrastructure and construction projects (MPIC) life cycle (from Di Maddaloni F., Davis K. [123])

Given the evolution of secondary stakeholders' perspective, it is important to add to the evaluation an external and objective point of view in order to assess the impact and reputation of such megaproject from an unbiased point of view. Finally, the evaluation with the promoter is aimed at highlighting if the expected benefits for local communities have been realized or not.

Another important aspect of such an evaluation model is dynamicity. As a matter of fact, given the enormous time span to complete a megaproject, the fast-changing world, and the evolving approach of local communities, it is important to continuously evaluate how the project is performing and to eventually consider corrective actions. The model is conceived to be used in three different moments:

- 1. During project development:** this approach is important to assess how stakeholders perceive the project and how it is performing. In this way, managers can notice what is wrong and perform actions to adjust it. Moreover, if values, what stakeholders consider important, and their needs change during the project development the KPIs inside the model should be changed, removed, or added on the basis of this evolution. The objectives given by the promoter are usually long-term and can be seen only after many years since project completion thus making them more relevant after megaproject completion rather than during construction phases. The only parameter in the promoter's eyes evaluation that can be easily assessed also during project is the overall service quality, which evaluates the quality of the provided service and the disservice caused by the construction works.
- 2. Final project evaluation:** the same evaluation can be conducted right after project completion. The aim of this stage would be to assess the overall satisfaction after the project is completed, evaluating how its development and delivery are seen by citizens and how the entire work has been perceived. At project completion, long term effects given by the project are still difficult to quantify.
- 3. Ex-post project evaluation:** years after the project has been completed and citizens got used to it, and final evaluation of stakeholders' satisfaction can be

performed to assess if the project has positively or negatively impacted peoples' lives.



Figure 24 - Megaproject evaluation phases

The usage of this model as presented in the above paragraph would give a complete and continuous assessment of the project performance on secondary stakeholder's satisfaction and would be a useful tool to adjust management practices and manage discontent.

The final aim of the model is to produce an indicator, the *Secondary stakeholders' satisfaction factor*, which would give a mark on a scale from 1 to 100 to the project. A high score on the scale would signify that the project has well managed secondary stakeholders and that satisfaction in the population is high, on the other hand, a low score would be a sign of discontent. The computation of this indicator should be done both during and after the project to assess satisfaction evolution throughout project development and after project completion. For this reason, the indicator includes both dynamic and static factors, but the latter are considered only in the case of ex-post evaluation. The formula below shows how to compute the indicator:

$$II \text{ stakeholder}_{satisfaction \ factors} = \frac{1}{3}DI_{factor} + \frac{1}{3}EO_{factor} + \frac{1}{3}PE_{factor}$$

Equation parameters are described in the following table:

Parameter	Description
II stakeholders _{satisfaction factor}	<i>Secondary stakeholder's satisfaction factor</i> : overall score of the megaproject
DI _{factor}	<i>Direct involvement factor</i> : score from 1 to 100 that derives from the evaluation with direct involvement
EO _{factor}	<i>External observation factor</i> : score from 1 to 100 that derives from the evaluation with external observation
PE _{factor}	<i>Promoter's eyes factor</i> : score from 1 to 100 that derives from the evaluation of promoter's eyes parameters

Table 10 - Symbols and description of the parameters

The final formula is the weighted average of the three parameters obtained from direct involvement evaluation, external observation, and Promoter's eye evaluation. For each evaluation method, a score from 1 to 100 is obtained and the final score is the average of the three. It has been chosen to give equal weight of 1/3 to all three parameters since no research has been done to certify which of the three should be weighted more. It is left to future developments to conduct an analysis with interviews with experts to give proper weights to the three parameters if the model results imprecise as it is.

In the following paragraphs, all the KPIs of the three categories will be analyzed and explained.

5.1. Direct involvement

The first methodology to evaluate secondary stakeholders' satisfaction is the direct involvement of impacted citizens through two parallel approaches: surveys to population and consultation with categories representatives. The aim of this approach is to directly obtain the opinion of impacted people, understanding how they are perceiving the project, how it is impacting their life, how they have been informed about the future benefits and if there are particular concerns about its development.

Two parallel approaches are used to obtain different feedbacks: surveys to population give the possibility to directly obtain the opinion of citizens, however, they are known to be costly, time-consuming and invasive [204], [205], making it difficult to perform them at short time intervals. As a matter of fact, public surveys require a lot of time to be prepared, completed by the public and to be analyzed. Moreover, it is hard to have a big amount of people completing the survey, especially if many surveys are proposed to the public at short time intervals. Finally, by asking the direct opinion of people, it is common to obtain only negative feedback since people usually tend to share their concerns more than the positive view, making the results biased. To overcome the limits of surveys, it is useful to introduce in the analysis the consultation with categories representatives. In this way, consultation can happen at shorter time intervals and require less resources than surveys. Moreover, by listening to representatives, the opinion of citizens is already filtered by them and it is possible to obtain a more rational and concrete feedback. So, by using both techniques for the analysis, it is possible to obtain the direct opinion of citizens at large time intervals, and more constant feedback filtered by categories representatives to understand how people and secondary stakeholders are perceiving the project and if there is any corrective action that can be done to improve their satisfaction and limiting inconveniences.

In the following paragraphs the two approaches will be better explained and analyzed.

5.1.1. Population surveys

Population surveys are the first way of gathering opinions of secondary stakeholders' satisfaction by directly asking citizens to answer several questions, at long time intervals, about the impact that a specific project is having on their life and how they are perceiving it. In fact, social scientists usually use questionnaire surveys to measure public opinions on conflictive large infrastructure projects. [206]

In this approach, the proper consultation strategy has to be adopted: the correct time to collect feedbacks has to be considered and the structure of the consultations, means of interaction and other details has to be chosen. The consultation window should last at least four weeks [207], however, a period of eight to twelve weeks would work better. [208] Questionnaires are one of the most immediate ways to collect feedback, because of their versatility and the acquaintance that people have with them. Questionnaires can be composed of open-ended or closed-ended question and each of the two methods have both advantages and drawbacks. Open-ended questions are particularly useful when researchers do not know how participants might respond or want to avoid influencing their responses. They are thus powerful in the early stages of a project, as there are no response options to worry about. However, they take more time and effort on the part of participants and are harder to be processed and analyzed. In fact, the answers need to be transcribed, coded, and submitted to some form of successive qualitative analysis. The advantage to open-ended items is that they are unbiased, at least on the organization side, and do not provide respondents with expectations of what the expected answer is. Furthermore, this type of question is often more valid and more reliable, allowing the respondents to use their own words and to emphasize their main priorities. One of the main disadvantages is instead that respondents are more likely to skip open-ended questions because of their length. [209] Moreover, they may find it difficult to articulate their responses to explain their attitudes or motivations properly and fully. Their answer could even result incomplete because they may forget to mention important points. For this reason, it is important to provide some kind of outline for the answer. On the other hand, closed-ended questions may restrict the depth of participant response [210] and thus the quality of

data collected may be diminished or incomplete, so attention is required when defining the recipients of questionnaires. Therefore, questionnaire-based methods are not the best choice where little is known about a subject or topic area. In such an instance, qualitative methods may be more appropriate. [211] Additionally, they are used when an organization is interested in a well-defined aspect, such as the level of agreement of the stakeholders with some project design choices, and perceptions of risk or potential conflicts already known, which could arise in the following phases of the development. Closed-ended questions are more difficult to prepare because they have to include an appropriate set of response options. However, they are relatively quick and easy for participants to complete, and their analysis is way easier than in the case of open-ended items. Codes can indeed be assigned to the responses, and their results can be inserted into a spreadsheet. For these reasons, closed-ended items are much more common. [209] The approach to such analysis does not have to be composed by only open-ended questions or closed-ended questions, in fact, it is also possible to adopt a mixed approach, where closed questions are used to give an outline to the respondent on the topic of the question and the information that are of interest, and open questions are used later to let the respondent deepen in the topic and express its opinion. In this case, the outline remains somehow vague to allow the interviewee to feel free to share any comment, suggestion or criticism without being biased by the structure of the question itself, but on the other hand it facilitates the subsequent clustering of topics addressed, reducing the time needed for processing. The main advantages and disadvantages of open-ended and closed-ended questions are summarized in the following table.

Question	Advantages and disadvantages
Open-ended	Harder processing and analysis of responses, they allow the stakeholders to provide their suggestions, concerns and feedback extensively, less biased on the side of the organization, do not need a priori response options, generally more reliable
Close-ended	Easier processing of responses, easier storage, provide a tool to obtain categories of stakeholders, much quicker, immediate feedback over general perception and issues of the project, lower quality of data, easier to involve a higher number of respondents

Table 11 - Advantages and disadvantages of open and closed-ended questions.

For the questionnaire inside the proposed model, it has been thought about the usage of a mixed approach. Closed questions are proposed with the aim of gathering from the respondent the grade of satisfaction about the project under several specific topics. In fact, the answer to those questions is a Likert scale going from 1 to 5 which assesses the level of satisfaction or dissatisfaction that the person is having. After each closed-ended question, some space is left to add comments on the specific topic. In this way, it will be easy to perform a quantitative analysis of the results and to give a score to the project, but it would also be possible to deepen the analysis by looking at people's comments in a qualitative way.

Another important aspect to be considered when delivering surveys to the population is the need to reach the greatest possible base for the pool. The surveys are always done under voluntary basis so, it is fundamental to correctly sponsor and deliver surveys in order to have a relevant number of people completing them. In addition, to have statistical relevance and to give a clear idea of citizens' perception, the survey must be delivered to and completed by the greatest variety of people in terms of gender, age, culture, social class and political view. In order to reach this objective, it is important that the survey is correctly delivered and advertised in the right ways to reach all kind of people. For example, youngest generations will easily access the survey in digital platforms, so it can be published on the municipal website or the

project website and also advertised on social media. In fact, booming popularity of social media platforms, such as Facebook, Twitter and Weibo (the biggest microblogging site in China), highlights a new opportunity to collect and assess public opinions, making them valuable resources for assessing public opinions on large infrastructure projects, which are controversial and have significant impacts to the environment and society [47] and to reach a big portion of the population with a small amount of resources. On the other hand, the oldest generations will have difficulties in reaching the survey through those platforms, so it has to be delivered to them in paper format directly at home or at the post office or at the municipal office. It is important that the project managers are aware of this problem and they use the proper communication means to have the survey delivered to the widest possible public. Managers, when they analyze the results derived from the surveys, also have to be aware of the “underreporting bias”, an issue usually related to online reviews on platforms. It has been studied that usually online reviews mainly capture extreme rather than moderate opinions, as the customers with a moderate view on the product are less likely to provide reviews, if compared to highly satisfied or dissatisfied customers. [212] For the same reasons, stakeholders highly interested in the project, and so with a strong positive or negative perception of the work, will be much more likely to contribute, while the moderate stakeholders will not perceive the participation to the debate as a priority. Since the survey are done voluntarily, people will tend to complete them only if they are strongly satisfied or strongly dissatisfied by the project. This tendency of human behavior can drastically impact the survey results and positive or negative opinions can be exaggerated.

5.1.1.1. The survey

In this paragraph, a base structure for the survey will be presented. It is important to notice that this is a general structure for the creation of a survey, with general guidelines and general questions, however, it is left to managers of the specific project

to add or remove any question and to tailor the questionnaire on the project they are following to gather the data they are interested in.

The survey is composed by three different sections: generalities, project awareness and project impact. The first one is aimed at gathering the general data to later analyze the statistical data, while the other two are aimed at getting a feedback from stakeholders about how much they have been informed about the project and how the project is impacting their life. For the second and the third sections, questions must be short and simple and the answer is provided through a Likert scale, from 1 to 5, that assesses the satisfaction under a specific parameter. After the Likert scale, a section is left to provide additional comments. The combination of closed questions and space for comments should give managers an easy way to elaborate and analyze data, while also giving them the possibility to deepening topics of interest by reading and analyzing comments. When formulating questions, it is important to underline that they have to be clear and rational, without giving space to emotional answers which could alter the results, especially the ones about delivered benefits and life impact. Even though this kind of closed questions already leave little space to emotional answers, it is still important to keep in mind this aspect.

An example of how a question should be structured is provided below:

How has this project impacted your life?

- 1 – strongly negatively
- 2 – negatively
- 3 – no impact
- 4 – positively
- 5 – strongly positively

Please provide any additional comment in support of your answer

.....
.....
.....

The final score is assigned to the project by making the sum of all the grades given to each question and computing the percentage over the total. For example, assuming that the survey is composed by 10 questions, the maximum score that can be reached

is 50. If the sum of all the scores given by a person is 42, the overall score, reported on a scale from 1 to 100 will be: $\frac{42}{50} * 100 = 84$.

The information that has to be gathered in each of the three sections are explained below:

1. Generalities: this section is dedicated to the collection of data that will be used to perform statistical analysis, the data to be gathered are:

- Age
- Gender
- Profession
- Study title
- Category of belonging: for this answer, a list of the reference categories will be provided and respondents can choose between this list or add their own. An example of reference list is provided below, it can be considered as reference list for non-market stakeholders in transport infrastructures:
 - Citizens
 - Residents
 - Taxpayers
 - Landowners
 - Non-Governmental Organizations (NGOs)
 - Local authorities
 - Small and Medium Enterprises (SMEs)
 - Local shops
 - Trade associations
 - Other stakeholders -> their identity could result from site and project-specific brainstorming and from surveys.

It is important to understand that different people, when writing their own category, can write the same thing in different ways. Analysts, when

performing the analysis must pay attention to added categories and group the ones that can be reconducted to the same group.

- If impacted by the project or not

2. Project awareness: this section is dedicated to gathering data about the level of awareness that citizens have about the project. This data could be useful to understand how the informational campaign has been performed and how informed citizens are about the value that the project will deliver and the inconveniences that it will cause. It is known that public information is crucial in megaproject development and the more citizens are informed, the more their opinion about the project and their willingness to accept discomforts in the present for future benefits increases. If the results from this section are low, managers can adopt corrective actions to inform people during project development or in future projects. The topics that questions should cover are:

- Level of awareness before project beginning
- Informational campaign evaluation
- Local communities' involvement in the decisional phases
- Trust in promoter, project and involved politicians
- Expectancy of outcome adherence to promises

From these results it will be evident if citizens are informed about the project and if they have positive or negative expectations from its outcomes.

3. Project impact: the aim of the last section is to gather opinions about how the project is impacting citizens' lives and how they are perceiving the inconveniences during project development and the delivered benefits after project completion. The topics that questions should cover are:

- Quality of life improvement with the project
- Inconveniences caused by the project
- Impact of the project on people's lives

- Impact of the project on local communities
- Impact of the project on the environment

With questions covering those topics, managers should obtain a clear view of how citizens are perceiving the impact of the project on the quality of their life and on the environment they live in, both social and natural.

The answers to the questions covering the topics listed above will give a clear idea of how secondary stakeholders and citizen are perceiving the project both during its development and after its completion, making it easy for managers to understand which are the critical points that negatively affect public opinion and perform actions to limit all those criticalities in order to improve secondary stakeholders' satisfaction.

Given the fact that surveys are costly, time consuming and require a lot of time to be answered, they cannot be repeated too often. That is why they should be delivered at large time intervals or as projects reach certain milestones. The decision on the best time window to perform surveys is left to managers, depending on the needs of the specific project.

5.1.2. Consultation with categories representatives

As previously stated, using traditional methods to measure the public satisfaction is relatively difficult, as questionnaire surveys, time-consuming and invasive in collecting data from a large sample of the public. [47] For this reason, they can be performed at large time intervals, leaving long time gaps between one survey and the other. During this time gap, project managers do not have any feedback about how citizens are perceiving the advancement of the project. Since the proposed model is also a dynamic tool that has to be used during project development to timely understand criticalities and perform corrective actions, a constant feedback during project development is fundamental. For this reason, together with community surveys, also an evaluation through the consultation with categories representatives have been included. The aim of this consultation is to obtain a more constant feedback

during project development, without the effort required for public surveys. The topics that have to be covered in this consultations are the same that are present in the surveys, but, instead of asking them directly to the public, they are asked to representatives, making the process faster and with less required resources. In the consultation process, representatives are interviewed about the perception that their represented community has about the megaproject. In this way, project managers can have a filtered feedback about how works are going and about how secondary stakeholders are perceiving their work. With this timely and constant feedback, it is possible to understand all the criticalities and the requests that are brought forward by secondary stakeholders and implement actions to adjust the management practices to satisfy their needs where possible. The representatives to be involved in the hearings have to be chosen for each project depending on which are the impacted categories from each single project.

Both direct surveys and consultations with representatives have positive aspects and drawbacks. As a matter of facts, the answers in public surveys can be provided by totally uninformed citizens who have an a-priori aversion for the project and just want to raise concerns, while representatives can be involved in lobbying actions and can be motivated by individual interests or interests of their single community. The usage of both approaches in parallel should give a more clear and unbiased idea of secondary stakeholders' satisfaction. In fact, representatives will filter opinions coming from citizens and are expected to report only those issues that really are important to their community, while the direct involvement of citizens can clarify the issues raised by representatives really are in people's bests interest or are driven by personal or lobby interests.

The direct involvement of citizens will give a clear idea of the project perception from the people who are impacted by its development and, together with the two following approaches, will lead to the overall score under secondary stakeholders' satisfaction for the megaproject.

5.2. External observation

The analysis through external observation of different objective factors is the second approach to assess secondary stakeholder's satisfaction. In this case, the aim is to perform an objective and unbiased analysis from an external point of view. This method should mediate between the view of stakeholders and the one of the promoters, giving a more detached evaluation.

The assessment through external observation takes into account different measurable factors. Some of them can be computed or obtained by publicly available data and sources, while others require data to be collected and kept during project development. The considered factors are stakeholders executed requests, secondary stakeholders' involvement in the decisional process, protests against the project, project reputation, prosecution and corruption in the project governing body and project political support or opposition. In the next paragraphs, all these aspects will be deeply described and a method to measure them will be proposed.

5.2.1. Secondary stakeholders' involvement in decisional process

Stakeholder involvement in the decision-making process of megaprojects is a critical factor that can significantly influence the success of these large-scale initiatives. Stakeholders in megaprojects encompass a wide range of individuals and groups, each with unique interests, knowledge, and power. Their involvement in decision-making processes is crucial as it can influence the direction, implementation, and outcomes of the megaprojects. Managers nowadays recognize the fact that involving secondary stakeholder in the decisional process can improve the social value delivered to citizens and even the performances of the project since their involvement could lead to a reduction of opposition actions. As a matter of facts, stakeholder involvement is essential for several reasons. Firstly, it ensures that diverse perspectives are considered in the decision-making process, leading to more comprehensive and robust decisions.

[213] Secondly, stakeholder involvement can foster a sense of ownership and commitment to the project, thereby enhancing cooperation and reducing potential conflicts. [214] Lastly, stakeholder involvement can increase the transparency and legitimacy of the decision-making process, thereby enhancing the credibility and acceptability of the project outcomes. [215]

Since secondary stakeholders involvement is becoming more and more important in the project management practices, the evaluation of the extent to which local communities and citizens are involved in the decision-making process gives an idea of how the specific project is being managed and how secondary stakeholders are being considered or not. The measurement of this involvement is quite trivial since it is not easy to know a-priori which are all the local communities that are impacted by a specific project. To overcome this challenge, the proposed measurement methodology is iterative and adjusts the number of local communities throughout the project development. The model articulates in the following steps:

1. A basic list of categories is provided and the first measurement of the percentage of represented groups is computed. It has to be clear that this measurement is a first and general indication since it is not yet clear which are the really affected local communities in the project area. The initial list will be provided later in this chapter.
2. The basic list has then to be updated as the first community survey is performed. As a matter of fact, one of the questions about generalities in community surveys is the group to which a single person identifies. In this question, the basic list is provided and people can flag one of the proposed categories, or they can add their own if they do not find it in the list. After having this data from community pools, only those categories that have a relevant recurrence (for example the ones that appears on more than 10% of surveys) or the ones that are considered particularly important by project managers are included in the new list. Note that the threshold percentage that makes a category relevant or the decision on its importance independently from its occurrence is left to the specific project manager. One important thing

to be considered is the fact that when people write their own category, it can happen that different people write different words but they can be related to the same group. Analysts should be aware of this possibility and should put together people from same category who wrote it differently. After having updated the original list by removing or adding categories based on the survey results, the percentage of represented secondary stakeholders is again computed against this new list.

3. The list is updated and the statistic is computed every time a new community survey is performed during project development.

