The BIM Impact on Stakeholder Management in Airport Construction Projects

by

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L'impact du BIM sur la gestion des parties prenantes impliquées dans les projets de construction aéroportuaires

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RÉSUMÉ

Les aéroports sont complexes et dynamiques et représentent un environnement impliquant de multiples acteurs, ce qui demande un effort important de la part des parties prenantes du projet lors de la mise en œuvre d'une intervention d'infrastructure. Développer des stratégies pour gérer les parties prenantes au sein des activités du projet est fondamental pour atteindre les objectifs du projet, en particulier en ce qui concerne le processus de prise de décision qui, dans les aéroports, devrait être aussi dynamique que possible en raison des nombreuses interférences qu'un projet peut avoir dans leurs opérations. C'est là que les nouvelles technologies, telles que la modélisation des données du bâtiment (BIM), jouent un rôle stratégique, en contribuant au projet en fournissant des informations de bonne qualité qui aident les décideurs. L'hypothèse de cette étude est que, avec des informations de meilleure qualité, le processus de communication sera amélioré, ce qui permettra de gérer efficacement les parties prenantes pendant le projet. Afin de vérifier cet impact sur la gestion des parties prenantes lors de la gestion de projets avec BIM, une étude de cas a été choisie et une série d'entretiens semi-structurés ont été réalisés avec les principales parties prenantes de l'aéroport, internes et externes au projet. Les résultats des entretiens ont été combinés à des concepts basés sur des recherches antérieures sur l'industrie aéroportuaire, l'industrie de la construction et la gestion de projet, axées sur la gestion des parties prenantes, pour aboutir aux résultats de cette étude. Le résultat final suggère une amélioration de la gestion des parties prenantes obtenue par: une amélioration significative de la compréhension du projet, car le BIM pourrait créer un langage commun qui aligne la perception de toutes les parties prenantes sur le projet; la création d'un environnement collaboratif permettant d'établir des relations de confiance entre les acteurs impliqués dans le projet; la création d'un sentiment d'appartenance à un projet, favorisé par la création d'une communauté de projets aéroportuaires; un engagement accru grâce à l'environnement de collaboration, au sens de la communauté et grâce à une meilleure compréhension du projet. Ces résultats ont été validés par deux spécialistes du domaine des aéroports. Les recherches futures pourraient englober les aspects du comportement organisationnel et individuel et de la résistance au changement, afin de tirer pleinement parti des technologies BIM en ce qui concerne la gestion des parties prenantes.

Mots-clés: BIM, visualisation 3D, compréhension, gestion des parties prenantes, engagement

The BIM Impact on Stakeholder Management in Airport Construction Projects

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ABSTRACT

Airports are complex and dynamic, a multiple stakeholder environment which demands a great effort from the project actors when running an infrastructure intervention. Developing strategies to manage stakeholders within the project activities is fundamental to achieve project goals, especially concerning to the decision-making process, which in airports should be as assertive as possible due to the numerous interferences a project can have on their operations. This is where new technologies like Building Information Modeling (BIM) assume its strategic role, contributing to the project providing good quality information that helps the decision makers. The assumption of this study is that, with better-quality information, the communication process will be improved, helping to efficiently manage stakeholders during the project. To verify this impact on stakeholder management when running projects with BIM, a case study was chosen, and a series of semi-structured interviews were made with the main airport stakeholders, internal and external to the project. The findings from the interviews were combined with concepts from previous research on the airport industry, construction industry and project management, focused on stakeholder management, to come up with the results of this study. The final result suggests an improvement of stakeholder management achieved by: a significant improvement on understanding, since BIM might create a common language that align all stakeholders' perception about the project; a creating of a collaborative environment that allows trustful relationships be built; a creating of a sense of project ownership, promoted by a creating of an airport project community; an improved engagement due to the better understanding, the collaborative environment, the community sense. These findings were validated with two specialists in airports domain. Future research could embrace the aspect of organizational and individual behavior and resistance to change impacting to achieve the full benefits of BIM technologies concerning stakeholders' management.