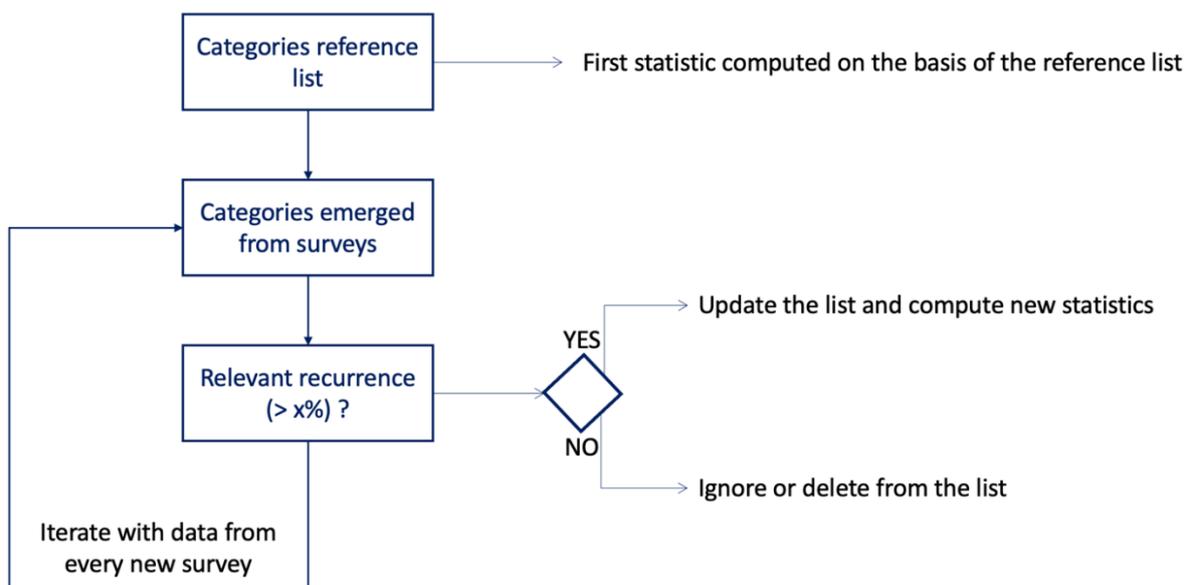


Figure 25 - Graphic representation of the iterative process for categories definition

The following list can be considered as reference list for non-market stakeholders in transport infrastructures:

- Citizens
- Residents
- Taxpayers
- Landowners

- Non-Governmental Organizations (NGOs)
- Local authorities
- Small and Medium Enterprises (SMEs)
- Local shops
- Trade associations
- Other stakeholders -> their identity could result from site and project-specific brainstorming and from surveys.

This analysis will result in a score from 1 to 100 which corresponds to the percentage of represented local communities over the total. For example, let's assume that from the surveys 15 categories of secondary stakeholders emerge and 8 of those are represented in the decisional process, the percentage of represented groups will be $\frac{8}{15} * 100 = 53\%$, meaning that the project score for secondary stakeholders' involvement is 53.

By performing this analysis during the project lifecycle, it is possible to understand if there are categories that have not been considered and that is better to involve in the decision-making process. Involving unconsidered groups throughout project lifecycle, will improve its performance under this parameter.

5.2.2. Stakeholders executed requests

Megaprojects are highly complex ventures that involve and impact on a huge amount of people. In fact, new infrastructure development is about developing a site-specific prototype based on the evolving needs and claims of many autonomous organizations and individuals, many of which are non-users of the future asset. [13] This is the reason why, during the development of megaprojects, many additional requests or claims are carried on by different people or organizations. All these additional requests are outside the original scope of the project and managers should decide to agree and realize the requests or to ignore them. This decision can sometimes be hard to take

because of the importance of the single request and the cost that has to be incurred in order to realize it. Additional requests are one of the causes of delays in the time schedule of the project and of cost increase and overbudget. However, it is important to consider and sometimes realize those requests since their realization is related to the perception and satisfaction of stakeholders for a particular project: the more additional requests are realized, the more stakeholders and secondary stakeholders should be satisfied from the project realization.

The stakeholders' realized requests are an important aspect to be considered in the analysis of the stakeholders' satisfaction and social impact of a megaproject. It has to be clear that for stakeholder 'requests are intended all those additional demands that are made by stakeholders and that are outside from the original project scope. Project performance under this parameter can be measure by keeping a database of all the requests performed by stakeholders during the development of a project. The database should include some simple data: first the request that has been received; second the timing of the request, meaning when the request has been done, if it has been done before the project started or when its development is already advanced; third the importance of the requests; its outcome, if it has been realized or not; and finally the cost incurred if the request has been realized. The database should be recorded in the following table:

Request	Importance	Timing	Outcome	Cost
	IMP(i)	TIME(i)	OUT(i)	COST(i)

Table 12 - Structure of the database for recording stakeholders' requests

- Importance is measures with a scale from 0 to 5 with the following criteria:
 - 0 – request has no impact on citizens or is incompatible with the project
 - 1 – request has a very low impact on a small number of people
 - 2 – request has low impact on a modest amount of people

- 3 – request has fair impact on a fair amount of people
 - 4 – request has a high impact on a big number of people
 - 5 – request has a really high impact and its realization is crucial for project success
-
- Timing scale measures the timing with which a request is submitted. Its values are applicable only for requests with importance from 0 to 4. Requests with importance 5 are considered crucial even if submitted lately. The scale values are:
 - 1 – request submitted before project beginning or if request importance is equal to 5
 - 0,66 – request submitted during early stages of project development
 - 0,33 - request submitted when project development is already advanced
 - 0 – request submitted at final project phases

 - Outcome represents the request's total realization, partial realization or non-realization with the following values:
 - 0 – request has not been realized
 - 0,5 – request has partially been realized
 - 1 – request has fully been realized

 - Cost keeps track of the cost of each single request if it has been partially or totally realized.

With such a database of data it would be possible to compute three metrics to understand how the project performed under this parameter. The metrics are:

1. Stakeholders requests realization factor:

$$STAKEHOLDER REQUEST_{realization} = \frac{\sum_i (IMP_i * TIME_i * OUT_i)}{\sum_i (IMP_i * TIME_i)} * 100$$

This metric measures the percentage of received requests that have been realized, weighted by their importance and the time of submission.

2. Average requests importance:

$$REQUEST IMPORTANCE_{average} = \frac{\sum_i (IMP_i * TIME_i)}{N^{\circ} \text{ of requests}}$$

This metric measures the average importance of the received requests, computed as the sum of importance * timing of each request, divided by the total number of received requests. This metric plays a central role in the correct interpretation of the previous one. In fact, if the realization percentage is low, but also the average importance is low, the overall performance is not poor. On the other hand, if the realization percentage is low but the average importance is high, the project performed poorly.

3. Total cost of realized requests, computed considering the cost of only fully or partially realized requests:

$$TOTAL COST_{realized requests} = \sum_i COST_i \quad \text{if } OUT(i) = 1 \text{ or } 0,5$$

This third metric gives an idea of the resources expended in order to realize all the requests. It is important since it gives an idea of the efficiency obtained in realizing requests, obviously the less the expended resources for realizing the same requests percentage, the higher the project performance. Moreover, by keeping the data about extra costs due to additional requests, it would be possible, at the end of the project, to evaluate if the budget has been respected or, if the project went overbudget, if the reason for this cost escalation are the additional requests or other causes. In this way, it would be possible to present to the public the real reason of cost escalations and the additional value that a project brought to communities and citizens.

Once the three presented metrics are computed, the project performance results from the combination of all of them. In a 3-axis graph, one for every metric, the overall performance of the project can be identified and a score from 1 to 100 can be given to the project. The precise score allocation depends on the single project and the project manager will be responsible for the final evaluation. In the following figure, an idea of how the score can be assigned is presented. Depending on the performance in each of the three metrics, the project will fall in one of the four color zones:

- **RED:** project score is from 0 to 20;
- **ORANGE:** project score is from 21 to 50;
- **YELLOW:** project score is from 51 to 80;
- **GREEN:** project score is from 81 to 100.

Project performance can be bad (red and orange zones) if the percentage of realized requests is too low and the average importance high, or if the incurred cost for realizing those requests it too high. On the other hand, if a high percentage of requests with high importance has been reached and the cost is moderate, the project will have a high performance. The following illustration better explains how the zones are distributed in the basis of cost, average requests importance and realization percentage.

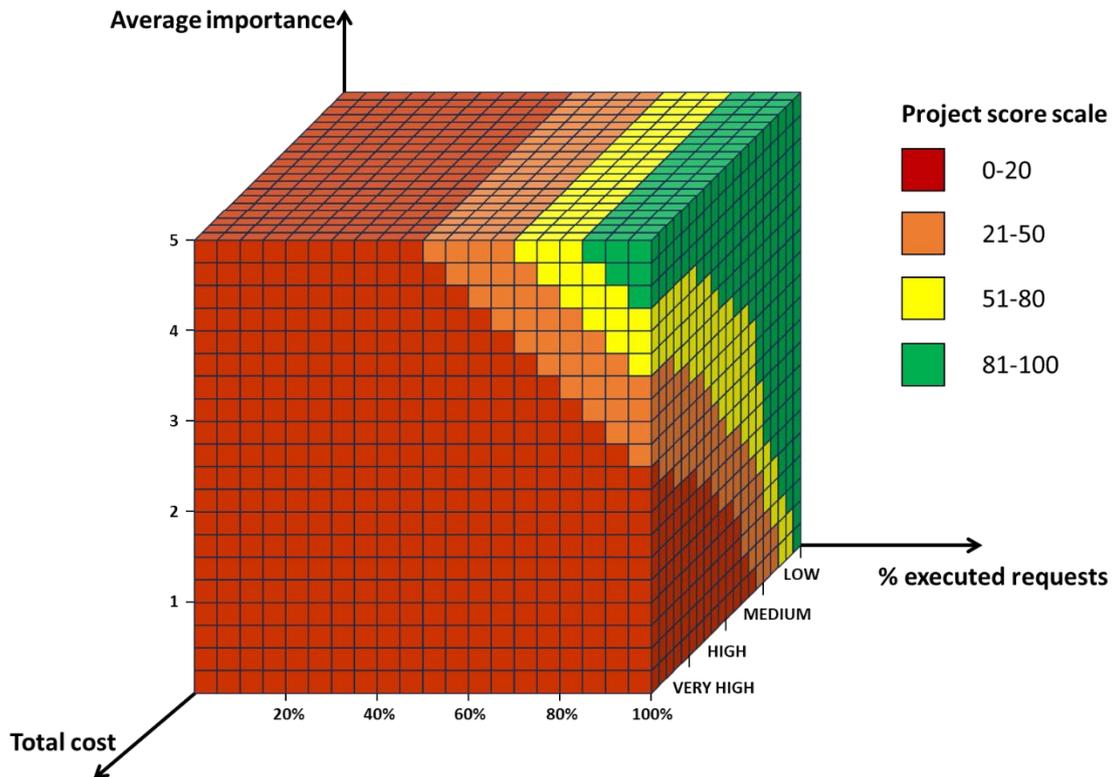


Figure 26 - 3D representation for evaluating Stakeholders' executed requests

This graph gives an idea on how to give the overall score to a project depending on the three computed metrics. In the cube, the front face represents maximum cost, so the project can have a good score only if both the average importance of realized requests and the percentage of the executed requests are high. The left face represents 100% of executed requests, in this case the project score improves as the cost decreases and the average importance increases. Finally, the above face corresponds to average importance equal to 5, here the project can be considered successful only if the percentage of executed requests is high. It has to be highlighted that some points on the graph have little sense, for example the down-left vertex, there average importance and percentage of realized requests is 0, while the cost is maximum. These points should not be considered, but for obvious graphical reasons are in the graph. This 3D representation is explicative, but hardly usable in real practice since the inside points are difficult to locate. Fort this reason, it follows a bidimensional representations of layers divided by intervals of average importance. The first graph is usable for average

importance between 0 and 1, the second for 1 to 2, and so on. Beware that this representation is qualitative and not extremely precise, so managers should use it with caution and adapting colors and evaluation scale to the specific project.

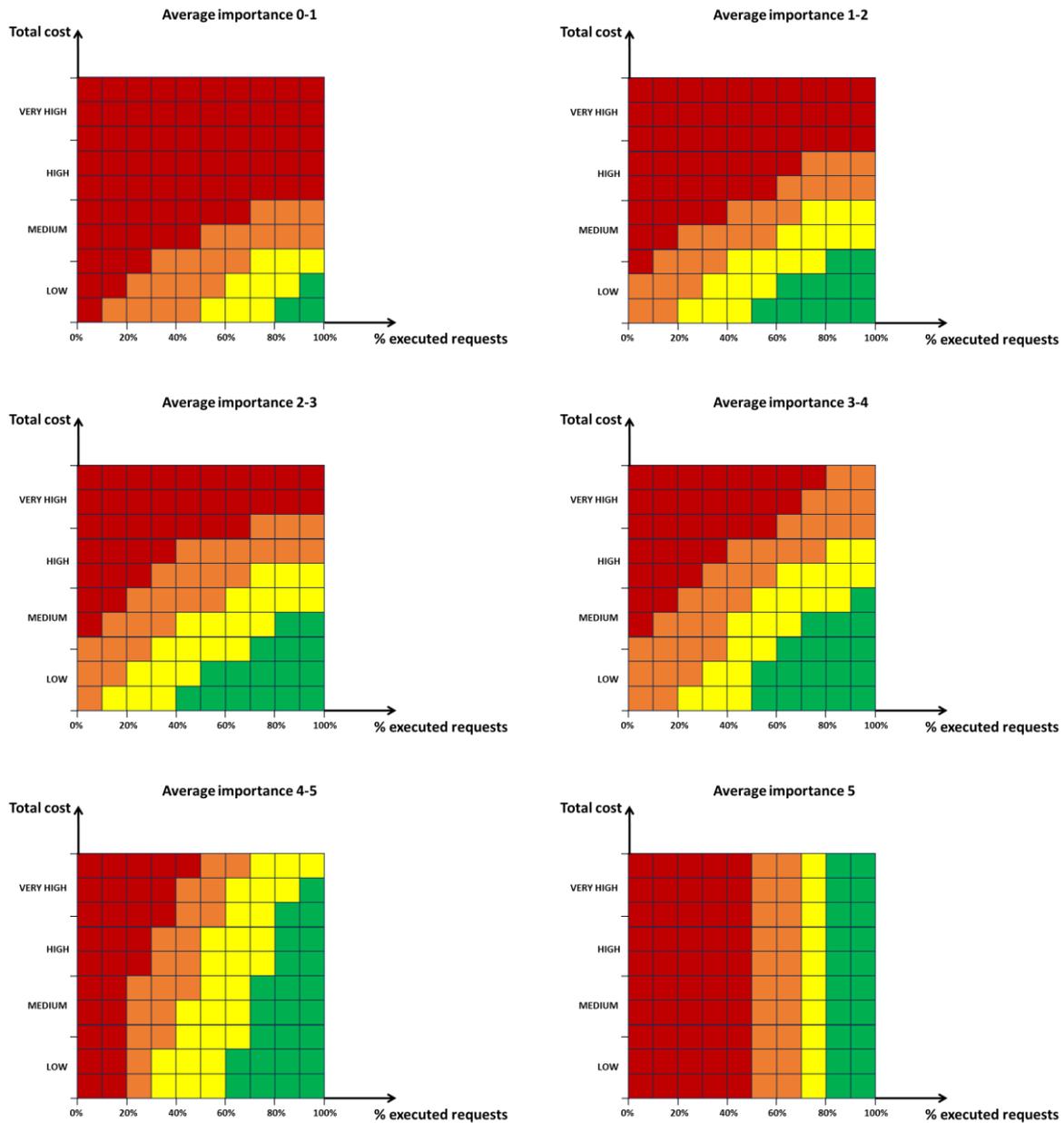


Figure 27 - Qualitative bidimensional representations of layers divided by intervals of average importance

5.2.3. Project reputation

Project reputation is a theme that is usually overlooked or not considered in megaproject management, and it is known that such kind of infrastructures suffer from negative reputation due to the fact that they are usually delivered late and they cost more than expected. However, in an economy where 70% to 80% of market value comes from hard-to-assess intangible assets such as brand equity, intellectual capital, and goodwill, organizations are especially vulnerable to anything that damages their reputations [216] so, paying attention to the reputation of a project where different companies participate should become a central theme of management practices. Moreover, in the evaluation stage of a large infrastructure project, the government and the management team are also exactly interested in the overall distribution of public sentiment, positive or negative, and the major topics of the public opinion on that project [47]

Reputation is perception, and this perception must be measured. This argues for the assessment of reputation in multiple areas, in ways that are contextual, objective, and, if possible, quantitative. Different techniques exist for evaluating a company or project reputation. Some of which are: media analysis, social media analysis, surveys of stakeholders (customers, employees, investors, NGOs) and industry executives, focus groups, and public opinion polls. Although all are useful, a detailed and structured analysis of what the media are saying is especially important because the media shape the perceptions and expectations of all stakeholders. [216]

Since in the model section of direct involvement the opinion of the population through surveys and consultations with categories representatives has already been analyzed, in this section the focus is primarily on what can be observed and measured from an external point of view, meaning traditional media analysis and social media analysis.

This kind of assessment can be performed both manually or with the support of computers and artificial intelligence. The manual procedure is difficult since the process of analyzing such a massive quantity of textual data requires a huge number of human resources and presents constraints of time, ability, and energy. [217]

However, to simplify the procedure, it is possible to reduce the pool for data gathering to only major local and national newspapers (considering something between 10 and 20 newspapers) and to understand if the articles written about a specific megaproject have positive, negative or neutral opinions about it. On the other hand, with the increasing analytic power of computers and of artificial intelligence, this practice can be easily done with this help, which reduces the needed resources and largely increases the amount of data and information that can be analyzed in order to understand the project's perception. As a matter of fact, AI-powered sentiment analysis is beginning to be used by enterprises as a key tool. It helps in obtaining an understanding of stakeholders' perspectives. The majority of the time, it is utilized to understand customer reviews, the seriousness of a service problem, social media references, etc. Though its full potential is yet unclear, sentiment analysis is currently being performed all over the world using cutting-edge AI algorithms. [218] Sentiment analysis can be a method for revealing insight into unstructured content by automatically analyzing people's opinions, emotions, and attitudes towards a specific event, individual, or topic based on user-generated data. [217] AI sentiment analysis is the process of recognizing emotions expressed in text. AI comprehends the tone of a statement, as opposed to merely recognizing whether particular words within a group of text have a negative or positive connotation. This process finds, evaluates, and categorizes as negative (-1), neutral (0), or positive (+1) the emotions expressed by individuals in any text data kind. It is a subtype of affective computing that seeks to recognize, evaluate, and categorize subjective information from the source material, such as emotions. Sentiment analysis is a task that uses information extraction and NLP to evaluate a huge number of documents to identify the writer's emotions expressed in negative or positive terms, interrogations, and appeals. [218]

In today's world, social media are the primary way in which people express their opinions and concerns about all themes. That is why, to get a more precise perspective on what people think about a project or a theme, it is wise to add to this analysis also posts and opinions on social media. In fact, using social media content to investigate the public opinion is a non-invasive research method avoiding the complications of interactions with human subjects and has a simple data collection process and a high

sampling rate (near 100%). The analysis of social media data can be performed from different dimensions. The first is the post intensity, which measures how many messages related to a specific issue have been published in a certain time period and/or within a certain region. Previous studies demonstrate that the post intensity on social media directly reflects the extent of prevalence of the issue. Another dimension is the sentiment of the public opinion. For any post collected from social media, sentiment analysis methods can determine whether the sentiment of the post is positive, negative, or neutral and subsequently obtain the sentiment distribution of all the posts collected. The sentiment distribution can reflect the extent of public support or satisfaction on the concerned issue. [47]

Once all data from traditional and social media analysis have been acquired, it is possible to compute the percentage of positive, negative and neutral stories over the total analyzed ones. From this data, the project reputation can be evaluated and a score can be given to it. As reported in an article by the Harvard Business Review [216], the Media Tenor Institute for Media Analysis in Lugano settled a threshold of positive and negative stories, above which the reputation of the analyzed project or theme can be considered positive. It is reported that reputation can be considered positive if there is at least 20% of stories which can be considered positive, and less than 10% of negative ones.

For our model, we considered positive, negative or neutral reputation as shown below:

- Positive: more than 20% positive stories and less than 10% negative stories.
- Neutral: if positive stories are less than 20%, but negative are still less than 10%.
- Negative: if negative stories are more than 10%, independently from positive stories percentage.

Then, a grade from 0 to 100 can be given to each project depending on manager perception and on the computed percentages. However, if a project has positive reputation, its score will be between 71 and 100; if its reputation is neutral, its score will be between 31 and 70; and if its reputation is negative, the score will be between 0 and 30.

This media analysis has to be continuously performed throughout project development at time intervals of 3-6 months. The percentages of positive and negative stories can then be plotted in a graph and the tendency of project reputation can be easily monitored. An example of resulting graph can be the following one.

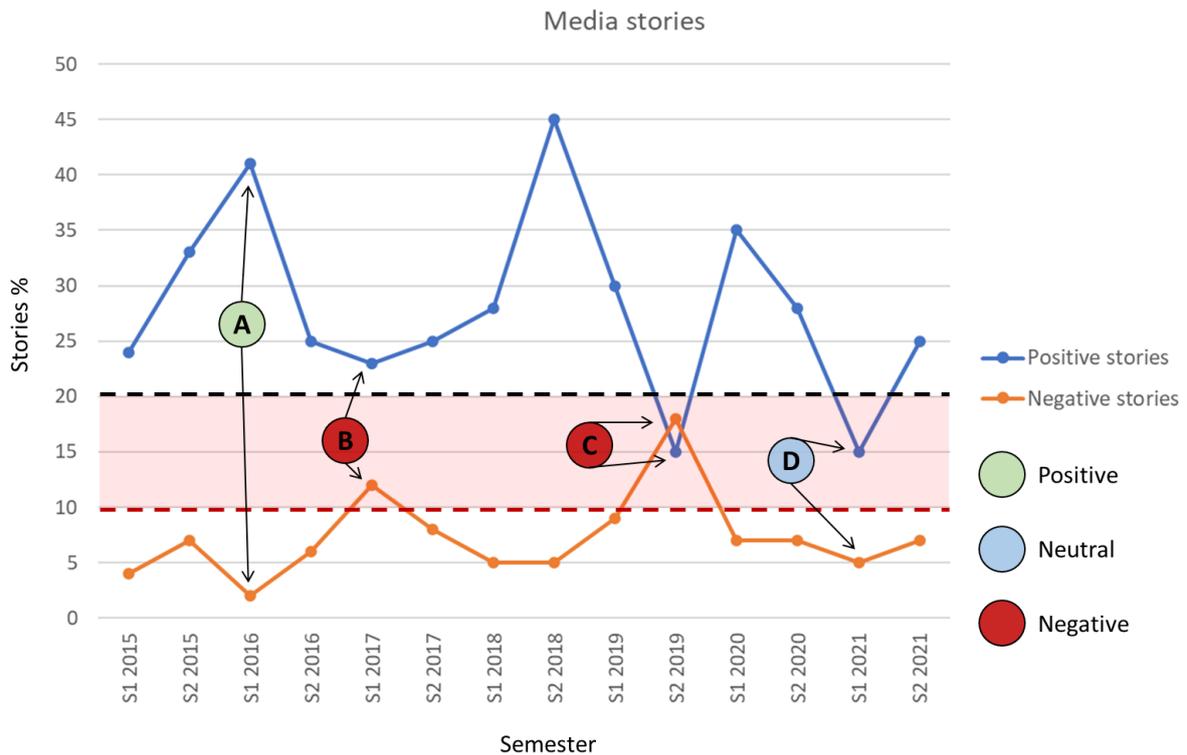


Figure 28 - Visual example for dynamic evaluation of megaproject reputation

From the graph it is easy to understand that in point A project reputation is positive, in points B and C it is negative and in point D neutral.

With a similar analysis, when there is a shift in reputational status, the management team can investigate the reason for this change and perform corrective actions if the reputation got worse or reinforce the positive trend if reputation is improving. In this way, project reputation can be monitored and actions can be timely undertaken to avoid bad media coverage or reinforce the positive moments, making project perception better.

5.2.4. Protests

The dynamic landscape of megaproject development often witnesses a consequential element: the emergence of protests or collective actions. These public manifestations of disagreement or concern are significant, acting as barometers for social acceptance of the projects and offering an important feedback mechanism. [219] Protests or collective-action problems arise when autonomous actors face a situation in which there is a tension between self-interest and the collective interest. This tension relates to the use or consumption, of common-pool resources, meaning resources that are shared by many autonomous claimants and have two attributes: first, the resource is rivalrous (or subtractable) because the use, or consumption, of the resource by one claimant reduces the flow of benefits to others. Second, the resource has low excludability because it is costly to limit the access of the legitimate beneficiaries either by physical means or through property rights. In the context of managing natural resources, collective-action problems lead to “take-some” social dilemmas. These are situations in which an individual action that benefits the self, often in the short term, leads to long-term losses for all, for example overfishing or overgrazing can make someone a short-term winner, but leaves everyone worse off in the long term. [20] Protest activity can influence the path of megaprojects, affecting their design, implementation, and reception. These mobilizations can originate from a multitude of issues, ranging from environmental concerns, perceived inequities, land acquisition disputes, to anxieties about cultural or social disruption. [220]

The gravity of protest activity in relation to megaprojects underscores the need for a well-defined evaluative framework. This would involve the measurement of the extent and intensity of protest activities, gauging their potential impacts on project outcomes. The precise measurement of protest activities is a multidimensional task, encompassing both quantitative and qualitative aspects. Quantitatively, the protest entity can be assessed using factors such as the number of protests associated with a specific megaproject, the estimated number of participants in these events, and the duration of the protest activities. However, these figures alone do not provide a comprehensive picture of the entity of protest activities. [221] Together with the

quantitative factors, also a qualitative assessment is equally essential. This includes examining the nature of the issues raised by protestors, the specific demands made, and the strategies adopted by protestors. [222] It also involves considering the geographical scope of the protests, whether they are localized to the immediate area of the megaproject or extend to regional, national, or even international levels. [223] Furthermore, the influence of protest activities on policy or project modifications serves as a critical indicator of their entity. It is crucial to discern the extent to which protests lead to tangible changes in the planning, implementation, or operation of megaprojects. [224] Thus, a comprehensive evaluation of protest entity requires a multidimensional approach that embraces both numerical data and qualitative insights. Integrating protest activity into the holistic evaluation of megaprojects is vital to accurately determine the project's social impacts and to lead to improved management.

Based on the above-mentioned evaluation factors, each project can be evaluated on a scale from 1 to 100. The following division can be a reference for megaproject protests evaluation; however, it has to be clear that the scale can vary depending on the specific project, its dimension, its location and many other specific factors.

- 0-20: huge protests with international relevance. Critical claims that can lead to substantial project changes or project cancellation.
- 21-40: large protests with national impact and long duration. Relevant claims that can lead to major project changes.
- 41-60: medium size protests with local to national relevance. Moderate issues raised that can lead to some project changes.
- 61-80: small protests with local relevance. Minor claims that can lead to minor project changes.
- 81-99: no real protests, just single individuals expressing concerns over project realization; no impact on project outcome.
- 100: no protests, nor single protestors.

With the previous analysis, managers can get an idea of how project is perceived and how protests are evolving throughout project development and implement actions to try to calm protestors before protests become too big to handle. As a matter of fact, major protests can lead firstly to project blockage or cancellation, but they also lead to bad media coverage and bad project reputation, damaging both the project itself and the participating companies.

5.2.5. Prosecutions and corruption

Megaprojects, due to their immense scale and complexity, often present a fertile ground for corruption and subsequent prosecutions. The intricate network of stakeholders, high financial stakes, and the often-opaque decision-making processes can create opportunities for illicit activities. [3] Such corruption can significantly impact the performance of megaprojects, leading to cost overruns, delays, compromised quality, and extremely bad reputation. Illicit actions during megaproject management practices lead to discontent throughout the population since people perceive that taxpayers' money are not used in their best interest. This leads to bad project reputation and to poor trust in governmental strategies to implement infrastructures, increasing a priori opposition and protest against megaprojects.

In the context of evaluating secondary stakeholders' satisfaction, considering corruption and legal actions against managers or politicians can give an idea of how stakeholders are perceiving the project. As a matter of fact, the absence of corruption or prosecutions largely improves the idea that people have about a certain project. To evaluate this parameter, it is necessary to monitor investigations and judgments throughout the project lifecycle. Project performance under these criteria can be positive, neutral, negative or strongly negative, depending on the presence of charges, their gravity and the level to which these charges become judgments. A possible scale to evaluate megaprojects on these themes can be:

- 0-20, strongly negative: conviction of one or more managers on definitive judgment.

- 21-50, negative: conviction of one or more managers in first instance judgment.
- 51-90, neutral: investigation of one or more managers.
- 91-100, positive: no investigations.

The score inside each interval is then assigned based on the severity of charges and the extent to which charges are distributed throughout the management team or political structure, and the value as percentage of project value that is gone into corruption.

The analysis of prosecution, corruption and judgments can be easily done by having a look to local and national media which usually give great space to such events.

5.2.6. Political support or opposition

The measure of political support and opposition of a specific megaproject gives the idea of how the interest in an infrastructure is shared among all parties or if it is politicized. This is an important measure to be included in an overall evaluation model since it can give an idea of how the project is perceived by citizens. As a matter of fact, usually the opinion of people around any governmental action is influenced by the opinion of the party in which they mostly identify. This is the reason why, from the measurement of political support of a project, it is possible to deduct also the support or opposition of citizens. Moreover, the interest in projects that have a huge impact on the economy and society of a country, such as mega infrastructure projects, such as mega infrastructure projects, should be shared among all parties since those should be infrastructures of regional or national interest. However, it is not always the case of such a clear and genuine practice. In fact, public investments and transfers serve not only the general interest but also the interests of specific groups. Driven by different motivations, politicians are likely to have an incentive to influence the allocation and spatial distribution of public investments and transfers. [225] Moreover, central governments might allocate resources to support aligned subnational governments. [226] Electoral concerns can be one reason for such alignment biases: subnational governments who share the central government's party are expected to offer support

in upcoming elections. Moreover, central governments might especially support aligned subnational governments to reward loyalty and to push through the own political agenda on the local level. [225] This usage of infrastructure as investments for political reasons can deteriorate a project reputation and the perception of citizens, which are influenced by opposing parties and not clear allocation of resources in citizens' best interest.

A metric that gives an indication of how much a project is politicized or shared is the percentage of governmental opposition that supports a particular megaproject. In fact, it is quite obvious that the parties that compose a certain government will be in favor of a project or an infrastructure sponsored by that same government. Opposition and concerns are usually carried forward by parties that are not inside the government, nor support it. In fact, governmental oppositions will only support projects and actions that are perceived by all as means of national development and national interest. Still, it is important also to consider that some parties could sustain an opposition a-priori, merely based on political antipathies and ideological reasons. In this case, this parties should not be considered.

The measurement of the common interest in a project is simply done by computing the percentage of opposition parties, weighted by their electoral results, that are in favor or not explicitly against a particular project and can be calculated as:

$$\text{Opposition support}_{factor} = \frac{\sum_i X_i * Party_i}{\sum_i Party_i} * 100$$

Where:

- X_i is a Boolean variable that is equal to 0 if the i^{th} party is explicitly against the project and 1 if it supports it or it is neutral;
- $Party_i$ is the percentage of consensus of the i^{th} party;

For example, let's assume that the government of a country is formed by parties that together form a majority of 52% of electoral consensus. The opposition is 48% and it is

formed by three parties with respectively 25%, 13% and 10% of consensus. Of this parties, the first one is in favor of the project ($X=1$), the second one is explicitly against ($X=0$) and the third one did not explicitly declare its approval or opposition to that project ($X=1$). The Opposition support factor is:

$$\text{Opposition support}_{factor} = \frac{1 * 25 + 0 * 13 + 1 * 10}{25 + 13 + 10} * 100 = 72,91$$

The overall score of the project under the political support aspect will be 72,91.

It is important to underline that for these statistics has to be computed considering national and regional governments for large infrastructure and only considering regional governments, or regional and local, for smaller ones. Moreover, these statistics should be computed at timely intervals during project development (for example yearly) since the political environment and the opinions can vary with time and if there is a change in the political support of a project during its life it would be important and useful to deepen into the reasons that brought to this change. If the change can be attributed to some good or bad introduced practices, or mistakes or success, it would be useful for managers to record what actions had what results in order to repeat them or not in following projects.

5.3. Promoter's eye

Promoter's eye is the third and last component of the holistic model that focuses on secondary stakeholders' satisfaction, the main scope of this section is to "analyze the impact of the Project from the Promoter's point of view, comparing the obtained results with initial expectations".

Choosing to evaluate the megaproject from the promoter's side seems out of context considering that the focus on the model is on secondary stakeholders (or local communities) but at the same time it's important to analyze a different set of KPI's that would come in handy to the promoter in order to understand if, during the project development and after its conclusion, everything went according to plan.

Unlike Direct Involvement and External Observation, which are characterized by KPI's that have short term variability, Promoter's eye parameters present a long-term nature, making their analysis more relevant in the ex-post evaluation. Nevertheless, especially for some of them, the analysis can be performed also during project execution.

Of the 7 introduced KPI's we can categorize them into two different types, the ex-post ones, and the dynamic one. This distinction is not strict and, as reported above, all parameter can be used during the whole analysis. In the following pages each category will be introduced and explained, showing why those KPI's were chosen, and which are the method to evaluate each of them. For the first category we consider:

- % of investment in social value
- n° of jobs created.
- Difference in average wage of employees
- GDP per capita/ Taxable income
- GDP growth rate/ Taxable income growth rate
- N° of served stakeholders.

And as the dynamic ones we can only consider the Overall Service Quality.

5.3.1. ROI vs SROI, the percentage of investment in social value

In today's world, the importance of openness, responsibility, and durability is growing for all entities. Society is increasingly demanding that organizations account for the social, economic, and environmental impacts resulting from their operations. This broader concept of value extends beyond mere financial considerations to embrace various dimensions affected by organizational activities. Both public and private sectors are recognizing the need to understand and manage this expanded concept of value. Despite societal expectations, organizations primarily evaluate their activities or projects based on the financial wealth they generate. Traditional investment appraisal methods, such as Return on Investment (ROI), Net Present Value (NPV), Internal Rate of Return (IRR), or payback period, have long focused on assessing the financial returns of an investment project. These methods often overlook potential project benefits that cannot be easily monetized, as well as potential negative impacts that are difficult to quantify in monetary terms. For instance, a project with a positive NPV but detrimental environmental impacts may not fully account for these negative effects in its NPV calculation.

From the traditional investment methods, we can define Return of Investment as an indication of the profitability of the company's operational management, represented as an annual percentage return on invested capital [227]

$$ROI = \frac{\textit{Total Benefits} - \textit{Total Costs}}{\textit{Total Costs}}$$

Figure 29 - From Wilson et al. [228]

Society is increasingly demanding that these hard-to-quantify effects be incorporated into project assessments. This demand extends beyond individual projects to the

concept of Integrated Reporting (IR), which requires organizations to account for both financial and non-financial impacts of value creation in the short, medium, and long term. This is also reflected in the concept of Corporate Social Responsibility (CSR).

Given the importance of the Social Return on Investment (SROI) in the context of promoter evaluation, it is crucial to dive deeper into this concept and demonstrate why it needs to be considered on the same plane as the traditional concept of Return on Investment (ROI). While ROI focuses primarily on the financial gains of a project, SROI extends this perspective to include social, environmental, and economic impacts. This broader view allows for a more comprehensive understanding of the project's value, acknowledging that the success of a project is not solely determined by its financial profitability but also by its contribution to society and the environment.

The importance of SROI in project evaluation, particularly in the context of megaprojects, cannot be overstated. Megaprojects often have significant social and environmental impacts, both positive and negative, that are not captured by traditional financial metrics. By incorporating SROI into the evaluation process, promoters can ensure that these impacts are taken into account, leading to more informed decision-making and better project outcomes. However, it's important to note that while SROI provides a more comprehensive view of project value, it is not without its challenges. Quantifying social and environmental impacts in monetary terms can be complex and subjective, and there is often a lack of standardization in how SROI is calculated. Despite these challenges, the use of SROI in promoter evaluation represents a significant step forward in recognizing the multi-dimensional value of megaprojects.

SROI is a relatively new technique, as said before it is a technique that quantifies and acknowledges a more comprehensive notion of value it assesses socio-economic and environmental influence, incorporating elements of cost-benefit analysis, stakeholder involvement, financial proxies, and project enhancement. It can be applied across a whole organization, a specific project, or even a minor activity, and is versatile across various sectors, including for-profit, non-profit, and governmental organizations. Its roots can be traced back to the mid-1990s in the United States, where it was initiated

by the Roberts Enterprise Development Fund (REDF). The New Economics Foundation (NEF) in the UK has further refined it since the late 1990s, emphasizing a broad stakeholder focus and a standardized approach.[229] SROI assigns a monetary value to social returns using financial proxies. These are then juxtaposed with the level of investment to derive an SROI ratio of costs to social outcomes. A SROI analysis can look back (retrospective) or look ahead (prospective), and it can cover the value generated by an entire organization or concentrate on specific programs or projects.

SROI serves as an instrument designed to aid organizations in addressing the essential query: "What amount of value are we producing?" It's designed for any entity that aspires to bring about a positive change in people's lives [187]. The emphasis of SROI is on value, transcending mere monetary considerations. As stated by [230], the outcomes that are quantified are the ones that are managed and given value. If the effects on individuals and communities aren't quantified, they risk being ignored, leading organizations to continue their efforts without a clear understanding of their efficacy. It can be approached from two angles:

- **Retrospective or evaluative studies:** These focus on examining the outcomes (results and impact) that a project or activity has already achieved.
- **Prospective or forecast studies:** These aim to project the social value that could be generated if the activities fulfill their intended outcomes. These types of studies are particularly beneficial for strategic planning and project selection with the goal of maximizing impact.

This allowed SROI to be only considered as a static KPI since its value during megaproject execution it's useless if quick actions need to be taken.

But why SROI over other methods?

A literature review carried out by Watson & Whitley [231] showed the various methods that fall under the Social Impact Assessment category.

Method/tool	Developer	Description	Benefits	Limitations
Social enterprise balanced scorecard (BSC)	Robert Kaplan and David Norton's BSC model (1992) modified by Social Enterprise London for the charitable sector	Internal management tool. Process focused. Visual representation of strategic objectives for multiple bottom lines, including social impact. Identification, achievement and measurement of two to four key goals (Clark, Rosenzweig, Long, & Olsen, 2004; Sanfilippo, Cooper, Murray, & Neitzert, 2009)	Useful for strategy development. Key goals communicated in a focused way. Encourages their deeper measurement via another social impact assessment method	Limited in scope to the essentials, not in depth. No quantitative results. No external validation or certification
The third sector performance dashboard	Social Firms UK – developed from an internal performance management tool	CD-ROM tool based on the BSC (see above). Software to monitor performance against typical objectives in the sector using template measures or build your own. Can be used for projects, programmes or a whole organization (Sanfilippo et al., 2009)	Simple, practical, user-friendly – provides templates and samples for busy organizations to use/adapt as required. Clear self-assessment of performance against set objectives. Can generate reports for external audiences	A dashboard of quantitative indicators – no exploration of long-term outcomes or impacts. No real external use. No external validation or certification
Ongoing assessment of social impacts (OASIS)	Roberts Enterprise Development Fund (REDF), 1999	Social management information system to assess organizational outcomes. Integrates tracking practices with mission goals (Maas & Liket, 2011)	Outcomes measurement based on credible research methods	Tracking process limited to outcomes of two years (Clark et al., 2004)
Social return assessment (SRA)	Pacific Community Ventures, 2000	Social investment portfolio system to assess the social return of each investor. Distinct from financial performance assessment. Retrospective. Process focused (Maas & Liket, 2011)	Useful to target and improve services. Social returns in financial form	No impact measurement
Social accounting and auditing (SAA)	Social Audit Network; also Jed Emerson's blended value accounting (Emerson, 2003)	Organizational framework for monitoring, evaluation and accountability. Evidence base for societal impact of economic activities for both internal and external stakeholders. Also used for internal decision-making. Does not require monetization of outcomes (Gibbon & Dey, 2011; Sanfilippo et al., 2009)	Flexible and holistic method for evaluating organizational performance and impact. Stakeholder engagement focus. Useful for strategic planning, CSR (corporate social responsibility) activities. External validation of social accounts	Time intensive, not yet recognized by funders. Flexibility of process reduces comparability of results. No benchmarking
Social impact measurement for local economies (SIMPLE)	Social Enterprise London and University of Brighton	Organizational framework to understand, measure and communicate impact. Internal strategic review combined with outcomes-based assessment. Five stages: scope, map, track, tell and embed (McLoughlin et al., 2009; Sanfilippo et al., 2009)	Quantifiable data collection. Strategic perspective to analysis. Holistic use across various levels of an organization	Time intensive at the beginning. No external validation or certification
Benefit–cost ratio	Robin Hood Foundation	Framework for making philanthropic investment decisions via predictive cost–benefit analysis. Underpinned by the principle of 'relentless monetization': outcomes are assigned monetary value relentlessly, even when they are hard to measure or evidence is slim. Can direct spending to programmes that do the most good per dollar of costs (Weinstein & Bradburd, 2013)	Offers a common yardstick to measure the success of philanthropic outcomes. Flexible seven-step framework (Clark et al., 2004; Weinstein & Bradburd, 2013)	Time intensive and costly. Requires a wide skill set. Broad-brush approach, no replicable method

Figure 30 - Summary of methods that fall under the Social Impact Assessment category (from the work of Watson and Whitley, part 1 [231])

Method/tool	Developer	Description	Benefits	Limitations
Social Return on Investment (SROI)	Roberts Enterprise Development Fund (REDF) in the mid-1990s in the US; brought to the UK in 2003 by the New Economics Foundation (nef); The SROI Network was established in UK in 2008 and renamed Social Value UK in 2014	Outcomes-based measurement tool, related to cost–benefit analysis. Project/activity focus. Mixed methods: qualitative stakeholder engagement, quantitative outcomes measurement, valuation via financial proxies, to produce the SROI ratio of costs to social returns. Also produces a narrative of the organization's value creation (Clark et al., 2004; Sanfilippo et al., 2009)	Produces a transferable, financial metric in 'ROI' (return on investment) language understood by investors and commissioners. Credible results based on actual data and proxy research. nef's version promotes consistency in approach for robust results. Can be applied as predictive or evaluative. External validation through Social Value UK and others. One of the most developed social value tools	Time intensive and costly. Requires a range of skills, from stakeholder engagement to spreadsheet analysis. The ratio is often used out of context of the accompanying narrative report
Social e-valuator	d.o.b. Foundation, Noaber Foundation and Scholten Franssen (Dutch consultancy)	Web-based software acting as a guide to the SROI method. Provides information, expert knowledge and on-line training (Anyetei, 2012)	Provides a comprehensive guide to the complex SROI process which requires a range of skills (as above)	Software is purchased under licence
Basic efficiency resource (BER) analysis	Dr Brian Cugelman and Eva Otero for the Oxfam GB global climate change campaign	Cost-effectiveness-based framework for the evaluation of complex programmes by enabling a comparison between operational 'units', e.g., teams, departments, functions. Shares underlying the theoretical foundation with SROI, but no financial valuation. Over- or underperformance visualized in two-dimensional matrix of quadrants (Cugelman & Otero, 2010; Eurodiacona, 2012)	Simple framework for the evaluation of complex activities. Provides results that are easy to understand. Initiates a deeper discussion to understand why units fall into specific quadrants. Can be used to compare internal and external perspectives	Time intensive and costly (less so than SROI). Lack of quantitative results. Not to be used as the only evaluation approach. No monetization. No external validation or certification
Best available charitable option (BACO) ratio	Acumen Fund	Prospective project-focused tool to identify how best to allocate philanthropic resources. Compares cost per output of intended project with similar project. No impact measurement or valuation (Lee & London, 2008; Weinstein & Bradburd, 2013)	Cost per output focus means output units common to both projects are used, e.g., number of end users. Avoids the need for aggregating across various types of outcomes which is complex	Cannot direct funding decisions across different types of projects. Impacts are not valued
Cost per impact	Center for High Impact Philanthropy	Metric to estimate the cost of achieving a single, primary outcome. Like an inverse cost–benefit analysis. Retrospective. Empirical definition of success and the costs associated with achieving that success (Maas & Liket, 2011; Weinstein & Bradburd, 2013)	Useful starting point from which to evaluate an opportunity	Cannot aggregate across different categories of outcomes
Expected return	William and Flora Hewlett Foundation	Measure for the expected impact of a grant. Benefit monetized and multiplied by the probability of success. A prospective cost–benefit analysis (Maas & Liket, 2011; Weinstein & Bradburd, 2013)	Useful for application to large-scale projects	No stakeholder engagement focus. Simplified divide between success and failure

Figure 31 - Summary of methods that fall under the Social Impact Assessment category (from the work of Watson and Whitley, part 2 [231])

Not all the methods that are listed are able to give a tangible quantification on the social impact of the megaproject. SROI was considered as the most developed method

and, by using Weinstein and Bradburd [232] research, there are four main elements that must be considered when evaluating SROI respect to other social impact assessment methods.