Keywords: BIM, 3D visualization, understanding, stakeholder management, engagement

TABLE OF CONTENTS

INTRODUCTION 1

CHAPTER 1 LITERATURE REVIEW 5
1.1 Airport industry 6
1.1.1 The airport economic impacts 6
1.1.2 The airport engineering projects 8
1.1.2.1 Airport Planning 8
1.1.2.2 Information within airport engineering projects 10
1.1.3 The airport project stakeholders 11
1.1.4 The airport complexity 12
1.2 Project Management 13
1.2.1 The concept of stakeholder management in project management 14
1.2.2 The human dimension within stakeholder management 17
1.2.2.1 Conflict in project environment 17
1.2.2.2 Adding trust to stakeholder management 19
1.2.2.3 The importance of relationships 20
1.2.3 Stakeholder engagement as element to project success 23
1.2.4 Efficiency of project process 24
1.2.5 Stakeholder management in the construction industry 25
1.3 Construction industry 27
1.3.1 The construction industry' performance 27
1.3.2 Decision-making process 29
1.3.3 BIM solutions for communication issues 31
1.3.4 The needed changes 34
1.3.5 Discussion 37

CHAPTER 2 METHODOLOGY 41
2.1 Research design 41
2.1.1 Conceptual Framework 42
2.1.1.1 The domains 43
2.1.1.2 The dimensions 44
2.1.1.3 The categories 45
2.1.2 The framework validation 47
2.2 The semi-structured interviews 48
2.3 Sampling 50
2.4 Data collection 51
2.4.1 Coding 51

CHAPTER 3 DATA ANALYSIS 55
3.1 Dimension 1 – Stakeholder Management 55
3.1.1 The challenges to engage stakeholders 56
3.1.2 The strategy to engage stakeholders 62
3.1.3 Dimension 1 discussion 71

3.2 Dimension 2 – Communication Process 73
3.2.1 The relevance of quality information on the communication process. 74
3.2.2 The 3D visualisation impacts on the communication process 82
3.2.3 Dimension 2 discussion 91
3.3 Dimension 3 – Decision-making Process....93
3.3.1 The challenges engaging stakeholders on the decision-making process .. 94
3.3.2 The 3D visualization impacts engaging stakeholder on the decision-making process..... 100
3.3.3 Dimension 3 discussion 109
3.4 The overall BIM impact on stakeholders' management 110
3.4.1 The final debate..... 112
3.4.2 How stakeholders would like to be involved on the project..... 120
3.4.3 Final debate discussion 121
3.5 Validation 122
3.5.1 Sampling 122
3.5.2 Framework 127

CHAPTER 4 DISCUSSION....133
4.1 Dimension 1 – Stakeholder Management 133
4.2 Dimension 2 – Communication Process 135
4.3 Dimension 3 – Decision-making Process....136
4.4 The 3D visualisation impacts on stakeholder management 137

CONCLUSION 141
Rival Explanations and Limitations....142
Recommendations for further research....143

APPENDIX I SEMI-STRUCTURED INTERVIEW PROTOCOL (English first version) 147

APPENDIX II SEMI-STRUCTURED INTERVIEW PROTOCOL (English final version)....149

APPENDIX III SEMI-STRUCTURED INTERVIEW PROTOCOL (French final version)....151

APPENDIX IV VALIDATION PROTOCOL....153

APPENDIX V CATEGORIES THEORETICAL REFERENCES 157

BIBLIOGRAPHY 165

LIST OF TABLES

Page

Table 1.1 Stakeholder definition 15

Table 2.1 Framework 42

Table 2.2 Categories theoretical references 46

Table 2.3 Interviewee profile 50

Table 2.4 Interviewees' participation 51

Table 2.5 List of categories, their definitions and examples from the interviews 53

Table 3.1 Summary of the main challenges 56

Table 3.2 Evidences for the challenges to engage stakeholders 61

Table 3.3 The resume of the main strategies 62

Table 3.4 Evidences for the strategy to manage stakeholders 69

Table 3.5 The relevant aspects of quality information to the communication process 74

Table 3.6 Evidences for the relevance of quality information 80

Table 3.7 The 3D visualization impacts to the communication process 82

Table 3.8 Evidences for the 3D impacts on the communication process 90

Table 3.9 The challenges to engage stakeholders on the decision-making process 94

Table 3.10 Evidences for the challenges to engage stakeholders 99

Table 3.11 The 3D visualization impacts to engage stakeholders 100

Table 3.12 Evidences for the 3D visualization impacts on engaging stakeholders 107

Table 3.13 The most relevant impacts of 3D visualization to stakeholder management 112

Table 3.14 Evidences for the overall BIM impact on stakeholder engagement 118

Table 3.15 Evidences for how the interviewees would like to be involved 121

Table 3.16 Evidences per interviewee 122

Table 3.17 Categories presented by each interviewee profile..... 124

LIST OF FIGURES

Page

Figure 1.1	Airport economic effects	7
Figure 2.1	Case study content	43
Figure 2.2	The dimensions	44
Figure 2.3	Categories from literature and their connections	45
Figure 2.4	The dimensions interrelations	49
Figure 2.5	Final coding	52
Figure 3.1	Relationships between the categories emphasized on Dimension 1	55
Figure 3.2	Categories emphasized on Dimension 1' answers	72
Figure 3.3	Relationships between the categories emphasized on Dimension 2	73
Figure 3.4	Categories emphasized on Dimension 2' answers	92
Figure 3.5	Relationships between the categories emphasized on Dimension 3	93
Figure 3.6	Categories emphasized on Dimension 3' answers	110
Figure 3.7	Relationships between the categories emphasized on the final debate	111
Figure 3.8	Categories emphasized on the final debate answers	122
Figure 3.9	Total occurrences for each category	125
Figure 3.10	Most cited categories for each interviewee profile	126
Figure 4.1	3D visualization impact on stakeholder management	138

INTRODUCTION

Airports deal with countless elements that impact on their efficiency. This industry changes constantly and it must be able to adjust itself quickly and efficiently to respond to those demands. To do so, it is mandatory to combine the airport client requirements, regulatory laws and financial goals all together to get the best response to every distinct situation. Amongst all these issues could arise different interests between the large number of stakeholders involved into the decision-making process regarding operational activities.

In airport projects, the concept of stakeholders may be understood as everyone that uses the infrastructure, i.e. passengers, services offered, governmental authorities, air companies, even the public in general, the city where the airport is located, or the country. With such huge different kinds of stakeholders, it is not difficult to realize that this type of venture is affected by many conflicting situations, which make the relations between the stakeholders and project team, as each other, so important. Thus, stakeholder management might be considered strategic to aim project objectives, engaging all different individuals, groups or institutions impacted by the project activities or with the power to impact them.

When dealing with large and complex endeavors as airport engineering projects, the communication problems amongst stakeholders are one of the main causes for the performance issues of those projects (Azouz et al., 2014; Egan & Williams, 1998). Collaboration on projects requires stakeholder engagement, which is based on the communication process and its information quality (Egan & Williams, 1998). Poor data flowing through project actors leads to a distrusted environment and all effort made by the project team in engaging stakeholders might fail (Pryke & Smyth, 2006). To maintain the commitment, all main stakeholders should be confident in the project decisions (Bourne, 2005). Inserted in the airport environment, the project is susceptible to many interferences and under the influence of several actors with different motivations. The negative impacts of an airport engineering project may represent significant financial losses for the entire related community, which adds yet another complicating element in this already complex context.

To deal with engineering project performance issues, new technologies had been developed, improving the quality of construction and its process and modifying the way projects are managed, like Building Information Modeling - BIM. The new work environment that comes with BIM demands skills and behavior that goes beyond the abilities project teams traditionally used to run projects successfully. Concepts like trust, engagement and sharing have been added, creating a positive atmosphere where the collaborative work can arise (Crotty, 2013), promoting the working culture of high performance (Kumaraswamy & Rahman, 2012) needed by airport projects.

The good quality and trustworthy information generated by BIM technologies improve communication flow, which, in airports, means that decision-making process might run quickly and assertively as demanded. All the conflicts generated by misunderstanding technical documents may be reduced and stakeholders should be able to communicate with each other in an efficient manner. This virtuous circle helps to improve construction projects productivity and predictability (Crotty, 2013), conditions required by airport construction projects due to their complex and uncertainty nature.