Those are:

- **Evaluating outcomes as opposed to merely counting outputs (i.e., the number of end users)**

A review of various existing social impact tools revealed a common focus on evaluating outcomes rather than merely counting outputs, with BACO being the only exception.

- **Capability to equate different types of benefits**

While most methods consider the cost of generating social impact, only a few assigns a monetary value to social returns, thereby enabling a comparison across different types of benefits and consideration of value returned. These methods include social return assessment (SRA), benefit-cost ratio, SROI, and expected return. SRA provides a financial representation of the social returns of investors, but this pertains to the returns of their processes, not impact measurement. Benefit-cost ratio, SROI, and expected return all use financial proxies to demonstrate the value of social returns in a more exchangeable manner.

- **Incorporation of counterfactual evidence (other factors) in impact creation**

SROI, unlike benefit-cost ratio and expected return, has a robust and repeatable method with detailed guidelines, including comprehensive impact establishment activities to avoid attributing counterfactual evidence. Moreover, while expected return does not stress stakeholder engagement, it is a crucial element of the SROI method to enhance the credibility of identifying, measuring, and establishing the impact of social outcomes.

- **Relevance to effective and coherent funding decisions**

SROI can be applied both prospectively and retrospectively, unlike the prospective application of benefit-cost ratio and expected return. This enhances its relevance to investment decisions and learning from completed projects.

SROI distinguishes itself as a highly refined tool for gauging social impact, being the sole instrument that aligns with all four elements of Weinstein and Bradburd's [232] model. Its design is oriented towards assessing the results of an action, as opposed to merely monitoring outputs. Moreover, its approach to assigning monetary value enables the juxtaposition of benefits from diverse activities that might otherwise be non-comparable. The outcomes are presented in a 'return-on-investment' style, a language that resonates with investors and commissioners. These outcomes are grounded in actual data, collected via qualitative stakeholder involvement, ensuring that the measurements taken are relevant to the end users. This is facilitated through a thorough, reliable, and repeatable approach that has undergone recent standardization [233]. Consequently, SROI has seen a considerable surge in its application within the social enterprise domain [234], and its use is progressively expanding into public policy [235], [236] and the commercial sector [237].

The unique value proposition of SROI lies in its ability to monetize outcomes identified through qualitative stakeholder involvement. This results in a versatile evidence base that can be shared with a broad spectrum of audiences.

According to [229] and the SROI network, SROI is grounded on seven principles designed to ensure a robust, transparent evaluation or implementation process that actively involves stakeholders. These principles are stakeholder involvement, understanding changes, valuing what matters, including only what is material, avoiding over-claiming, maintaining transparency, and verifying results.

These principles underpin a six-step approach:

- **Stage One:** Define the project's scope and identify key stakeholders.
- **Stage Two:** Develop an impact map with stakeholder involvement. This map outlines the relationships between inputs (resources), outputs (results of

change), outcomes (immediate effects), and impacts (long-term effects per year, considering additional influencing factors).

- **Stage Three:** Assign value to the identified outcomes using indicators. SROI employs financial proxies for inputs/outcomes that may not have a direct financial value.
- **Stage Four:** Evaluate four additional scenarios: deadweight (outcome that would have occurred regardless of the activity), displacement (potential unintended outcomes), attribution (assessment of the outcome's causation by other projects), and drop-off (deterioration of the outcome over time). These scenarios are also valued using indicators.
- **Stage Five:** Calculate the SROI ratio, which requires a projection of inputs and benefits over the project's lifespan. The impact per year is calculated by summing all benefits and subtracting all negative outcomes or scenarios, with a discount rate applied to calculate the Net Present Value (NPV). The SROI ratio is then calculated as follows:

$$\text{SROI} = \frac{(\text{Net Present Value of Impact})}{(\text{Net Present Value of Investment})}$$

A sensitivity analysis is recommended to assess the robustness of the ratio.

- **Stage Six:** Communicate the results to stakeholders and embed positive outcomes.

A study conducted by Gosseling et al. [238], analyzed seventeen studies published between 2010 and 2018, on PAS (Physical Activity and Sport) used to prevent and treat noncommunicable diseases such as heart disease, stroke, hypertension, diabetes and breast and colon cancer. Even though the study treats a completely different topic it's

useful as a foundation to understand how to create an evaluation range for SROI in different types of megaprojects.

Each analyzed study from Gosseling et al. [238] produced a different SROI from which a range has been created varying from a value of 1.7:1 up to 124:1, even the authors stated that depending the size of the pool of the analyzed projects the range could vary significantly, also too high values of SROI should be justified and depending on the outcome can also be considered as outliers. A study review on public health showed even different values of SROI, ranging from 1.1:1 up to 65:1 [239]; that shows that depending on the type of analyzed project a different scale should be adapted, for instance we would have a different SROI range for infrastructure megaprojects respect to health related megaprojects, since the last ones would likely shows higher ranges of SROI due to their nature of health and public relation.

For future developments it suggested to create a megaproject database that groups the different types of megaprojects, for each one of them the SROI would be computed and a range for each category created. This will allow future megaprojects to know instantly how they would position on this range assessing their success or failure. The real comparison should be done on a ex-post evaluation to really understand if the forecasted SROI was calculated correctly or not, also to understand if it exceeded expectations or not. Those considerations where the base on why SROI was chosen as a major KPI in the presented holistic model.

In the same category of SROI, considering it as the most important KPI, lie other three performance indicators: n° of jobs created, Overall service quality and number of served stakeholders.

5.3.2. N° of Jobs Created

The objective of this KPI is to assess the number of new jobs positions created by the megaproject and all the collateral activities related to it.

It does not only include the jobs directly created by the megaprojects itself, but also includes the jobs generated or supported by the local economy and subcontractors.

As proposed by the work of Chazara et al. [240], the jobs created can be divided into 3 categories: direct, indirect, and induced jobs. The work proposed by Chazara is focused on the jobs creation by production systems, but the concept can be easily extended in the realm of megaprojects.

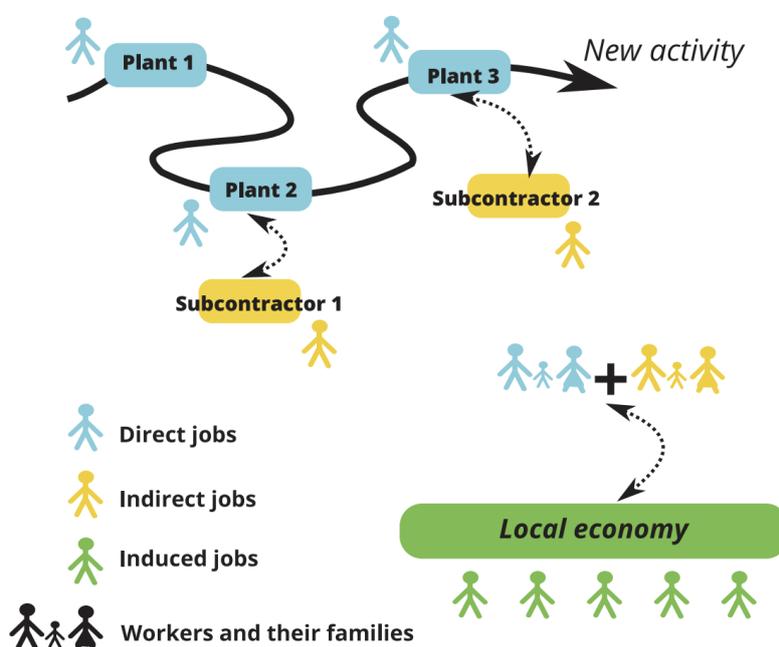


Figure 32 - Different types of created jobs (from the work of Chazara et al. [240])

The sum of direct employment opportunities is indicative of the aggregate of positions that are directly established as a result of the project's initiation, in other words, the job openings that arise directly from the megaproject starting.

The count of indirect jobs pertains to the total of subcontractors engaged with the newly initiated project. This figure may or may not reflect new job openings, but it does indicate a secondary effect on the local economic structure.

The concluding figure refers to the induced number of jobs within the community, denoting the workforce that is maintained by the new (either direct or indirect)

employees of the establishment, the subcontractors, and their respective families within the local economy. This includes job creation external to the megaproject activity, linked with current household spending in the local economy due to the job creation (both immediate and secondary). As a result, the aggregate job count is region-specific.

So the total number of jobs created can be estimated as:

$$N^{\circ}ofJobsCreated = DirectJobs + IndirectJobs + INducedJobs$$

Each of the three categories follow different methods for their estimation[240]:

- **Direct Jobs**

When talking about direct jobs creation in the realm of megaproject it must be said that it has significant implications for regional economic health and societal well-being, so warranting a rigorous methodological approach for accurate assessment is necessary. While megaprojects are inherently multifaceted, estimating the direct jobs they create can often be framed within two broad paradigms: traditional employment formulas and more complex economic models.

One of the most straightforward approaches to calculating direct jobs relies on the concept of man-hours. The formula can be expressed as:

$$Direct\ Jobs\ Created = \frac{Man\ hours\ required\ for\ the\ project}{Average\ Man\ hours\ per\ Employee\ per\ Time\ Period}$$

The numerator, representing total man-hours, is the summation of the estimated labor hours needed for every role directly associated with the project. This could include a range of workers from engineers and managers to clerical staff. The

denominator, on the other hand, specifies the average number of hours an employee is expected to work during a given time frame, such as a week or month. This average is shaped by the terms of employment contracts and prevailing work culture. By using this formula, project planners can acquire a rudimentary yet useful approximation of how many direct jobs would be created, thereby facilitating workforce planning and broader economic impact studies.

While this approach offers an initial approximation, its simplicity may sometimes overlook crucial elements such as part-time versus full-time employment or the transient nature of some jobs, such as seasonal or contractual employment [241]. For a more nuanced understanding, Input-Output models have been increasingly recognized as potent tools. These models integrate a range of economic activities and their inter-sectorial dependencies to offer a comprehensive picture of direct employment impacts. While these models are robust, their customization to specific industries or geographical regions adds layers of complexity [242]. State-of-the-art software tools have further refined our understanding. These software solutions incorporate industry and region-specific employment multipliers but tend to envelop not just direct, but also indirect and induced jobs, thereby providing a more holistic but less 'direct-only' focused understanding. It is also worth noting that certain specialized megaprojects necessitate project-specific metrics. For instance, construction-based megaprojects may require an employment calculation based on the types and quantities of labor required for different tasks, each varying in their complexity and man-hour demands. These metrics can often be sourced from industry benchmarks and labor statistics databases, offering another layer of specificity (U.S. Bureau of Labor Statistics).

- **Indirect Jobs**

As said before, indirect jobs regard the total of workers from subcontractors engaged with the megaproject. The formula used to calculate this number is the following one:

$$\text{IndirectJobs} = pCA * NbW$$

Where:

- pCA : it is the part of the turnover generated from the studied activity respect to the global turnover of the megaproject.
- NbW : it is the amount of subcontractor manpower.

▪ Induced Jobs

The premise of this estimation is the belief that the count of induced jobs within the local economy correlates with the household expenditure generated by individuals in direct and indirect employment, along with their families.

$$InducedJobs = JIA * PWLP * \frac{(DJ + IJ) * SF}{P}$$

Where:

- DJ : number of direct jobs
- IJ : number of indirect jobs
- SF : average household size nearby the megaproject
- P : dimension of the population of the interested area
- $PWLP$: portion of the local workers supported by the local population. It is the percentage of sales coming from household consumption reported to the sales by the sector of the megaproject.
- JIA : number of jobs in the area

Quantifying indirect and induced employment is challenging due to their complex nature. The count of subcontracted workers, influenced by various activities, can only be approximated. This approximation, as suggested by Chazara et al.[240], is determined by comparing the turnover of subcontractors from the activity to the

overall turnover, assuming an equal contribution from each worker. However, Dutailly [243] argued that the workforce size does not scale proportionally with the capital invested, implying a non-linear relationship.

Induced employment, a statistical concept, is estimated based on assumptions about household expenditure patterns, so local household consumption habits significantly influence this parameter. The approximation is derived from the ratio of family members to the total population in the region under study, considering the proportion of employees supported by population consumption. However, these indicators are challenging to compare with actual figures due to the difficulty in obtaining real data. [244]

In summary, precise job creation estimation is complex, and only rough approximations have been achieved. Megaproject related activities can positively impact the region where it is established, and the estimation should consider all dimensions. Therefore, the classification into direct, indirect, and induced employment is fitting. Economic outputs are frequently used to measure these indicators, particularly for direct and indirect employment. For induced employment, local area characteristics are crucial.

The impact of a megaproject on the local economy varies between rural areas and cities. In cities, existing infrastructure can accommodate the new population, while in rural areas, new industrial activity can stimulate growth, thus creating a higher employment demand in future years.

As for the other calculated KPIs, those must be compared with real data gathered after project completion to see if the forecasts were accurate enough and the megaproject has been a success in terms of Jobs generated. Data for post evaluation can be easily accessed through governments statistical data sites (as the likes of ISTAT for Italy, Office for National Statistics in UK, Statistics Bureau of Japan in Japan and others).

To align the KPI to the other ones it must be transformed into a scale from 0 to 100, of course if the actual total number of Jobs created exceeds the forecasted one the score assigned would be equal to 100, if not the percentage would be calculated as:

$$\frac{N^{\circ} \text{ of Jobs Actual}}{N^{\circ} \text{ of Jobs Forecasted}} * 100$$

To be able to better understand the effect that the megaproject had on the increase of jobs from a social point of view it could be better to calculate the final evaluation leaving out the direct job creation, since its performance is biased by the internal organization of the megaproject and doesn't really represent the effect that the megaproject had on society. The formula would then become:

$$\frac{(N^{\circ} \text{ of Indirect} + N^{\circ} \text{ of Induced})_{Actual}}{(N^{\circ} \text{ of Indirect} + N^{\circ} \text{ of Induced})_{Forecasted}} * 100$$

5.3.3. Difference in average wage of employees

When events of such magnitude as a megaproject take place, it is expected to see a large impact on the economy of the area, and so also the wage of employees of the interested area are likely to increase.

The methodology proposed to measure this increase, or less likely decrease, is the Difference-in-Difference (Did) method. This method is one of the most frequently used methods when an impact assessment study needs to be carried out. It was firstly introduced by Labor economists Lechner [245], the scope of this approach is to amalgamate the perspectives from comparisons of treatment-control across different sections and studies conducted before and after an intervention, thereby enhancing the reliability of identification.

Let's consider an assessment aiming to determine the impact of a policy (or "treatment") that's not randomly implemented. This is done by comparing the outcomes in the group affected by the policy (treatment group) to a group not affected

(control group), using data from after the policy's implementation. Suppose there's a difference in outcomes. Firstly, if there are other changes over time that also affect the control group, these factors are accounted for when the difference in the control group's before-and-after outcomes is subtracted from the impact estimate. Secondly, if there are significant characteristics that influence outcomes and differ between the treatment and control groups, these differences are negated as long as they remain constant over time, by focusing on changes over time.[246]

The formula used to describe this “difference” is the following one:

$$Did = \left(\bar{y}_{s=Treatment,t=After} - \bar{y}_{s=Treatment,t=Before} \right) - \left(\bar{y}_{s=Control,t=After} - \bar{y}_{s=Control,t=Before} \right)$$

Where:

- y : outcome variable, where the bar represents that it's an average (usually over individuals with index i).
- s : is the indexing of the group.
- t : time.

Since this calculation doesn't consider the significance level of the DiD estimate, a regression analysis to account for that needs to be used. The ordinary least squares is used to calculate the DiD estimate as β with the following regression:

$$y_{ist} = A_s + B_t + \beta I_{st} + \varepsilon_{ist}$$

Where:

- A_s : treatment/control group fixed effects
- B_t : before/after fixed effects

- I_{st} : dummy variable that varies from 0 to 1 when considering treatment observations in the after period
- ε_{ist} : error term

So to verify that β will match the DiD estimate in the first equation, we use the regression one to get:

$$E(y_{ist}|s = Control, t = Before) = A_{Control} + B_{Before}$$

$$E(y_{ist}|s = Control, t = After) = A_{Control} + B_{After}$$

$$E(y_{ist}|s = Treatment, t = Before) = A_{Treatment} + B_{Before}$$

$$E(y_{ist}|s = Treatment, t = After) = A_{Treatment} + B_{After} + \beta$$

Where:

- $E(y_{ist}|s, t)$: expected value of y_{ist} in the population subgroup (s, t) , estimated by the sample average $\bar{y}_{s,t}$

So, by estimating the set of 4 equations and inputting the result in the first DiD equation I will obtain $DiD = \hat{\beta}$, where the hat represents the coefficient estimate.

The model can also be extended by the introduction of X_{ist} and Z_{st} . Those are vector variables that introduce a higher level of detail into the model. X_{ist} could be gender, age and income and Z_{st} could be for example state unemployment, variables representing racial composition, number of hospital beds, etc., depending on the study that needs to be carried out.[246]

The equation for the control variable becomes:

$$y_{ist} = A_s + B_t + cX_{ist} + dZ_{st} + \beta I_{st} + \varepsilon_{ist}$$

Where c and d are the regression coefficients.

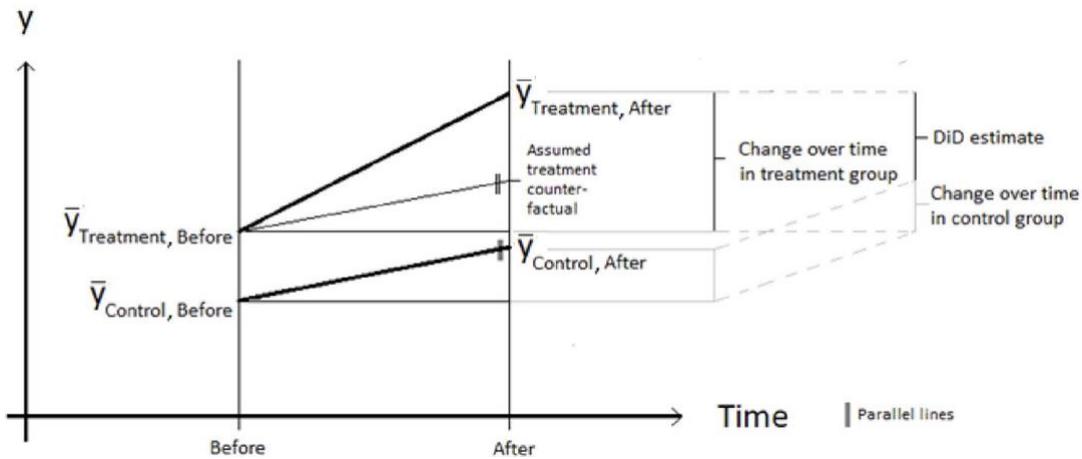


Figure 33 - Visual representation of the DiD (from the work of Fredriksson and de Oliveira[246])

Model assumptions [245]:

1. Parallel Trends

The principle posits that, without the intervention, the group receiving the intervention (treatment group) would have tracked the same temporal progression as the group not receiving the intervention (control group), specifically in relation to the outcome variable of interest. Various factors, both seen and unseen, might result in a disparity in the level of the outcome variable between the treatment and control groups. However, this variance (excluding the intervention in the treatment group) needs to remain unchanged over time. Given that the treatment group is only observed when treated, this supposition is inherently unverifiable. Nevertheless, one can bolster this supposition by utilizing several periods of data prior to the intervention, demonstrating that the treatment and control groups follow a similar trajectory in the periods before the intervention. If this holds true, it becomes more plausible to conclude that the estimated impact arises solely from the intervention, rather than a mix of other factors (including those leading to the different pre-intervention trends).

2. Stable Unit Treatment Value Assumption

This suggests that there should be no "spillover effect" between the groups receiving and not receiving the intervention, as the impact of the intervention would then not be distinguishable.

3. Xist and Zst should be exogenous

These variables need to be unaffected by treatment, so they don't make $\hat{\beta}$ biased.

Thus, by using this method I can assess the change in wages caused by the introduction of a certain policy, the megaproject.

5.3.4. Overall service quality

The notion of "Overall Service Quality" (OSQ), traditionally anchored in the commerce sector, has been identified as a fundamental performance indicator (KPI) in the assessment of diverse service-driven industries [247]–[249]. Many firms view service quality enhancement as a vital strategy for gaining a competitive edge and persevering in today's increasingly competitive economic landscape [248], [250], [251].