Thus, an engineering project inserted in this panorama shows a fertile field to observe the influence of BIM technologies implementation on the effectiveness of the stakeholders' management. Our assumption is that, by refining the way technical teams produce and manage information, moving from document-centric to information-centric management, communication between internal and external stakeholders will gradually improve, producing a positive effect on stakeholder management.

Thus, considering the airport engineering project context, this study aims to assess how the use of BIM technologies, here translated into 3D visualization[1], can impact the efficiency in managing stakeholders.

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[1] For the purpose of simplification and considering that the sample profiles include airport stakeholders that may not have the knowledge of BIM and its technologies, this study decided to use the term "3D visualization" as a format for any information in opposition to those traditional forms of presenting engineering project

The objectives of this research are:

- to establish the relationship between the improvement on the quality of information flow that BIM can add to projects and its impact on the stakeholders' project engagement;
- to expand the comprehension about how stakeholder engagement is affected by project information quality;
- to enlarge the knowledge about the effects of BIM in the decision-making process, highlighting its impact on project efficiency.

A single case study will be used to investigate the impact of BIM technologies in stakeholders' management: the terminal area enlargement of the Québec City International Airport, where the whole project was run using BIM technologies.

This report is organized in five main parts. Based on the referenced authors, Chapter 1 starts studying and critiquing structured knowledge upon three different technical domains: Airport Industry, Project Management, and Construction Industry. The literature review aims to highlight the connections between these three domains, especially those concerning to stakeholders. Chapter 2 details the methodology used to answer the research question based mainly on long interviews. After that, Chapter 3 describes how the data gathered on the interviews was analyzed. Chapter 4 follows linking the analysis results to the concepts extracted on the literature review. At last, the Conclusion summarizes this study and suggests topics for further research.

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information, as 2D drawings, spreadsheets, Gantt graphics, specification texts. Doing so were included on the term "3D visualization" for example, the virtual model, virtual reality, 3D/4D, etc.

CHAPTER 1

LITERATURE REVIEW

Airports are, by nature, complex, dynamic and involve multiple stakeholders in their operational activities. Any situation that interfere in their operations have to be cautiously analyzed before producing its effects. Then, a very systematic planning is required to run engineering projects in an operational airport infrastructure, and a strict activity control to assure that the planning is being precisely executed. As the project is running, it might face many conflicting situations where the decision-making process will demand a difficult negotiation due to its multiple stakeholders with divergent interest. Besides, the complex documentation generated by engineering projects and the constant difficult technical documentation understanding by the main stakeholders, could bring extra elements to the project team deal with.

This intricate reality faced by engineering projects in airports could be overcome by establishing a collaborative project environment and improving the quality of technical documents produced, increasing the stakeholders overall understanding and trusting in project information, improving the engagement to the project objectives and the decision-making process as well. The implementation of BIM technologies can provide a better-quality data, which increase the overall communication process by allowing to build the trustworthy relationships needed for an assertive decision-making process, fundamental for running engineering projects in airports.

This chapter presents a literature review that establish the links between these three domains that compound airport engineering projects: airport industry, project management and construction industry. The aim is to identity elements from these three domains that could be aligning to improve airport stakeholders' management strategies focusing on the project success. The first part presents the contextualization of the airport environment, its business model and what are the elements involved when running engineering projects. The second part presents the theoretical overview of stakeholder management, especially on the construction

industry, emphasizing the human aspects that reflect on the decision-making process. The third part highlights difficulties faced by the construction industry, especially on the decision-making process, and the impact of BIM technologies on the stakeholders' management.

1.1 Airport industry

The aim of this section is aligning the understanding of the context within which airports operate and the consequences of its complex nature when running engineering projects. It starts with the economic impact airports have on the region they are located. The next subsection is about engineering projects, the challenges to planning any engineering intervention to the airport and aspects related to the needed data to run such projects. The third subsection is dedicated to the multiple stakeholders' environment that airports encounter, followed by the complexity of its systems.

1.1.1 The airport economic impacts

Aviation and airports have a wide ranging of impacts. "The ability to move people and goods across the globe in a matter of hours is fundamental to the global economy" (Airports Commission, 2013, p.18). Considering the number of flights and the number of people working on its facilities, the activity of an airport might have an important impact on the region it is located (Bosi, 2015a). In this sense, airports can also work as a growth pole in the regional economy (Hakfoort, Poot, & Rietveld, 2001). Figure 1.1 below shows how the airport activity can impact its economic environment.

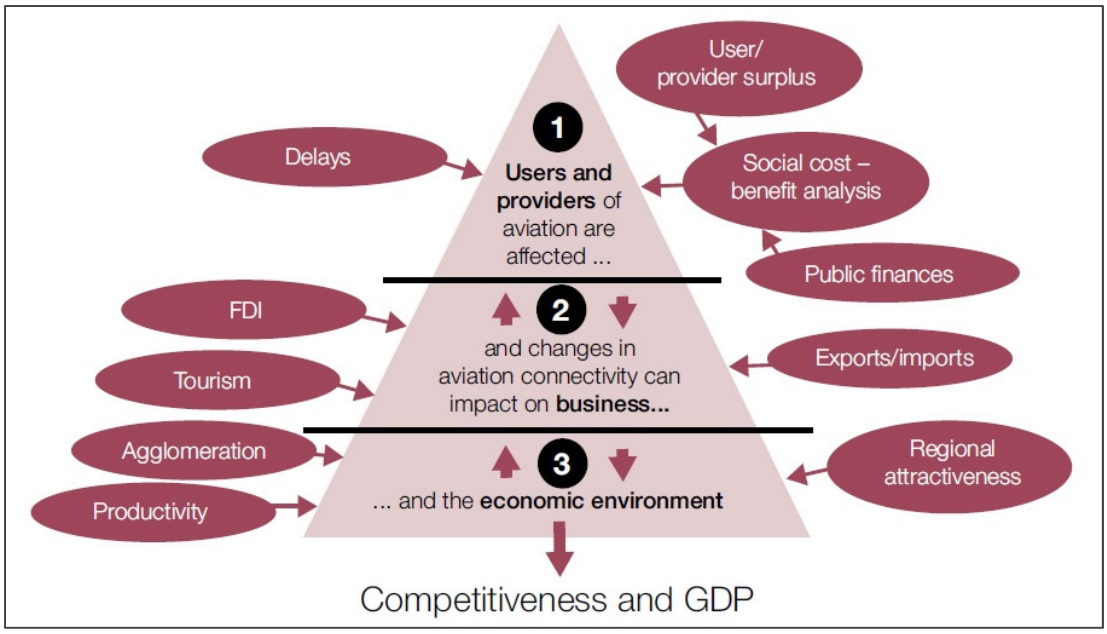

Figure 1.1 Airport economic effects

Taken from Airports Commission (2013, p.93)

The Figure 1.1 organizes the economic impacts that any airport might have in three dimensions: users and workers, business, and economic environment. Each dimension is influenced in its own way, but all of them will receive some impact concerning to any decision on the airport environment. These impacts and their consequences will dictate the competitiveness of each airport on the domestic and international market (Airports Commission, 2013).

By stimulating business, creating employment, promoting tourism and trade, airports might support economically their regions. More than that, they also play a wider role supporting the national and/or international networks (Kleinschmidt, Goonetilleke, Fookes, & Yarlagadda, 2010), which make "decisions on airport location and capacity […] the most important strategic choices a country or city can make, influencing the economic, environmental and social development of cities and regions" (Airports Commission, 2013, p.06).

Besides their economic influence on the market they are inserted into, airports are also impacted by the industry changes (Airports Commission, 2013). For example, the new entrance of "low-cost carriers in the market forces airports to increase the efficiency of the existing

infrastructure in order to preserve competitiveness and to maintain their sales" (Pabedinskaitė & Akstinaitė, 2014, p.399). Also, the demands of more airport services as well as for faster and efficient processing of aircraft, passengers and baggage has been increased by the deregulation/liberalization of the airline industry worldwide (Oum, Yu, & Fu, 2003).