A plethora of scholarly research proposes that the delivery of superior service quality not only contributes to the organization's competitiveness and profitability but also extends to societal outcomes, improving the communities' quality of life [252]. Despite the prevailing consensus on the vital role of service quality, it remains an abstract and elusive concept, challenging to define and measure [247], [253]. Nevertheless, it's apparent that enhancements in quality yield a myriad of benefits and could dramatically influence an organization's longevity [248], [249].

Service quality, as per several definitions in academic literature, is primarily focused on satisfying customers' needs and surpassing their expectations [247], [254]. This is often referred to as the "disconfirmation paradigm", it's the divergence between anticipated and observed outcomes that results in a phenomenon known as

disconfirmation, which can manifest in either a positive or negative form. It bases itself on individual norms, values, desires, and needs, thus being highly individualistic [253]. Customers' expectations of the service act as benchmarks against which quality is judged [228]

It's important to acknowledge that expectations can greatly vary between individuals, even when the service provided is identical [253]. Furthermore, these expectations can evolve over time due to factors like changes in income levels, educational attainment, or increasing aspiration levels. They can also be influenced by various factors such as media, service providers, other customers, and observation of specific situations [253]. In the past decade and a half, numerous industry-specific scales and models of service quality have surfaced [255]. OSQ provides a comprehensive evaluation of the delivered service, considering aspects like reliability, responsiveness, assurance, empathy, and tangibles. In the business sphere, OSQ plays a crucial role in determining customer satisfaction, nurturing loyalty, and ultimately, driving the success of an enterprise. However, the application of OSQ is not confined to the business sector. Its principles and methodologies can be adapted to various fields, including the domain of megaprojects. These large-scale, complex projects with significant impacts on communities, economies, and environments necessitate robust and comprehensive evaluation models. By integrating OSQ as a dynamic KPI within a holistic model for megaproject evaluation, one can gain invaluable insights into the project's performance from a service delivery perspective, allowing the megaproject promoters to gain valuable data in order to understand if the service quality of the megaproject, during the construction phase, is upholding high standards.

This application of OSQ exceeds conventional project performance metrics such as cost, time, and scope. It introduces a stakeholder-centric perspective, emphasizing the expectations and experiences of the diverse stakeholders involved in the project. This can encompass project beneficiaries, project team members, investors, regulatory bodies, and the broader community impacted by the project.

Incorporating OSQ into the megaproject evaluation allows for an assessment that extends beyond tangible project outcomes. It also considers intangible aspects related

to the service delivery process, such as the efficacy of communication, responsiveness to stakeholder needs and concerns, the degree of professionalism and competence exhibited by the project team, and the overall stakeholder satisfaction with the project outcomes. In essence, the employment of OSQ as a dynamic KPI in a holistic model for megaproject evaluation represents a paradigm shift in project success evaluation. It highlights the significance of service quality in attaining project objectives and stakeholder satisfaction, thereby offering a more comprehensive and nuanced understanding of project performance. Consequently, the exploration and development of suitable methodologies for measuring OSQ in the context of megaprojects is a valuable endeavor that can contribute significantly to the field of project management.

A study conducted by the University of Pretoria [256] analyzed 13 different Service Quality models, here it follows a table with a brief description of each model.

Model	Key Findings
1. Technical and functional quality model of Grönroos [254].	Service quality relies on the technical capabilities, functional efficiency, and organizational reputation. Functional efficiency is often seen as more critical than technical capacity.
2. SERVQUAL model of Parasuraman et al. [257], [258]	The model operates as a diagnostic resource, enabling executives to systematically discern gaps in service quality by examining various influencing factors. With an outward orientation, the model aids in determining key service quality aspects from a consumer's perspective.
3. SERVPERF model of Cronin and Taylor. [259]	It solely employs the perceptions segment of the SERVQUAL scale, gauging only service quality experiences, excluding customer anticipations. This method directly cuts the number of elements in half.

<p>4. Attribute service quality model of Haywood-Farmer. [260]</p>	<p>This model sets the foundation for categorizing service organizations along three aspects for enhanced quality management, namely, infrastructure, behavior of personnel, and expert discretion. It deepens the comprehension of the service quality concept.</p>
<p>5. The dynamic process model of Boulding et al. [261]</p>	<p>The model seeks to deliver insights into the mechanism through which consumers generate service quality assessments and how these impact their future actions. With fluctuating customer expectations and perceptions, the model proposes to examine the connections between expectations, perceived quality, and planned behavior.</p>
<p>6. The three-component model of Rust and Oliver. [262]</p>	<p>The tripartite structure of this model encompasses the service product, the process of delivery, and the context in which the service is rendered.</p>
<p>7. The return-on-quality approach of Rust et al. [263]</p>	<p>The model suggests that the parameters for evaluating service quality ought to be connected to the entity's operational processes. It places an emphasis on ensuring that endeavors to enhance quality are economically justifiable</p>
<p>8. The P-C-P attribute model of Philip and Hazlett. [264]</p>	<p>It proposes a straightforward, efficient, and universal blueprint for appraising service quality across diverse service sectors. The model underlines potential service quality enhancement areas based on interaction frequency. The dimensions associated with these three attribute levels are sector-specific and consumer-centric.</p>
<p>9. The antecedent's model of Dabholkar et al. [265]</p>	<p>Service quality is more aptly envisioned through its precursors rather than its constituents. This model can bestow a comprehensive comprehension of service quality and the formulation of these assessments. In the quest to comprehend customer evaluations of service, customer contentment should be scrutinized separately from service quality.</p>
<p>10. The hierarchical approach of Brady and Cronin. [266]</p>	<p>Service quality is a multi-layered, hierarchical entity. Perceptions spring from evaluations of three principal dimensions - result, interaction, and environmental quality, each of which contains three sub-dimensions. The sub-dimensions are evaluated initially, influencing the assessment of the main dimensions, culminating in an overall perception of service quality.</p>

11. Grönroos's model as adapted by Kang and James. [267]	For a complete perception of service quality, technical attributes, functional characteristics, and image need to be measured. Grönroos's model, which has undergone empirical testing, confirms the five-factor structure of SERVQUAL. It stands apart from many models by suggesting that customers are capable of assessing technical quality
12. Kang's hierarchical structure of service quality. [268]	The five-factor structure, as proposed by SERVQUAL, is validated and stands for the functional dimension of perceived service quality. This model offers empirical support for the notion that perceived service quality is founded on both technical and functional quality elements.
13. Carr's FAIRSERV model. [269]	The five SERVQUAL dimensions are approved for gauging service quality, with the addition of equity or fairness as a significant dimension. The concern is that customers care about receiving their due compared to other customers availing the same service. Their judgment of the service encounter's fairness can shape their overall perception of service quality.

Table 13 - Summary of different Service Quality models (from the study conducted by the University of Pretoria [256])

Even though there is a vast number of models which can be used to evaluate the Overall Service Quality of a Megaproject, the SERVQUAL models stood out as the one to be used. SERVQUAL was chosen because of it is without a doubt the most used and tested method to estimate customers' perception of Service Quality [247], [251], [253], [255]

SERVQUAL was introduced for the first time in the work of Parasuraman, Zeithaml and Berry [257] as a method to measure customers perceptions of service quality.

They derived their insights from twelve consumer focus groups, concluding that the quality of a service is determined by consumers through a comparative analysis of their initial expectations and their ultimate perceptions across ten distinct dimensions. These dimensions were tangibles, reliability, responsiveness, communication, credibility, security, competence, customer understanding, courtesy, and access [257]

In a later study, however, the team refined these ten dimensions into five key categories [258]. These categories included:

1. **Tangibles**, which pertains to the physical elements of the service, such as the facilities, equipment, and personnel.
2. **Reliability**, which is about the dependability and precision of the service.
3. **Responsiveness**, which involves the readiness to assist customers and deliver swift service.
4. **Empathy**, which is about offering individualized care and attention to customers.
5. **Assurance**, which is the capacity of employees to exhibit knowledge, courtesy, and the ability to instill trust and confidence.

Each of these categories is assessed using four to five specific indicators, leading to a total of 22 indicators across all categories. These indicators are evaluated in two ways:

1. by gauging the expectations customers have of a service; and
2. by measuring the perceived quality of the service that was actually provided.

To collect this data, respondents are asked to rate their level of agreement with certain statements on a seven-point Likert scale, where 1 represents "strong disagreement" and 5 denotes "strong agreement". For each indicator, a "gap score" (G) is calculated by subtracting the raw "expectations score" (E) from the raw "perception-of-performance" (P) score. A larger "gap score" suggests a higher perceived service quality.[255]

An example of a questionnaire that could be developed for applying SERVQUAL could be the following one.

Tangibles

- 1 The project's physical facilities are visually appealing
 - 2 The project team appears neat and professional
-

3 The equipment used in the project is modern and well-maintained

4 The project's physical facilities are comfortable

Reliability

5 When the project team promises to do something by a certain time, they do

6 When a problem arises, the project team shows a sincere interest in solving it

7 The project team performs the service right the first time

8 The project team provides its service at the promised time

9 The outcomes of the specific phase of the megaproject meet the stated objectives and promises

Responsiveness

10 The project team communicates clearly about when services will be performed

11 The project team is always ready to assist stakeholders

12 The project team promptly responds to requests and inquiries from stakeholders

13 The project team resolves issues and problems in a timely manner

Assurance

14 The behavior of the project team inspires confidence in stakeholders

15 Stakeholders feel secure in their interactions with the project team

16 The project team consistently demonstrates courtesy and respect

17 The project team possesses the knowledge to answer stakeholder questions and concerns

Empathy	
18	The project team provides individual attention to stakeholders
19	The project team understands and considers the specific needs of stakeholders
20	The project team prioritizes the best interests of stakeholders
21	The project team provides personalized service to stakeholders
22	The project team demonstrates an understanding of stakeholder needs and expectations

Table 14 - Example of a SERVQUAL questionnaire applied to the megaproject world

After assigning a vote from 1 to 5 (Likert scale) the Overall Service Quality evaluation can be converted into a scale from 0 to 100, so it's easier to consider when also including the other KPIs.

An example could be:

Tangibles average score	4
Reliability average score	3
Responsiveness average score	4
Assurance average score	5
Empathy average score	3

First, calculate the average score for each dimension, then calculate the overall average across all dimensions. In this example, the overall average would be $\frac{(4+3+4+5+3)}{5} = 3.8$.

To convert this to a scale from 0 to 100 the following formula should be used:

$$\frac{\text{Actual score} - \text{Minimum possible score}}{\text{Maximum possible score} - \text{Minimum possible score}} * 100$$

In this case, with a 5-point Likert scale, the minimum possible score is 1 and the maximum possible score is 5. So, the calculation would be: $\frac{(3.8-1)}{(5-1)} * 100 = 70$

So, the Overall Service Quality of the megaproject, as measured by the SERVQUAL model, would be 70 out of 100.

In order for the questionnaire to be effective at assessing Service quality during the different megaproject's phases the questionnaire should be rolled out with 6 months up to a year frequency to be effective. Not only the questionnaire should be carried out periodically to make corrective actions during project execution but also periodically after its completion to effectively see if the megaproject is serving its purpose without generating any inconveniences.

Since it's a new approach further additions and studies should be conducted in order to tailor the questions and refine the delivery modes for each specific category of megaproject.

5.3.5. Number of served stakeholders

The number of served stakeholders is a KPI created to understand which is the magnitude of secondary stakeholders and non-market stakeholders that will be served by the megaproject. Its aim is to give back a number (people served/ year) that will be compared to the data gathered respect to post megaproject analysis, that's why when firstly computed it has only to be considered as a forecast of the serving capacity of the megaproject.

Given the diverse types of megaprojects, it would be too complicated to find tailored approaches for each one of them. Generally knowing the capacity of the future infrastructure is forecasted during the feasibility phase of the megaproject. This chapter will show a brief overview of different models that could be used in practice

to assess this KPI, in the end it will be important to show, respect to the forecasted data how much in terms of percentage it's the deviation.

The choice of model can vary depending on the type of the megaproject.

Highways, Roads, and Tunnels: For these types of megaprojects, it could be used a mix of Four-Step Travel Demand Models, Gravity Models, and Microsimulation Models. These tools are beneficial in forecasting traffic patterns, determining route selection, and tracking the precise movements of each vehicle.[270]

Public Transit (e.g., Railways, Buses): In the context of public transportation initiatives, Activity-Based Models (ABMs) are frequently employed due to their ability to simulate personal traveler choices, including mode of transport, travel timing, and route selection. Additionally, Microsimulation Models serve as valuable tools for depicting the intricate movements of individual vehicles and passengers.[271]

Airports: When it comes to airport initiatives, a blend of Four-Step Travel Demand Models, Gravity Models, and Activity-Based Models (ABMs) is often employed. These models are instrumental in forecasting air travel demand, determining airport selection, and tracking the specific actions of individual passengers.[272]

Ports and Harbors: In the context of such projects, Gravity Models and Four-Step Travel Demand Models are typically utilized to forecast the movement of commodities and passengers. Additionally, Microsimulation Models serve as valuable tools for simulating the intricate movements of individual vessels and vehicles.

Housing and Commercial Development: For these types of projects, Land Use Models and ABMs can be used to predict how the development will affect land use patterns and how individuals will interact with the new development.[273]

Energy Infrastructure (e.g., Power Plants, Pipelines): For these types of projects, Econometric Models and Gravity Models can be used to predict the demand for energy and the flow of energy products.[274]

In all cases Machine Learning models can be implemented to handle large amounts of data and complex relationships to give even more accurate results than solely using the traditional models.

Due to the high diversity of types of Megaprojects, we will only focus on the infrastructural ones (Highways, Roads, Tunnels ecc.).

The most widespread model among these is the Four Step travel demand model[275]. It was firstly introduced by Manheim [276] and later expanded by Florian et al. [277].

The model system was originally designed for the assessment of large-scale infrastructure projects, rather than for intricate and multifaceted policies that involve the management and regulation of existing infrastructure or the implementation of policies that directly affect travel behavior. The use of travel forecasting models is an ongoing process. The time span needed for data gathering, model estimation, and subsequent forecasting activities can span years. During this time, changes occur in the activity and transportation systems, as well as in the policies of interest, often necessitating new data collection initiatives and a fresh modelling effort. There seems to be limited time available for a systematic investigation into the accuracy of these models' post-implementation.

The Four step model, as other models, is structured in a step-by-step sequence that seeks to understand the decisions made by travelers. The journey simulation process tracks trips from their starting point in a trip-generating zone, through a network of connections and junctions, and concludes at a trip-attracting zone. The four main steps are: trip generation, trip distribution, mode choice, and traffic assignment.

The work of McNally is useful to understand how the model is structured [275]. Once the location of the megaproject is chosen, the research area is delineated to include the expected impact zone, defined by a boundary line. This zone, made up of Traffic Analysis Zones (TAZs, which is the unit of geography considered, for example a zone of under 3000 people is commonly used), is the focus of detailed modelling and analysis. Interactions with areas beyond this boundary are managed through external stations (ESs), acting as gateways for trips into, out of, and across the research area.

The Activity System for these ESs is based on the trips passing through them, modelled separately and more simply than the interactions within the research area.

The internal *Activity System A* is usually characterized by socio-economic, demographic, and land use data for TAZs or other suitable spatial units. The number of TAZs can vary widely, depending on the model's purpose, data availability, and model vintage.

The *Transportation System T* is typically depicted through network graphs defined by links and nodes, the first ones are homogeneous sections that represent transportation infrastructure or service, and the second ones are the link endpoints which are usually intersections or points representing changes in link attributes. Activity and transportation systems interface together by centroid connectors, which are abstract links connecting TAZ to realistic access points.

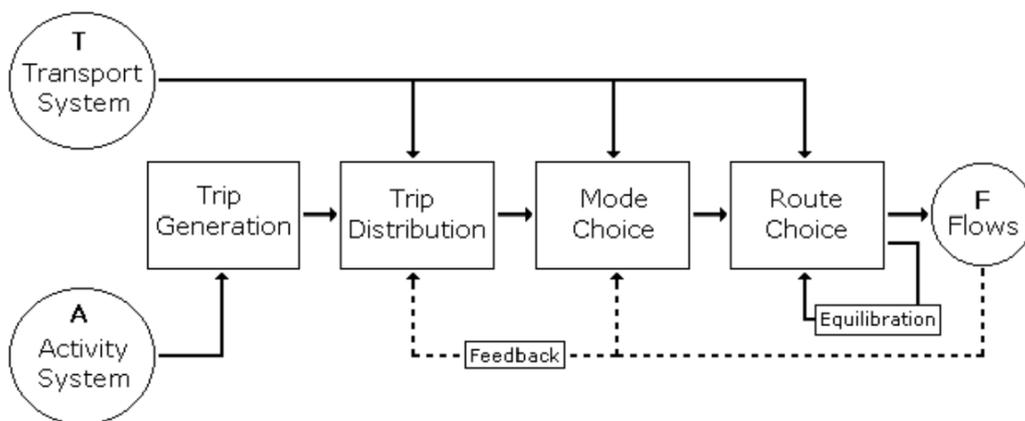


Figure 34 - General structure of the Four Step Model (FSM) [272]

1. Trip Generation

The first stage of the FSM process is designed to determine the volume of total daily travel in the model system, at the levels of both households and zones, for various activity-related trip purposes. This stage also converts the FSM from being activity-focused to trip-focused, while splitting each trip into a production and an attraction, thereby preventing the impact of network performance measures on

travel frequency. Essentially, generation sets the total travel in the region, with the subsequent steps acting as share models.

2. Trip distribution

The goal of the process's second phase is to merge trip ends from trip generation back into trips, usually characterized as production-attraction pairs rather than origin-destination pairs. The trip distribution model primarily functions as a destination selection model and creates a trip matrix (or trip table) T_{ij} for each trip purpose used in the trip generation model. This is done based on the attributes of the activity system (indirectly through the generated productions P_i and attractions A_j) and network attributes (typically, interzonal travel times).

3. Mode Choice

Essentially, trip tables are adjusted to represent the relative percentages of trips made by different modes of transportation.

4. Route Choice

In the final stage the FSM, a balance between demand and performance is finally achieved. Modal Origin-Destination (O-D) trip matrices are applied to the modal networks, typically under the assumption of user equilibrium where all paths used for a specific O-D pair have equal impedances. For off-peak assignments, stochastic assignment is often employed, which tends to distribute trips across a greater number of paths, more accurately reflecting observed traffic volumes in uncongested periods.

Now that the forecasted data have been obtained, they have to be compared with the actual data which will be available after a certain period of time from the completion of the megaproject.

The idea is to calculate a delta between the before and after to see if the infrastructure exceeded or not the expectations. This result will be then converted into a scale from 0 to 100 to make it comparable to the other KPIs.

As seen with SROI, there are also other two KPIs that have been grouped under the performance indicator of ROI, those are: GDP per capita/ Taxable income and GDP growth rate/ Taxable income growth rate.

5.3.6. GDP per Capita/Taxable Income

The metric "GDP per capita/Taxable income" offers an overview of the economic prosperity within a specific geographic region where a megaproject is being undertaken. GDP per capita is widely acknowledged as a robust indicator of economic health and is frequently used in various economic studies to compare the well-being of different populations [278]. The calculation is straightforward, requiring publicly available data on GDP per capita for the target population, typically sourced from governmental statistics or financial reports. Although data could be easily accessible when considering large areas as regions or whole countries it could be harder to find statistics when zooming in certain areas. Fretz S et al. [279] in their work about the regional economic effects of traffic infrastructure expansion suggest a different way of measuring GDP when such data is not available. Therefore, according to the GNI (Gross National Income), it is needed to approximate the nominal income per capita concept with the average taxable income per taxpaying unit, this method was based on an updated version of the data presented in Schaltegger and Gorgas. [280]. To check and attribute the difference in GDP per capita to the effect of the megaproject it could be useful to adopt a difference-in-difference (DiD) method, method that has already been adopted to measure the difference in average wages in the area of interest in the 5.3.3.

5.3.7. GDP Growth Rate/Taxable Income Growth Rate

The "GDP growth rate/Taxable income growth rate" KPI further extends the evaluation by focusing on the rate of economic growth or contraction. Economic growth rate is a

crucial metric that reflects the expansion of an economy over time, with implications for employment, investment, and quality of life [281]. The KPI offers a nuanced understanding of whether the benefits of economic expansion are being equitably distributed amongst the population. This is especially important for secondary stakeholders who are concerned not just with current status, but with economic trajectories that indicate future well-being. Similar to the first KPI, the necessary data for calculating this KPI can be sourced from governmental statistics and compared year-over-year to establish trends.

Both KPIs enable stakeholders to assess the economic impacts of a megaproject not just in terms of aggregate wealth, but also in relation to individual incomes. This dual perspective is essential for capturing a more comprehensive view of stakeholder satisfaction, thereby providing invaluable insights for decision-makers.

6 Model validation

6.1. Model validation theory

This part of the thesis will focus on the validation of the model for assessing secondary stakeholder satisfaction when a megaproject is being built. Validating a model is essential to show its credibility. [282]

To validate this model the approach used is “Validation through experts” by conducting semi structured interviews to 10 experts of the field. This type of validation was chosen instead of a case study analysis because of the lack of evidence and data of past megaprojects. Indeed, the role of decision-making often surpasses the capabilities of existing data and modeling tools. For the successful implementation of effective policies and optimal management choices, decision-makers must often go beyond available data, augmenting it with expert judgment. The essentiality of this practice lies in filling the information gaps that traditional science and statistics may not be able to address [283]. This utilization of expert judgment is not a mere supplement; it forms a critical underpinning of the entire decision-making framework. It furnishes the tools to quantify the uncertainty surrounding parameters that are otherwise difficult to define or comprehend. The breadth of the application of this approach is vast and varied, spanning from casual solicitation of an expert's personal perspective to the formal execution of documented procedures for acquiring and synthesizing probabilistic judgments.

Expert elicitation, a method of integrating expert judgment, has risen to prominence as a crucial tool in policy analysis and modeling. The fundamental objective is to systematically and meticulously capture a diverse array of expert perspectives. The

end product is a comprehensive, well-structured, and thoroughly documented procedure for obtaining and combining probabilistic judgments. This tool becomes an indispensable resource, especially in scenarios where the probabilities of interest remain unknown, thus creating a challenge for validation against empirical data [284]

This strategy, often denoted as the “classical model” or structured expert judgment, has seen broad applications across a multitude of domains, including investment banking, volcanology, public health, ecology, and aeronautics, among others [285]. The process engages experts to provide probabilistic belief statements concerning unknown parameters. These expert-generated probabilities function as a supplement to other types of evidence, serving as valuable inputs for economic, decision-analytic, and other types of modeling. However, the utility of expert judgment has its limits. It's not a one-size-fits-all solution. For instance, if a quantity is readily observable, such as the speed of light in a vacuum, expert judgment becomes redundant. Similarly, it becomes irrelevant in scenarios where a field lacks established scientific expertise and associated measurements [286]. Furthermore, its necessity diminishes when there's abundant historical data and a consensus about translating that data into future predictions [287]. In situations where outcomes are heavily influenced by behavior, predictive expertise may not exist, rendering expert elicitation ineffective [288].

The implementation of expert elicitation is a demanding process, necessitating considerable commitment from both analysts and experts. Given the significant resources required, the value of expert elicitation should be weighed against its potential impact on the final decision or outcome. If the impact is deemed minimal, then the time and effort involved may not be justifiable [287]. Thus, it's critical for analysts to conduct a thorough assessment of potential uncertainties within a problem area before undertaking an expert judgment study. A deep understanding of these uncertainties aids in guiding the suitable application and integration of expert judgment in decision-making and modeling processes, ensuring optimal resource allocation and efficacious outcomes.

6.2. The interview

As stated by Yin [289], one of the most important sources of case study evidence is the interview. As previously mentioned, the data was collected by conducting 10 semi-structured interviews with experts that took part in large scale projects. At the same time purposeful sampling [290] was used to identify thoughts and comments about the proposed model. Data collection involved 10 informants mostly coming from managerial positions. These individuals showed knowledgeable insights about the project management and management of megaprojects world.

The duration of the interview varied between 45 and 80 minutes, and were conducted between July 2023 and August 2023 and all interviews were recorded and transcribed. During interviews lively discussions arise with the respondents, the aim was straightforward, the scope was to double-check and confirm that the given answers were aligned with the proposed evaluation model conclusions.

Then, data have been analyzed by using textual coding and emerging categories in the data or recurrent topics that weren't considered in the proposed model have been searched. Moreover, it was essential to ensure that findings were not just abstract theories but methods of performance measurement that could be mirrored within their organizations and in general in the project management world. More importantly, the aim was to ascertain that these findings could be translated into actionable strategies in real-life megaprojects. Additionally, these dialogues offered an extra chance to dive deeper into individual results. This helped to further refine and flesh out even more the proposed findings. After all, the devil is often in the details, and this stage allowed to ensure that no crucial piece of information was overlooked or understated. It's an iterative process, and every round of conversation added another layer of depth and clarity.

6.2.1. Interview structure

The model validation has been done through semi-structured interviews. In this paragraph, the structure of the validation interview will be deeply explained in all its parts. The first part is dedicated to the explanation of how the interview have been

structured in order to be accurate for the purpose of validating the proposed model. Later, all the questions inside the interview track will be provided, and finally, the interviewed sample will be described. Even though, for privacy reasons, interviews will be anonymous, a description of each interviewee will be provided in order to understand the experience and the background of the sample.

The interview has been designed in order to validate the model in all its parts, with a top-down approach, starting from the overall goal of the model and going through all its parts, KPIs and measuring techniques. As shown in the following figure, the interview has a structure made of four levels, excluding what can be called level zero which is about generalities and past experience. In all the performed interviews, the overall structure has been respected, leaving some space to each person to talk about personal experiences and adapting the structure to each discussion, so that the interview resulted smoother.

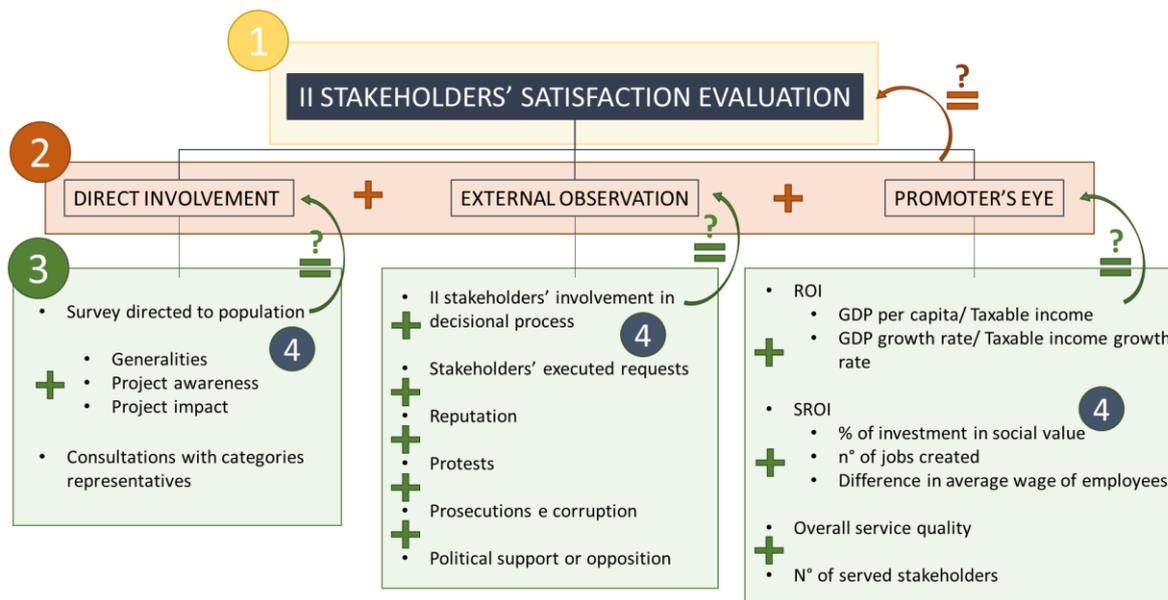


Figure 35 - Model validation interview structure

The different levels are:

- 0. Generalities and personal experiences:** in the first part of the interview, the respondent is asked about his background in terms of past experience, filed of past experience, years of experience in the field and actual role. The aim of this

section is to gather data about each person to understand if his or her opinion can be accurate and valuable for the discussed topics. Moreover, an idea of the background is useful to contextualize opinions and views, for example different generations can see things differently, or the experience in different fields can shape ideas and values in different ways.

1. **Importance of model objective:** this is the first level of the model validation part. In this section, interviewees are asked about the importance of secondary stakeholders in megaproject management and if, in their experience, they ever encountered and considered this aspect. Finally, the applicability of such a model during the project, after its end and several years after completion is investigated.
2. **Correctness of the three parallel approaches:** in this section, interviewees are asked to give their opinion on the usage of direct involvement, external observation and promoter's eye evaluation to assess secondary stakeholders' satisfaction. The three methods are explained, together with the reasons why they have been concurrently used. The aim is to understand if this techniques can be a correct way to measure the overall model objective.
3. **Correctness of the dimensions (KPIs) inside each approach:** in the third section, it is asked to respondents if they consider correct and complete the sets of KPIs inserted in each approach. The goal is to understand if the inserted metrics are correct and if the sum of all the metrics in each approach can clearly give an indication on project performance for that method.
4. **Correctness of the evaluation method for every voice:** the last level of the interview is dedicated to the measurement techniques for each KPI. In this section, the global view of the model is abandoned and each KPI is considered alone to gain the opinion of the interviewees about the measurement techniques that have been identified for each indicator.

The proposed interview, developed in four levels as previously explained, gives a complete idea of the structure of the proposed model and of the measurement techniques. It covers every aspect of the model and gives interviewees the opportunity

to approve or reject project parameters, and to elaborate on their opinion with personal experiences.

6.2.2. Interview questions

The interview is composed by the following 23 questions, covering all levels and all model parameters:

Generalities

1. Can you briefly tell us something about yourself, your professional experiences, your background and your actual job?
2. Which are the sectors in which you are mostly specialized?
 - Public infrastructures
 - Architecture and urban development
 - Transportation
 - Energy
 - Oil and gas
 - Military
 - Naval
 - Aerospace
 - Other

Overall model validation

3. Could you share your thoughts on the importance of evaluating secondary stakeholders' satisfaction when assessing the social sustainability of megaprojects?
4. In your opinion, does an evaluation encompassing direct stakeholder involvement, external observation of objective factors, and the project

promoter's perspective offer a comprehensive, unbiased measure of secondary stakeholders' satisfaction?

5. Do you think that one of the three aspects of the analysis is more important than the others?
6. What are your views on conducting this evaluation throughout the project lifecycle for timely corrective actions, at project conclusion for a final evaluation, and several years post-project for an ex-post assessment? (Have you ever implemented something similar? Only if something has been said from his/her experience)

Direct involvement

7. In your opinion, do community surveys and consultations with representative groups effectively gauge stakeholders' satisfaction via direct involvement? To which extent?
8. Community surveys are done at project milestones or within large periods of time, asking for generalities, project awareness and project impact on people's lives. What are your thoughts on this approach?
9. On the other hand, consultation with category representatives is done at shorter time intervals, asking for project impact. What do you think about it?

External observation

10. We identified for the external observation category KPIs related to the following dimensions: involvement of secondary stakeholders in the decisional process, the number of stakeholders realized requests, protests against the project, project reputation, prosecution and corruption in project governance structure, and project political support and opposition. In your opinion how important is to identify a set of unbiased dimensions?
11. Secondary stakeholders' involvement in the decisional process is measured as the number of categories represented in the decisional process over the total categories. What do you think?

12. What are your thoughts on measuring stakeholder satisfaction through a database of requests, timing, importance, outcomes, and costs, and assigning a score based on the percentage of fulfilled requests, average importance, and cost?
13. Project reputation is measured by media analysis where main papers/television shows are analyzed and the number of positive and negative stories is computed. This can be done manually or with the help of computers or AI. What do you think? In your experience did this dimension ever play a major role?
14. The analysis of protests is done by assessing both authorized protest and unauthorized protests reported by the media. From the number and dimension of protests a score is given to the project. What do you think?
15. Prosecution and corruption are analyzed by the number of investigations, first instance judgments and definitive judgments. A scale of scores is assigned from 'no investigation' to 'final judgments convictions. What do you think?
16. Political support of the project is assessed as the % of the parliament opposition that supports the project. This gives an idea of how much a project is politicized or widely supported. What do you think?

Promoter's eye

17. We identified for the promoter's eye category KPIs related to the following dimensions: percentage of investment in social value, n° of jobs created, difference in average wage of employees, GDP per capita/ Taxable income, GDP growth rate/ Taxable income growth rate, N° of served stakeholders. and Overall Service Quality. In your opinion how important is to identify a set of dimensions to support the promoter's decision making
18. Percentage of investment in social value is measured by using the SROI (Social Return on Investment), have you ever used this method, or do you think that other social impact assessment methods would be more beneficial?

19. The number of jobs created by the megaproject is forecasted by counting the number of direct, indirect and induced jobs. Then only forecasted indirect and induced jobs are compared to the actual values. What do you think?
20. Difference in average wage of employees is measured by the Difference-in-Difference model to verify that the increase or decrease in wages is caused by the megaproject, then the value is compared to the forecasted one. What do you think?
21. GDP per capita and GDP growth rate are forecasted to measure the positive or negative impact of the megaproject on the nearby Area, to see if the forecasted results match the actual data. What do you think?
22. The number of secondary stakeholders that are served by the megaproject are forecasted by calculating the capacity of the megaproject through the Four Step Model, then the data is compared to the actual one. What do you think? Did you use other models?
23. Overall Service Quality is carried out as a set of question for each SERVQUAL category to which a vote applied, then an average is calculated and the final score is given. What do you think?

The questions above are the main structure of the interview, then, each question have been adapted and modified to each interview by including it in the broader discussion about the subject. Even the order have almost always been respected, except for some cases where the discussion developed in a non-linear way and the order of the questions have been changed to give priority to the conversation flow.

For each answer, the following process have been utilized to get the greater possible information for each question:

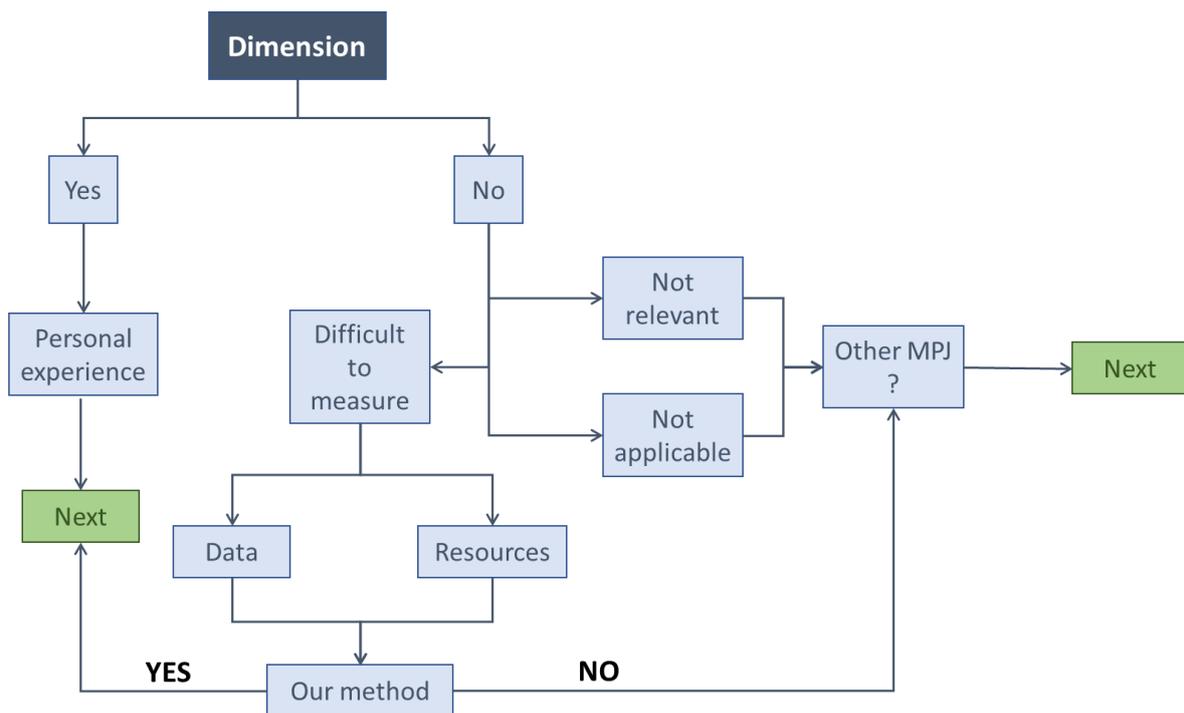


Figure 36 - Iterative process used during interviews

The process starts by asking a question about a dimension or an approach. If the dimension is approved, respondents are asked to elaborate on their experience about the theme and the interview proceeds to the next one. Otherwise, if they reject a dimension, they are asked the reason for that choice: in particular if they think that it is not relevant, or they think it is too difficult to measure or if it is not applicable. In case the parameter is thought to be not relevant or not applicable, it is asked why and if it can be relevant for some specific megaproject type; if they think it is too difficult to measure, they are asked if it is because it is hard to obtain data or if the measure requires too much resources, then the method proposed in the model is explained and the interview proceeds to the next parameter. This structure will be followed for almost every question in the interview, always in the context of a fluent discussion.

6.2.3. Interviewed sample

The interview has been conducted with ten people who have slightly different backgrounds and job positions, but all specialized in large engineering projects, urban development and social sustainability. The respondents are from Italy or from the United States. The following table resumes the profiles of all ten interviewee and a deeper description of the profiles will be provided later.

N	Role	Company description	Working field	Country	Years of experience	Category
1	CEO (former Project manager)	Project management consulting for large engineering projects	Infrastructures Civil engineering Energy plants	USA	35+	
2	Project manager	Project management consulting for large construction projects	Construction management	Italy	30+	Project manager
3	Project manager	Project management consulting for large construction projects	Construction management	Italy	15+	
4	President	Infrastructure development company	Infrastructures	Italy	40+	Manager
5	CEO	Infrastructure development company	Infrastructures	Italy	40+	
6	Managing principal	Large projects structural engineering	Structural engineering for Infrastructures	USA	40+	Structural engineer

7	Global head of architects	High-end architectural design and urban development	Architecture and urban development	USA	20+	
8	Architectural designer	Architectural design and urban development	Architecture	USA	10+	Urban development architect
9	Architect director	Architectural design and urban development	Architecture and urban development	Italy	10+	
10	Senior manager	Consultancy on social and environmental sustainability	Social sustainability	Italy	20+	Social sustainability expert

Table 15 - Interviewed field experts' generalities

As it is easily noticeable from the above table, all the interviewees have more than 10 years of experience, many even more than 20 or 30, and they come from different backgrounds. In the following pages, the profiles of all interviewees will be briefly presented. The following list follows the same order of the above table.

1. The first interviewee is a civil engineer who worked his all career as project manager in construction management, architecture, urban development and civil engineering in the United States. Later in his career he founded his own consultancy firm where he is CEO. The main theme of his consultancy firm are the ones he based his career on: project and construction management. He took part in different kind of projects in both the United States and in Egypt: from the construction of new highways to hotels and residential complexes. Right now, his firm has entered in the Energy sector and it is developing projects for hydrogen extraction plans, which have a cost of 5 billion dollars each, around the world.
2. The second respondent is a project manager who works for a construction management and project management consultancy firm in Italy. She spent all

of the 30 years of her career in the same firm and she participated in some of the biggest urban projects in Milan, the most remarkable are the management of the construction of the new Lombardy Regional Palace and the new district of City Life, with the development of three high rise buildings and several residencies inside the area.

3. The third respondent is another project manager from the same consultancy firm in Milan. She served as PM in that company for more than 15 years and she took part in the same projects described above.
4. The first interviewee is the President and Co-Founder of one of the largest infrastructure companies in Italy. He has a 40-years long remarkable career where he worked for the biggest companies in the country. He worked in different sectors, starting from the energetical industry, passing for the industrial world, the nuclear sector and finally infrastructures. He took part in some of the largest and most famous projects in Italy, one of the most remarkable is the construction of Ponte Morandi in Genova, a project that he described as extremely complex for both technicalities and timing and with a huge impact on secondary stakeholders.
5. The fourth respondent is now the CEO of the same infrastructure company in Italy. He has 40 years of experience in the Italian industry, having worked for some of the largest national companies. He worked in many sectors: industry, energy, nuclear power plants and infrastructures. In infrastructures, he has been board member and president of the national road infrastructure company and he was at first selected as commissioner for the construction of Ponte Morandi.
6. The sixth interviewee is a civil engineer graduated at one of the most prestigious Universities in the United. He is now Managing Principal in one of the world's largest structural engineering firms, based in New York. He has more than four decades of experience in the design and analysis of a wide variety of building types, such as super-tall and mega-tall structures, mixed-use developments, hotels, airports, arenas and residential towers worldwide. He took part in the development of some of the largest buildings in the world, such as the Petronas

Towers in Kuala Lumpur, the Jeddah Tower in Qatar and now the Dubai Creek Tower, building designed by Calatrava, that is going to be the highest in the world, with its 1000 meters.

7. The seventh respondent is an Italian architect who now works in the United States. He has more than 20 years of experience in the architecture of high-rise buildings and urban development. He worked for some of the most famous architectural studios in the world and took part in the design of several towers, including one of the three towers in City Life area in Milan. Right now, he is the Global Hedge of Architects for a famous architectural firm in Miami and the main focus of his company is the development of high-level tall buildings in America and South America, with a particular focus on social impact sustainable urban development practices.
8. The eight interviewee is a young architect who works for an important American architectural firm. He has more than ten years of experience in the architectural field, especially in large structures. He followed projects in the United States and in Brazil, and he took part in the design of different project-types: several stadiums in Brazil, an international airport and many high-rise residential buildings.
9. The ninth respondent is another young architect from an architectural studio based in Italy. He is the youngest architect director in his firm. In his ten years of experience, he focused its work on urban regeneration and urban development projects in Italy. He collaborated with several international architectural and landscape design studios between Milan and Amsterdam, and now he is in charge of some of the most important urban transformation projects in Milan.
10. The last interviewee is a Senior Manager in the department of Climate Change and Sustainability in one of the most important consultancy firms in the world. She works in Italy and she has more than two decades of experience in the field of social sustainability. She is an expert in social impact assessments and she applied her knowledge in many different areas: from social projects proposed by private companies, to fund-raising consultancy for non-profit organizations,

to social impact assessment of construction projects and urban development strategies.

The pool of interviewees is complete and varied, having people who faced the world of large infrastructures and large construction projects from different points of view. Such a pool of experts allows to have opinions arriving from different sectors, always correlated to infrastructures, urban development and social sustainability. Many of the people involved in the interviews took part in their life to projects that meet the strictest definition of megaprojects as projects that cost more than 1 billion dollars. However, especially in European countries and Italy, there are very few projects that exceeds the billion dollar mark, reason why the IPMA revisited the megaproject definition by putting the threshold to 500 million or even 100 million dollars. For this reason, the interviewees that never participated to a 1 billion project, but took part in projects valued several hundred million dollars and with extreme complexity and huge impact on secondary stakeholders and local communities, were considered for the interviews.