As complicated business they are, airports combine different elements and activities to serve passengers and flight airlines (Pabedinskaitė & Akstinaitė, 2014) through organizations with their business particularities concerned to commercial, logistical, security and safety aspects (Fernandes & Pacheco, 2010). This diverse and heterogeneous industry presents "high degree of quality differentiation, different ownership and regulatory structures, different mixes of services and operating characteristics, as well as external constraints such as location and environmental factors" (Oum et al., 2003, p.285), elements that make each airport unique in its specificities.

Despite the uniqueness of each business model and infrastructure available, the services provided by an airport can be divided into airside and landside operations, being airside related to operations involving the aircraft, and the landside, the passenger and cargo (Oum et al., 2003). These two sides of operations are fully integrated and connected in one single flow of activities (Pabedinskaitė & Akstinaitė, 2014). Furthermore, these activities demand the support of a large number of other organizations, which also have their own operations (Park, 1999).

1.1.2 The airport engineering projects

Considering the importance that airports assume to the areas they are located in, this section focuses on the challenges faced by airport authorities and project teams when running any intervention to the airport infrastructure. The challenges related to planning the intervention are discussed and aspects related to the data used in this process.

1.1.2.1 Airport Planning

It is a common sense that the construction and operation of an airport have significant impacts in the area where it is located (Pitfield, 1981). This "decisions on airport location and capacity

are among the most important strategic choices a country or city can make. These choices influence the economic, environmental and social development of cities and regions more than many other planning choices" (Airports Commission, 2013, p.18). Despite the positive impacts an airport can bring to the region where it is located, they also have some negative consequences as aircraft noises, landscape alteration that can affect natural habitats, stress to the local transport network, air pollution (Airports Commission, 2013) to say just a few. These wider impacts demand the involvement of a large number and diverse profiles of stakeholders in order to achieve a better solution with lowers negative impacts.

Even if airport operators have been integrating a variety of stakeholders in the airport planning and decision-making processes, this increased involvement has not led to improved decision-making with respect to future development (Wijnen, Walker, & Kwakkel, 2008) simply because "airport decision makers and stakeholders exhibit various – and in many cases conflicting – objectives and priorities regarding the assessment of the airport performance" (Zografos & Madas, 2006, p.16).

These conflicting interests might exist on airport planning because it is hard to achieve a "balance between investments, expenditure, resource consumption, design flexibility and compliance to international and local technical references and regulations, while providing a quality experience for passengers, operators, airlines and service companies" (Bosi, 2015a, p.83). The input for new interventions on an airport is more often related to new technologies (as a development of a new aircraft design) than to the end of a facility life cycle, starting with the commercial, operational or management needs, or simply imposed by a new legislation or trends, as environmental challenges, for instance (Pastor & Benavides, 2011).

Besides, depending on the intervention, it can take years to be completed (Pitfield, 1981). Thus, planning an airport intervention is a long-term endeavor that has to deal with the risk of becoming obsolete before delivering due to new conditions or even stakeholders needs and objectives misunderstandings (Wijnen et al., 2008). "Moreover, the infrastructure conceived must be valid for the current and the future air traffic demand which fluctuates around the predicted number of passengers and airplanes movements" (Pastor & Benavides, 2011, p. 50).

Because all of that, “airport strategic planning should be a continual, repetitive process” (Wijnen et al., 2008, p.21) due to is multiple stakeholders environment and complex systems.

1.1.2.2 Information within airport engineering projects

Airport design is so complex that it demands a proper integration of the many disciplinary areas involved being delivered successfully (Bosi, 2015a). Its process is sequential and requires a collaborative platform based on multiclient and interoperable communication process, reflecting the inputs of designers, constructors and key suppliers (Pastor & Benavides, 2011). In this sense, project participants are responsible for the project information creation and management and as also sharing this information with other project participants, stakeholders and airport management (Bosi, 2015b).