In the following paragraph, the results of the ten interviews will be presented and deeply analyzed.

6.3. The results

In this section, the results derived from the analysis of the interviews by transcription and textual coding will be presented. The first part will be dedicated to the overall presentation of the results, with a table resuming the opinions of experts on all the model aspects. Later, each model parameter will be deeply analyzed and experts' opinions will be described and presented with quotes from the interviews. Finally, at the end of this section, a resuming table filled with the most relevant quotes for each parameter will be inserted.

The following table resumes the opinions of all the interviewees for all the model parameters. Opinions are described by three symbols, each with a specific meaning:

Symbol	Description
	Green tick: it means that the parameter has been approved without doubt
	Yellow bars: it means that the parameter has been approved, but some observations have been done about it.
	Red cross: parameter has been rejected.

Table 16 - Result's legend

	Int 1	Int 2	Int 3	Int 4	Int 5	Int 6	Int 7	Int 8	Int 9	Int 10
Secondary stakeholders' satisfaction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dynamic model usage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Final evaluation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ex-post evaluation	✓	▬▬▬	✓	✓	✓	✓	✓	✓	✓	✓
Direct Involvement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
External Observation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Promoters' eye	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Surveys to population	✓	▬▬▬	▬▬▬	✓	✗	▬▬▬	✓	✓	✓	✓
Consultations with categories representatives	▬▬▬	▬▬▬	▬▬▬	✓	✓	▬▬▬	▬▬▬	▬▬▬	✓	✓
Secondary stakeholders' involvement in decisional process	✓	✗	✗	✓	✗	✓	✓	✓	✓	✓
Secondary stakeholders executed requests	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project reputation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Protests against the project	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Prosecutions and corruption	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓
Political support and opposition	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Social Return on Investment (SROI)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
% of investment in social value	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of jobs creates	✓	✓	✓	✓	✓	✓	✓	✓	✓	▬▬▬
Difference in average wage of employees	✓	✗	✗	✓	✓	✓	✓	✓	✗	▬▬▬
Return on Investment (ROI)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GDP growth	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
GDP growth rate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Overall Service Quality	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of served stakeholders	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 17 - Interviews results

From the table it is immediate to understand which are the parameters that all respondents agreed upon, and the ones that were less unanimous. In particular, all interviewees agreed upon the importance of the overall model objective and on the

three main approaches used to evaluate it. They also agreed on the possibility to use the evaluation model during project development, after its completion and for an ex-post evaluation. Their opinions were aligned also on many of the KPIs and parameters that compose the model, except on few parameters, such as surveys or consultations, corruption and secondary stakeholders' involvement, where some respondents had observations about them or rejected the parameter. In the following pages, the findings and opinions for each investigated parameter will be presented.

Secondary stakeholders' satisfaction

The overall objective of the proposed evaluation model found unanimous approval from all respondents, independently from their background, their culture and the country they live. All agreed to the fact that megaprojects have a huge impact on people and secondary stakeholders and that their opinion and satisfaction should be a priority for managers and politicians.

One respondent commented: *"Absolutely, it is extremely important. Projects, especially when they have huge dimensions, have impact on a network of economic and social realities and on people's lives. So, it is crucial to evaluate their satisfaction. [...] Secondary stakeholders, thar are not so secondary since projects are usually financed by taxed that we, as citizens, pay, have the right to be recognized as subjects that will incur in inconveniencias and that need to have some value delivered to them, not only as obstacles to the project's realization"*. It was common also to hear that companies right now are moving toward the goal of social sustainability and are trying to develop projects that bring value to society, local communities and secondary stakeholders, by changing the way project are conceived and implemented. Talking about this subject, a person commented: *"we are trying more and more to transform infrastructural projects also in social infrastructures. [...] not only thinking about social impact in terms of created jobs, economical projection etc., but also about how these places can by physically lived by people in a different way. For a competition for the fourth bridge of Panama, we realized a concept where the part under the bridge, which usually is a forgotten corner of cities, was upgraded to an active part of the city, useful to society"*.

Even though this measurement found unanimous approval, a few comments and concerns have been risen. The first is the cost of this analysis. In fact, such a deep analysis can be costly and not convenient, especially for private companies. One respondent commented: *“sometimes there is not enough budget for the project to involve this kind of detailed study, but in some projects which will affect the public, the environment, and the political opinion of the people, it becomes very important”*. Other two respondents highlighted this problem and commented that one way through which this assessment can become common could be making it a standard or a certification which allows companies to attract more investors or to increase their chances of winning a contract. Another issue is the risk of falling into over-management if too many resources are allocated to this study.

Three approaches: direct involvement, external observation and promoter’s eye

The parallel usage of the three approaches also found unanimous approval from all respondents. Everyone agreed upon the fact that such an analysis would give a complete and unbiased idea of the real performance of the project on satisfying secondary stakeholders. As an interviewee commented: *“if you’re just going to look through one type of lens, then for sure your research is going to be very biased. If you’re trying to look into multiple lenses, you might have something that is closer to the truth”*.

However, even though every respondent approved these three approaches, they were not aligned on the weights that each approach should have in the overall evaluation. In fact, some interviewees agreed with our hypothesis of giving equal weight to all three methodologies to make the metric unbiased, others sustained that *direct involvement* should be the most important part of the evaluation, and others thought that *promoter’s eye* should be valued most. The ones that sustained the predominance of direct involvement argued that secondary stakeholders are the most impacted entities in the development of a megaprojects, reason why they should be listened to, and their opinion should be valued more than the other aspects. On the other hand, people sustaining that the evaluation through promoter point of view, argued that citizens are usually uninformed and emotional about megaprojects and they lack the view on the bigger picture of economic and social development of the whole country

through mega infrastructure projects. They sustain that the only entity who has this vision is the one promoting the project, being it the government or a big corporation and for this reason that evaluation should be valued more.

These different views must be deeper analyzed and studied and the weight given to each approach should be properly defined by conducting several interviews with more experts with the sole purpose of assigning the proper weight to the model parameters.

Model application: during project realization, final evaluation and ex-post evaluation

The theme of this question was the usage of the model in three different moments: during the project development as a dynamic tool, after its completion for a final evaluation and 3-5 years after project delivery for the ex-post evaluation. As shown in the Table 17, the three application found almost unanimous approval from all respondents. In particular, everyone thought that the usage of such a model during project development would be a great tool to implement corrective action and improve project performances. The only concern that was raised by one respondent is the fact that, especially private companies, would not be interested in investing resources to analyze the impact of a project 5 years after its realization, and suggested to reduce the time to 2-3 years or to apply that evaluation just for publicly sponsored projects.

Population surveys

Population surveys to investigate the sentiment throughout the population are one of the two parallel methods proposed to analyze stakeholders' satisfaction through direct involvement. This parameter found different opinion in the interviewed pool. In fact, 60% of the interviewed sample approved the parameter, 30% approved it but had some concerns about how people could answer to such difficult questions, and 10% rejected it, sustaining that citizens without knowledge in these themes should not be involved nor listened to.

The 60% of the sample who approved this metric, considered secondary stakeholders' direct involvement a crucial part of the evaluation model since they are the most impacted entities and their life can drastically change because of a project, giving them the right to be listened to. Moreover, they consider the direct opinion of citizens extremely important for project's success. One of the respondents stated: *"I have done something similar on large projects and they tend to be really very effective into the success of the project. [...] interviews are crucial in both infrastructure and especially energy projects because they directly affect the public"*. The opinion of citizen is therefore seen as a potential added value to reach project success, another respondent, talking about road infrastructures stated: *"so the answer to your question in terms of highways and bridges and all these projects, that also affects how people live and how people move from point A to point B, is that the analysis that that you're suggesting in your model is then very, very important and it can add a huge value to the final decision on how to do and improve a project"*.

On the other hand, 30% of the sample have approved the parameter, but was skeptical about the utility of the results. In fact, the major concern was that the opinion of people could be emotional, not rational and uninformed. They argued that usually citizens have the tendency to focus only on inconveniences and the negative part of project development, so the results obtained from the surveys could lead to negative judgments only. Moreover, usually people are not correctly informed about the future benefits that a project will provide, so they are not willing to accept disturbances during its development. About these themes one respondent said: *"questionnaires have to be done with caution. Usually people that are interviewed, are unaware of the impact of a project, nor have the sensibility of the promoter or the State. [...] So, it is important to ask the opinion of people with precise questions about rational and objective elements"*. This quote underlines a recurring theme in the opinion of interviewees: the need to be careful in the asked questions that should be brief, clear and objective, without letting space to emotional responses. On the other hand, also education about the project plays an important role in the expected results of questionnaires and respondents highlighted the need for a better and broader education about a project before it starts. *"An important theme here is how to educate people. How do we educate population or who gets involved? How do we educate them about the project and about the judgment? How do we share a project of such dimension with citizens? New technologies should be used more and*

more and in a more intelligent way for this aim [...] It is unclear how promoters are convincing us that an infrastructure has to be done or not. They just create opposing sides: who is in general in favor of infrastructures and who is against, but there is not a real education". So, educating the population about a project is something that managers and promoters should work on in order to improve the perception of large infrastructure project throughout the population.

The last 10% who rejected the metric argued that people uninformed and incapable of judging such complex themes, so, their opinion is useless and can be also damaging. He made the example of the referendum done in Italy about nuclear energy, saying that it is a perfect example of how uninformed people can take decisions based only on emotions that can drastically damage the development of a country.

Consultation with categories representatives

Consultation with categories representatives is the second method to assess satisfaction through direct involvement. This is another parameter that encountered different opinions among interviewees. In fact, 70% of the interviewed sample approved the metric, while 30% approved it but with some concerns.

The main concern that was raised by the 30% is the fact that this representatives and organizations could be biased and could pursue personal or category interest that do not represent the demands and needs of citizens. The risk of lobbying has been outlined several times during the interviews, as an interviewee stated: *"these entities are very biased because they represent a category and the industries. Most likely they are going to come to the table trying to get as much benefits as possible for the industrials"*. Another respondent outlined the same risk, but he also provided a vision for a future in which categories will be outdated and technology will allow a complete decentralization of power, making citizens involved in every decision: *"the lobby risk is real, but when I was talking about decentralization, it is also about this theme. Clearly categories are important, but it is also a bit risky and I would be more for the attempt to democratize the process, otherwise we will always risk that the approach is top-down"*. On the other hand, the remaining 70%

who approved the metric, argued that by listening to category representatives allows to obtain a filtered and more relevant opinion about citizens' needs and concerns, while also using less resources to perform the analysis.

It is important to underline that all the concerns about the lobbying risk were raised by people who work in the United States. As a matter of fact, three over four American interviewees raised this problem. On the other hand, Italian respondents never cited this issue and viewed the involvement of categories representatives as a positive thing since information arriving from them would already be filtered and requests would be rational and adequate.

Secondary stakeholders' involvement in the decisional process

This metric is aimed at measuring the level of involvement of secondary stakeholders in the decisional process. It is another metric that found contrasting opinions among experts, and again highlighted different views and practices between Italy and the United States. In fact, 70% of the sample approved the metric, while 30% rejected it.

From the interviews it was evident how secondary stakeholders' involvement in the decisional process is a common and usual practice in the United States, while in Italy it is not performed, even if some Italian respondents recognized that it would be an important practice to implement. One of the respondents said about it: *"based on my practice in America, here for almost any project the public has to be involved. They will hold a community meeting for whether it's a small project, a medium project or a large project. And the community meeting will involve the people who are in the same neighborhood where the project will be developed."* He also brought an example of a project that was cancelled because of the opposition of local representatives during the first decisional meetings. It was not a megaproject; it was a local project for the construction of a new elementary school that found opposition in some local organizations and it was deleted. This example is not connected to megaprojects, but it gives an idea of how much local communities have relevance in the decision-making process in the USA. On the other

hand, every Italian expert stated that he or she has never seen this kind of practice in the country, for any project of any dimension.

Also, for this metric, the issue of biased organizations and lobbying has been underlined: *“I think it is important to put as many players as part of the situation. For me, the only problem is to see how unbiased those players would be because sometimes, if you bring a Union to vote for things happening to the part, they are most likely to vote for things that are interest for the Union workers, not necessarily for the community”* one respondent said.

On the other hand, the 30% who rejected the metric did so arguing that the involvement of local communities’ representatives in the decisional process would make it more confused and longer, leading to many additional requests, time slippages and cost increase.

Stakeholders executed requests

All the interviewed panel agreed to the fact that stakeholders’ additional requests are a major theme in megaproject management and usually they are not properly recorded and analyzes. That is why, all respondents agreed and approved this parameter and its measuring technique.

Everyone agreed to the fact that these additional requests have huge impact on some project, as a person stated: *“it can be a huge factor on whether the project can be successful or even start. Sometimes, if the requirements are legitimate, and the project happens to go over budget, then one of two things can happen: either they cancel the project or they request more funds to accommodate those additional things”*. Another interviewee reported: *“I think it makes extreme sense and it goes back to the example of the International Airport: there were definitely a few things that the primary stakeholders didn’t want to do, but they had to because the government required them and they went over budget and the overall project got less profitable than it should have been”*. It is evident that additional requests have a huge importance in megaprojects management practices and keeping a database of their execution and cost is considered an extremely positive factor, not only to understand the eventual over-budget, but also to learn and include in future projects something

that has not been considered, as an expert said: *“which are the costs and where they came from? But for the purpose of the model, this analysis allows you to understand what can be considered as a parameter in a second project, something that was not considered or was underestimated in the first one”*.

Something that emerged as impactful on this theme is the difference between private and public projects. In fact, experts said that in public projects it is easier to obtain more funds since the project is of public interest and governments can easily allocate more money to complete it. On the other hand, if the project is private, the cost impact will be greater and, if the company cannot get more funds and see an excessive reduction on the project profitability, it could cancel the project. In private sector *“projects are not done for charity. They’re done for profit”*.

Another important aspect to be underlined in this paragraph is the difference between Italy and USA also in the usage of additional requests as negotiation tools. In fact, Italian experts reported that in their country there are strict and rigid rules about buildings and there is not much space for too much negotiation, on the other hand, in America rules are less rigid and negotiation happens more. As one expert who used to work in Italy and now works in the United States reported *“there is a huge negotiation, like I allow you to make three or four more floors in your building if you also deliver this other thing. In Italy it is not like this because everything is ruled by the civil code. [...] So, in my opinion, especially here in the USA, the risk of having too high costs and a low compensation is lower. But it remains a great parameter to measure”*.

Project reputation

Project reputation aims at measuring how the project is being described by the media and on social media to understand the sentiment in the population. This measurement found unanimous approval from all respondents since everyone recognized how media and social media *“always can affect the success of the project one way or the other”*. They also underlined that the difference between media and social media is relevant since social media give an idea of the real sentiment of the population, while *“traditional media can be deceiving and try to shape people’s perception for other interests or*

can be honest and present the truth about the project.” For this reason, some experts gave particular emphasis to the importance of social media over traditional ones. A respondent described them as: “the real thermometer of reality. They have an enormous and immediate aggregation capacity and it is crucial to work by anticipating them because, if the back-wave arrives, and it has been underestimated, it becomes a tsunami and you get run over”.

Another theme that experts agreed on is the extreme potential of performing this analysis with the help of computers and artificial intelligence. One respondent commented: *“absolutely in favor of this metric, and also here technologies are crucial, it could be possible to obtain some really important output data. [...] Trying to do data analytics considering various demographics, various social levels, various generations could give incredible results, also allowing to make prediction, especially with the help of AI. It is crucial to go toward that direction [...] If in the future we can manage this data in real time, they can give amazing results and really help project management”.*

Protests

The analysis of protests to assess secondary stakeholders' satisfaction in megaproject found unanimous approval from all respondents. They all recognized that protests are a sign of discontent and that reducing protests would improve project's perception and citizens' satisfaction. However, many of them highlighted the fact that a deep analysis of each protest should be done to understand the reasons and the motivations behind it. In fact, some protests are legitimate and they actually represent some needs and urgencies of the population, while other are driven by an a-priori opposition against infrastructure and economic development. For this reason, a profound study of protests should be done before giving a score to the project. Another aspect of protests is the huge influence of media. As a matter of fact, it is true that protests cause media coverage and bad project reputation, but also the opposite is true: media can boost protest by the way they describe a project. One respondent commented: *“the protest against the project typically follows the media presentation, so the media becomes so influential in terms of how the media presents the project to the public”.*

Media coverage, project reputation and protests are linked and this should be taken into consideration when performing the analysis.

Prosecutions and corruption

The analysis of prosecution and corruption found profoundly contrasting opinions among experts. In fact, 70% of the approved the parameter and stated that it is an important measure for megaproject's success, while 30% strongly rejected it, saying that it could be counterproductive, or it does not impact project's success.

People who were in favor of this metric recognized that corruption can hugely impact on project's success and reputation and it has to be included in the analysis, however, they also highlighted that corruption is usually present in this kind of works. A respondent stated: *"corruption can definitely destroy a project or end up doing a project that's not good for the public or the stakeholders, especially secondary stakeholders. So yes, the less corruption, the better, obviously. Corruption can affect the project one way or the other, but typically corruption does exist, everywhere, especially when you have political involvement"*. Another respondent linked corruption to bad management, in fact he thought that *"corruption is a byproduct of bad management. If you have a good management, you can eliminate it. You can have a better system to control how the money are well spent"*. In his idea, which was shared by some other experts, corruption is caused by bad management, so its measure could be useful to understand what practices are wrong and to work on management structure to eliminate it.

On the other hand, the 30% who opposed to this metric brought up two different arguments. The first is the fact that the presence or absence of corruption is an internal problem to the management structure and it does not affect the final project result, nor project's performance and satisfaction. The second was a more structural critic to the battle against corruption that is considered more damaging than beneficial. As one expert argued: *"Too much focus on corruption is a bad thing. Unfortunately, we have an experience, talking about the last thirty years in Italy, where for example the operation Mani Pulite, born as an anticorruption operation, revealed itself non just useless, but extremely*

damaging. For that operation we passed from a corrupting system that was practical by nature, to a system that now is individual, much more difficult to control". So, in their opinion corruption should not be included in the analysis since it is irrelevant for project's performance and a high focus on it could be damaging for the whole system.

Political support or opposition

Political support and opposition are another metric that encountered unanimous support by all the interviewed experts. In fact, everyone recognized the central role of politics in megaprojects, as defined by a respondent, *"politics is the driving horse of megaprojects"*.

Moreover, all interviewee agreed to the measurement technique, recognizing that it is a simple way to measure the politicization of a project and confirming that infrastructures and megaprojects that brings economic development should be shared among all parties. As one of the respondents said: *"especially megaprojects are not right-wing or left-wing because they have an impact on citizens' lives, they are not ideas. [...] If a project is good, it is not because it is right-wing, nor left-wing. It is so true that this oppositions, in some states as France or Germany or the United Kingdom, where the State is more consolidated, projects do not encounter these political polarizations"*.

Additionally, in America this subject is particularly important because megaprojects' support is usually a driving force for candidates to be elected in states. A respondent commented: *"You are touching on a subject that is essential, especially in the elections of the government officials, at least in America. [...] it's a natural thing to consider the political disputes and the political involvement in a project"*.

SROI, % of inv in social value

The assessment of the social value delivered by a megaproject through the Social Return on Investment and the percentage of investment in social value found

unanimous approval by the interviewed panel. In fact, everybody agreed that megaprojects should be a means through which social value is delivered to citizens and communities and recognized the importance of such a quantitative metric in the assessment of megaprojects' success and secondary stakeholders' satisfaction. This view of megaprojects as social value creators was recurrent in every interview and different people highlighted different aspects: one respondent focused on inefficiencies and stated: *"the focus should be on the inefficiencies before the project, understanding what world we want to develop before the project because if you remove the inefficiency, you automatically have the benefit. [...] For example, if you evaluate bottlenecks in the highway system or in telematic networks, you create a project to resolve and improve them"*. Another person saw megaproject as means of connection between people. Bridges, highways, airport networks and railways can all deliver social value in terms of increased connectivity. Finally, another point of view is about the improvement of disaster management through megaprojects: *"megaprojects have many social impacts such as disaster management impact. Because by doing a lot of highways, a lot of bridges, a lot of harbors and tunnels, you can consider how you turn it into a national network of defense and disaster management. You can manage the flood, since you build the bridge, you build the right highway network, so you have a better disaster management and control"*. From these testimonials, it is evident how social value is crucial for megaprojects' success.

N° of jobs created

All respondents agreed on the importance of this metric in a global evaluation of the social impact of megaprojects. In fact, megaprojects are a means of economic and social development for countries and one of their aims should be to generate indirect and induced long-term jobs for citizen in the impacted areas. The creation of jobs is one of the tangible impacts of megaprojects, *"it is the most evident, and maybe the most important"* one of the interviewees stated. Another person highlighted the connection between megaprojects, jobs and immigration: *"for the job market, the realization of some projects can block the emigration process, the one exiting a country and it is possible to get back to an entering flux, especially of highly educated people. One of the main goals should be to stop*

the brain drain and to attract new people". Moreover, together with new jobs, megaprojects are also drivers of technological development, as highlighted by a respondent: "about job impacts, when you create a mega project, you create a lot of jobs, and not only jobs, you also created the upgrading of construction and technology. Upgrade because through the megaproject you have to start to look into the technology and management, because you're doing a very complicated train station, very complicated bridge, or a tunnel. [...] Difficulty forced your own technology to move up, and the job, and education jumps out, the education of new technology. [...] New technology development and education jump-start to match these mega social projects".

On the other hand, the 10% of the sample that raised some concerns, did not raise them about the metric itself, but about the usage of such a specific metric in a wide evaluation. The respondent underlined how the measurement scale between the SROI or the GDP and the number of jobs created is different and they cannot be put on the same plane. The same observation has been done for the following parameter, the difference in average wages, saying that if we reach such a level of detail, then many more specific parameters should be added in the model. A deeper analysis of the weight of this parameter in the overall model, or the study of some additional parameters should be performed in future development.

Difference in average wage of employees

The measure of the difference in average wages of employees did not find the approval of all interviewees. In fact, only 60% approved the parameter, while 30% rejected it and 10% raised concerns about it.

The people who were in favor of this metric thought that it would be useful to understand the impact of a megaprojects in terms of economic development and industrial development of an area. For example, one interviewee argued that the construction of a new highway or a railway can connect places that were before isolated and allow the generation of industrial pools, leading to a wider job market and higher salaries. On the other hand, 30% of the pool rejected the metric stating that

in their opinion, megaprojects do not usually have impact on average salaries, they have impact on economy and economic growth, but not specifically on salaries. Finally, 10% raised the same concern explained in the previous parameter, this measure is too detailed compared other metrics in the model. A deeper study on the impact of megaprojects on the job market and on salaries should be performed in order to better understand if this metric makes sense in the context of this evaluation.

GDP and GDP growth rate

GDP and GDP growth rate are two metrics that measure the impact of megaprojects on the economy of a country or an area. This two KPIs found unanimous approval in all the pool of interviewees. Everyone agreed on the fact that megaprojects are the main drivers of economic development of countries and their impact on the GDP and GDP growth rate is a central metric also in the assessment of secondary stakeholders' satisfaction. An interviewee commented: *"It's very, very important, because that's how communities grow and that's how economy grows and becomes stronger. Otherwise, there is no reason to do projects"*. Another important aspect about megaprojects' impact on the economy have been underlined by another respondent, who argued that megaprojects can jumpstart and rejuvenate the economic growth and the GDP of a country: *"Long term economic growth is being stimulated due to this social project, this megaproject, but what kind of economic growth it can jump start when I provide Taipei 101 Mega Tower, or the Petronas Tower in Kuala Lumpur, or the three super tower in Shanghai? Each city is trying to do a megatower downtown. The reason of that is not just if the Mega tower will make money or not. Because you cannot use expenditure versus revenue. It is because after this megatower is built, it makes all the adjacent land, which is depressed and not useful, a very vital part of the city and it jumpstarts land value and urban development. That's the whole incentive to do all this, so you can look at the economic impact as direct project expenditure versus revenue versus, versus the long-term debt and versus the local economic rejuvenation"*. Economic development and growth are recognized to be one of the most important reason to implement megaprojects and should be included in an holistic evaluation.

Overall service quality

Overall service quality is a parameter that aims at measuring the level of service offered by the infrastructure, both in terms of quality of the policies to lower inconveniences during project development, and in terms of quality of the service after the project is completed. Also, this metric found unanimous approval among experts, and many of them had examples about this aspect in projects they followed.

The first example is about Ponte Morandi construction in Italy: *“this construction went way above the pure physical aspect of rebuilding the infrastructure. It was the principal connection between East and West Genoa, and the urban passage of Autostrada dei Fiori, a principal highway. So, the interruption of such an infrastructure, brought to the stop not only of private traffic, but also of the freight traffic, and being Genoa Port one of the main for our country, it was a problem. [...] A secondary network had to be built to avoid an excessive slowing or the blockage of those activities that constitute the economy of the area. [...] This all had a huge impact on citizens moving around the city, to not cite the ones living below the bridge”*. Another respondent talked about a highway widening in Orlando, Florida, *“I actually was involved in in one of those projects in Orlando, where the major highway, called Interstate 4 was approved for widening. It used to be four lanes going through downtown Orlando, and now it’s going into four lane. [...] So, I was actually part of a project where the public was involved in voting on such a intervention, and then also the public was inconvenienced by going through a slower lanes and closure of lanes and stuff like that”*. A third interviewee talked about the strategies that are being implemented in the construction world to try to diminish the inconveniences as much as possible: *“It is an extremely important aspect, and it has a huge impact also on technologies. In fact, in architecture, real estate and construction, offsite construction technologies are being born and developing with the aim of reducing construction times. The final goal is not only economical, but to actually reduce the impact of the construction process. [...] In general, having this system that allows you to make decision also during construction is important”*.

Some comments were done also about service quality after project delivery: *“the evaluation of many aspects is not only economical. The impact on the quality of life given by*

the offered service is a parameter that can be measured and can be tangible. Service quality has a huge impact on communities and on the quality of life”.

Number of served stakeholders

The measurement of the number of served stakeholders have been approved by all interviewed experts as an important parameter to assess if the project forecasted capacity have been adequate and if it is used as forecasted or not. One of the respondents made an interesting comment about this aspect saying that: *“you measure this after completion, but you also have to consider the growth of the community after the completion because some of those projects will take maybe you know three, four or five years to complete. During those years the population will continue to grow while construction is going. So not only you have to consider the capacity after construction is completed, but also you have to consider the capacity 5 to 10 years after that and that becomes your determining capacity to start with”*. The importance of correct project capacity and usage has been considered an important parameter to assess project success and stakeholders’ satisfaction.

The following table reports some of the most relevant citations taken from the interviews.

Secondary stakeholders’ satisfaction

Secondary stakeholders are sometimes very important, very essential to the success of the project.

Absolutely, it is extremely important. Projects, especially when they have huge dimensions, have impact on a network of economic and social realities and on people’s lives.

We are trying more and more to transform infrastructural projects also in social infrastructures.

Three approaches: direct involvement, external observation and promoter’s eye

If you’re just going to look through one type of lens, then for sure your research is going to be very biased. If you’re trying to look into multiple lenses, you might have something that is closer to the truth.

Model application: during project realization, final evaluation and ex-post evaluation

It is a great way to rethink project evaluation and provide continuous feedback.

Population surveys

I have done something similar on large projects and they tend to be really very effective into the success of the project.

The analysis that that you're suggesting in your model is then very, very important and it can add a huge value to the final decision on how to do and improve a project.

Questionnaires have to be done with caution. Usually people that are interviewed, are unaware of the impact of a project, nor have the sensibility of the promoter or the State.

An important theme here is how to educate people. [...] New technologies should be used more and more and in a more intelligent way for this aim [...] It is unclear how promoters are convincing us that an infrastructure has to be done or not. They just create opposing sides.

Consultations with categories representatives

Representatives could be a great filter for citizens' requests.

These entities are very biased because they represent a category and the industries. Most likely they are going to come to the table trying to get as much benefits as possible for the industrials.

Clearly categories are important, but it is also a bit risky and I would be more for the attempt to democratize the process, otherwise we will always risk that the approach is top-down.

Secondary stakeholders' involvement in the decisional process

Based on my practice in America, here for almost any project the public has to be involved. They will hold a community meeting for whether it's a small project, a medium project or a large project.

I think it is important to put as many players as part of the situation. For me, the only problem is to see how unbiased those players would be.

Stakeholders executed requests

It can be a huge factor on whether the project can be successful or even start.

Which are the costs and where they came from? But for the purpose of the model, this analysis allows you to understand what can be considered as a parameter in a second project, something that was not considered or was underestimated in the first one.

In the United States there is a huge negotiation, like I allow you to make three or four more floors in your building if you also deliver this other thing. In Italy it is not like this because everything is ruled by the civil code.

Project reputation

Media and social media always can affect the success of the project one way or the other.

Traditional media can be deceiving and try to shape people's perception for other interests or can be honest and present the truth about the project.

Social media are the real thermometer of reality. They have an enormous and immediate aggregation capacity and it is crucial to work by anticipating them because, if the back-wave arrives, and it has been underestimated, it becomes a tsunami and you get run over.

Absolutely in favor of this metric, and also here technologies are crucial, it could be possible to obtain some really important output data. [...] If in the future we can manage this data in real time, they can give amazing results and really help project management".

Prosecutions and corruption

Corruption can definitely destroy a project or end up doing a project that's not good for the public or the stakeholders, especially secondary stakeholders. So yes, the less corruption, the better.

Corruption is a byproduct of bad management. If you have a good management, you can eliminate it.

Too much focus on corruption is a bad thing and can bring to counterproductive results.

Political support or opposition

Politics is the driving horse of megaprojects.

If a project is good, it is not because it is right-wing, nor left-wing. It is so true that this oppositions, in some states as France or Germany or the United Kingdom, where the State is more consolidated, projects do not encounter these political polarizations.

It's a natural thing to consider the political disputes and the political involvement in a project.

SROI, % of inv in social value

The social impact assessment is a central theme in megaprojects' success evaluation.

The focus should be on the inefficiencies before the project, understanding what world we want to develop before the project because if you remove the inefficiency, you automatically have the benefit.

Megaprojects have many social impacts, such as disaster management impact. Because by doing a lot of highways, a lot of bridges, a lot of harbors and tunnels, you can consider how you turn it into a national network of defense and disaster management.

N° of jobs created

It is the most evident, and maybe the most important.

For the job market, the realization of some projects can block the emigration process. [...] One of the main goals should be to stop the brain drain and to attract new people.

About job impacts, when you create a mega project, you create a lot of jobs, and not only jobs, you also created the upgrading of construction and technology. [...] New technology development and education jump-start to match this mega social projects.

GDP and GDP growth rate

These social megaprojects can jumpstart and rejuvenate the GDP and the economic growth of the of the entire nation.

It's very, very important, because that's how communities grow and that's how economy grows and becomes stronger. Otherwise, there is no reason to do projects.

Each city is trying to do a megatower downtown. [...] It is because after this megatower is built, it makes all the adjacent land, which is depressed and not useful, a very vital part of the city and it jumpstarts land value and urban development.

Overall service quality

The impact on the quality of life given by the offered service is a parameter that can be measured and can be tangible. Service quality has a huge impact on communities and on the quality of life

It is an extremely important aspect, and it has a huge impact also on technologies. In fact, in architecture, real estate and construction, offsite construction technologies are being born and developing with the aim of reducing construction times and impacts.

So, the interruption of such an infrastructure, brought to the stop not only of private traffic, but also of the freight traffic, and being Genoa Port one of the main for our country, it was a problem. [...] A secondary network had to be built to avoid an excessive slowing or the blockage of those activities that constitute the economy of the area.

Number of served stakeholders

Serving stakeholders is the principal reason for building megaprojects and it is important that these infrastructures serve the purpose for which they were designed.

Not only you have to consider the capacity after construction is completed, but also you have to consider the capacity 5 to 10 years after that and that becomes your determining capacity to start with.

Table 18 - Summary of salient citation for each KPI

The analysis of the interviews with experts highlighted some points of the proposed model which importance is shared among all respondents, while others where opinions were different. However, the main goal of the model, its application and the three main approaches used to measure the proposed KPI found unanimous approval, making the general structure of the model successful. The difference in experts' opinion has been found only on the detailed parameters inside each category. In particular, some experts highlighted how population surveys must be done with caution and results must be correctly considered. The same is true for consultation with categories representatives, where the main concern was the risk of lobbying. Some respondents did not agree on the fact that involving secondary stakeholders in the decisional process could be a good thing for project's success. Others thought that the measurement of corruption is useless or even damaging in such an environment, and finally some had doubt about the direct impact of megaprojects on employees' salaries. Apart from these observations, the majority of the parameters have been approved unanimously, even by people coming from different countries.

The fact that the cultural aspect is central with regards to stakeholders' management and importance is of common knowledge, and it was interesting to find experts coming from different cultures and different working environments aligned on some elements, even though the European and the North American cultures are similar under many aspects. Given this fact that the two cultures are similar, it was even more interesting to see the differences that the interviews highlighted. In fact, it was evident how secondary stakeholders are considered differently in Italy and in the United States: in the first country, it is very unusual to involve them in the decisional process of large infrastructure projects, and their opinion is usually seen as not so trustworthy or relevant, reason why is positively seen to listen to categories representatives who filters citizens' opinions and needs. On the other hand, it emerged that in the United States it is a common practice to involve secondary stakeholders and local

communities in discussion about the development of new megaprojects and their opinion actually counts. Additionally, experts from the US were concerned about the involvement of categories' representatives, highlighting a high risk of lobbying and biased requests. They tended more to directly involve citizens and listen to their opinion, rather than involving their representatives.

This fact that two similar cultures had different points of view on some practices and metrics reinforces the relevance of the ones on which they agreed upon. However, it would be important and interesting to investigate the opinion of experts coming from more countries with even more different cultures and see how they perceive such an evaluation model.

Conclusion and future developments

This thesis introduces a practical model to assess social sustainability of megaprojects through the analysis of secondary stakeholders' satisfaction. In recent years, the consideration of secondary stakeholders has profoundly changed, with academics and practitioners that started to consider their opinion and their needs relevant. Secondary stakeholders' management and involvement in the decision-making process is one of the central themes around megaprojects environment, and theories on how to manage them and how to involve them in decisions in order to create a joint value for both projects promoters and society were born. This vision shift made it necessary to introduce new performance evaluation parameters for megaprojects, in order to give relevance to modern values as social sustainability, environmental sustainability, workers' safety and much more. However, even though literature widely reports this necessity, a real practical tool to evaluate these metrics is missing, and performance evaluation is still done through the lenses of cost, time and scope, with all the limitations related to this model.

The aim of this work is to fill this gap by providing a global evaluation framework for megaprojects performance assessment, a framework that extends the classical metrics and includes parameters that reflect what society considers important in this historical period. After a detailed review of both recent and core literature, a global evaluation framework is presented. The framework is composed by nine key performance indicators that together aim at providing a holistic evaluation of megaprojects performance. The inserted parameters are: cost, time, scope, value, stakeholders' satisfaction, quality, environmental impact, reputation and risk. Cost must be intended in a wider way than comparison between budget and actual cost. The comparison must be done between forecasted and actual costs, and if there is a difference between the two, either positive or negative, the reasons for this difference must be investigated

in order to avoid bad practices in future project and repeat good ones. Also, time evaluation must be expanded by including aspects as the speed of response to changing project conditions or the time to market. Scope, the third vertex of the iron triangle, must also be updated to fit the holistic evaluation. As megaprojects are inherently complex and susceptible to changes in requirements and objectives over time, dynamic and adaptive scope management becomes crucial. A more progressive interpretation of scope can consider the adaptability to evolving stakeholder needs, the project's alignment with broader societal and environmental objectives, and its long-term impact. Value, the fourth parameter, can be defined as the sum of the economic benefits and wider social gains to be accrued, minus the capital costs to be incurred. Economic value and social value constitute the two primary components of total value creation and both have to be evaluated in a global model. In modern world, public satisfaction has become and will become more and more important in the evaluation of large infrastructure projects, for this reason, an assessment of how satisfied primary and secondary stakeholders are from a given project is central in a global evaluation framework. Quality is another aspect that gained more importance in recent years, and its evaluation encompassing quality of services and quality of outcomes has to be inserted in the overall performance measurement. Another aspect that gained extreme relevance is environmental impact, with people becoming more and more concerned about nature disruption and human footprint, this parameter is crucial in the success of a megaproject. Its evaluation is a multifaceted process that extends beyond the project's development phase and into its post-completion period. With the expansion of media and social media, public opinions and reputation became a priority for many companies, the same can be said about megaprojects. In fact, large infrastructures are historically tainted with a bad reputation and this fosters public opposition. The evaluation of megaprojects reputation is crucial to understand criticalities and work toward improving people's view. The last parameter is risk and safety, another theme that gained relevance in today's practices. Risk evaluation should encompass the management of social risks, technical risks, economic risks, environmental risks and political risks, together with workers' safety.

The proposed framework should serve as a guideline to a deeper and wider evaluation of megaprojects performance, but it has not been completely transformed into a practical tool yet. This step has been exploited for one parameter, secondary stakeholders' satisfaction. In fact, following the framework, a practical, dynamic and applicable model has been devised for assessing the satisfaction of secondary stakeholders. This metric would give an idea about a megaproject social sustainability by evaluating how impacted people are perceiving it. The model is thought to be used in different moments of the project life: during project development as a dynamic tool to timely identify criticalities and implement corrective actions; right after project completion to perform a final analysis and get feedback about the whole work done; and after 3 to 5 years after completion, for an ex-post evaluation, to understand the long-term impacts and long-term perception of the project.

In the model, the analysis of secondary stakeholders' satisfaction is performed through three complementary methodologies: direct involvement of citizens, to obtain the direct opinion of the impacted communities; external observation, to have an unbiased perspective of how the project is perceived through the observation of several objective factors; and an evaluation with project promoter, to understand if the initial objectives are being met. Each of the listed methodologies includes several measurable parameters from which a score from 1 to 100 is assigned to the project. The final goal of the model is to assign to each project a score for secondary stakeholders' satisfaction as the average of the three obtained scores. Direct involvement measurement is performed by two parallel techniques: surveys directed to the population, performed at large time intervals or project milestones with the aim of having a direct opinion of how the project is being perceived and how it is impacting people's lives; and consultations with categories representatives, to have constant and filtered feedback during project lifecycle without an excessive resource allocation. On the other hand, external observation includes: secondary stakeholders' involvement in decisional process, measured as the number of local communities represented in the decisional board over the total; stakeholders executed requests, measured by keeping a database of the received requests, their importance, their outcome and their cost and by computing the percentage of realized requests, weighted by their importance; project

reputation, measured by analyzing media stories of major local and national newspapers and evaluating the percentage of positive and negative articles; protests against the project, measured by analyzing authorized and unauthorized protests, their importance and entity; prosecution and corruption, parameter that considers the number of investigations, first instance judgments and definitive convictions; and political support and opposition, where the percentage of parliament opposition that supports a megaproject is measured to understand if the project is politicized or if its interest is shared among all parties. Finally, promoter's eye evaluation is the comparison between project expectations and project outcomes for the following parameters: percentage of investment delivered in social value, measured by using the SROI (Social Return on Investment); number of created long-term jobs, measured through the comparison between forecasted indirect and induced jobs and the actual values after megaproject completion; difference in wages of employees, measured by the Difference-in-Difference model to verify that the increase or decrease in wages is caused by the megaproject; GDP per capita and GDP growth rate, measured comparing forecasted values with actual ones after project completion; Overall Service quality, measured through SERVQUAL model, with a series of questions to gain an evaluation of the service quality perceived by citizens; and number of served stakeholders, forecasted by calculating the capacity of the megaproject through traveling forecasting models or other models depending on the type of megaprojects, then comparing the data with the actual one.

In the last part of the work the model was validated through experts' opinions. Ten semi-structured interviews were conducted with field experts coming from the USA and Europe, particularly Italy, but with worldwide experience. These interviews highlighted the validity of the overall model goal, its usage and the three main approaches to evaluate the metric, with unanimous approval from all experts. The same can be said for most of the parameters under each approach. However, some of them highlighted doubts or disagreement about some of the inserted KPIs. Moreover, interviews evidenced some cultural differences from Italy and Unites States: for example, involvement of secondary stakeholders in the decisional process is a common practice in the US, while it Italy it is not; another interesting difference is the

view about category representatives, which are seen as good filters for citizens' opinions by Italians and as biased and untrustworthy by Americans. This fact that two similar cultures had different points of view on some practices and metrics reinforces the relevance of the ones on which they agreed upon. However, it would be important and interesting to investigate the opinion of experts coming from more countries with even more different cultures and see how they perceive such an evaluation model.

This research could serve as the basis for a practical holistic evaluation model for megaprojects performances, however, many themes must be further developed to completely fill the gap. Firstly, there is the need for developing the same practical model that has been presented for secondary stakeholders' satisfaction for all the other metrics inside the global evaluation framework. In fact, such framework aimed at exploiting all the important parameters to be measured to globally assess megaprojects success, but just one of the metrics has been translated into a practical evaluation tool. Interviews and experts' opinions highlighted that the developed model for secondary stakeholders' satisfaction assessment requires further research to be refined. As a matter of fact, one of the first evidences is the non-unanimous opinion of equal weight for all parameters in the model. This aspect has already been anticipated during the presentation of the model, since weights have been assigned equally in absence of evidence to do otherwise, however, it was evident that a further study on how to weight the three approaches and the parameters inside each approach had to be done in the future. Interviews confirmed this prediction, so it would be important to further investigate, maybe with specific interviews to experts, the optimal weights for each parameter. Moreover, a deeper analysis has to be performed also about those parameters that did not find unanimous approval among experts: limits, advantages, drawbacks and proper application techniques of each of them should be deeply examined.

The presented model has only been tested by experts' opinion, but not yet applied to a real megaproject to understand its practical usability. An important step that should be implemented in the future is the application of such model to a real case. This practice would better highlight model strengths, criticalities and utility. Additionally, the model has been based on literature predominantly from Europe and United States

and validated through experts coming from the same countries and cultures. This leaves uncertain the validity and applicability of this evaluation model in other countries that have different cultures, since secondary stakeholders' consideration is deeply connected to cultural aspects. A further investigation by involving experts coming from other countries and cultures could clarify if the relevance of such an evaluation is shared worldwide or localized in western societies. Finally, the presented model is a general evaluation technique, structured on construction megaprojects in general. It would be useful to deepen the analysis considering the different categories of megaprojects and how such model can be adapted or modified in order to align with the relevant aspects of the specific category.

The impact of megaprojects on society, local communities and people's lives is evident and it is continuously being investigated by academics to find solutions that can maximize their delivered social value and limit their negative impact. This work aims at adding a practical evaluation tool in this field that can serve as a basis for the continuous improvement of megaprojects performances, thanks to the measurement of what is now missing.

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