Often, the data used on airport planning is inconsistent and not integrated, because it is generated by different experts, from different organizations, using diverse aspects of airport operations, being the cause to the dispersion of that data, information and knowledge within the airport operator and its stakeholders (Wijnen et al., 2008). This data dispersion persists because still there is not a collaborative organization provided by an interaction between project team members (Pastor & Benavides, 2011). “Expensive design errors showed the need to push design towards more integrated processes based on information sharing within the Design Team, Airport Owner, Authorities, etc.” (Bosi, 2015a, p.137)

This disruption in the multidisciplinary integration is one of the most common and important design management errors, and is based on the inefficiency of communication, lack of information and document output errors (Bosi, 2015a). However, “there are still a lot of resistance and barriers to be overcome in order to ensure an efficient and effective communication in airport projects” (Pastor & Benavides, 2011, p.18). Some of them are procedural, referring basically to the lack of that integration. But also, there are some technical and cultural barriers. Being temporary-based organization, the project team does not have the continuity of its relationships affecting the collaboration among its members (Pastor & Benavides, 2011).

To overcome the challenges to be faced when planning airport interventions, planners need to improve their understanding of the system and its problems, as airport decision-makers need to understand how their business decisions affect their goals (Wijnen et al., 2008). To achieve such output, the information used in the design process, and the communication process itself, need to be improved, having the organization working with its stakeholders, sharing information effectively to gain understanding of each other's perspectives and objectives. "Only when there is a mutual understanding is it possible to look for solutions that are satisfactory to all parties involved" (Wijnen et al., 2008, p.18).

1.1.3 The airport project stakeholders

The ultimately airport project goal is to meet customer and owners' expectations, which involves numerous actors both from inside and outside of the organization, who play different roles (Wijnen et al., 2008). However, the challenge is to build a common understanding within all involved in the project to align the decision-making in technical solutions. The late involvement of the airport stakeholders on the decision-making process might affect the future airport operation (Pastor & Benavides, 2011). Thus, having them involved and working together on solving problems is crucial to improve understanding about the airport systems, its problems and potential solutions (Wijnen et al., 2008).

Although its significance to the process, to get all the relevant stakeholders involved on the airport planning process is another big challenge (Wijnen et al., 2008). Being airport stakeholders those interested in the airport operation, such as private interests (the airport owner, shareholders, the airlines); government bodies (customs and security); customers (passengers and visitors); and agencies (such as IATA[2]) (Popovic, Kraal, & Kirk, 2010), they have divergent objectives concerning the airport development.

Satisfying simultaneously conflicting interests from diverse stakeholders is a complex task (Harrison, Popovic, Kraal, & Kleinschmidt, 2012) simply because they diverge about what

[2] International Air Transport Association - IATA

would be a good airport performance from its operation perspective (Kleinschmidt et al., 2010). Also, there would always be conflicts among the various airport stakeholders due to disagreements about results, assumptions, and the methodologies used to plan and design an airport intervention, or because they are not involved in the process, or because they cannot understand each other (Wijnen et al., 2008).

Besides involving airport stakeholders on the project decision-making process, it is also fundamental to imply professionals from many different disciplines to deal with such diverse technical issues as those present on airport projects. It requires "a multi-disciplinary approach that involves engineers, mathematicians, management professionals, architects, product designers, and IT specialists forming a collaborative team to work with airport operators" (Kleinschmidt et al., 2010, p.02).

Then, airport construction project is an endeavour that to be successful should count with the participation of many professionals from inside and outside the airport organization. Considering their active involvement to the project activities, the stakeholders might be assumed as internal and external do the project, despite their connection to the airport organization. Internal stakeholders are those that actively participate on the project activities, as firms responsible for the design and construction, as airport employees responsible for the project requirements and approvals. The external stakeholders are, for instance, the government agencies that control the respect to regulations, or commercial companies that intend to close new deals when the project is delivered, or even airport employees that are not involved on controlling the meeting of project requirements or the contract execution, participating just as external observers.

1.1.4 The airport complexity

Airports are complex systems (Harrison et al., 2012; Kleinschmidt et al., 2010; Park, 1999; Pastor & Benavides, 2011; Popovic et al., 2010; Wijnen et al., 2008; Wu & Mengersen, 2013; Zografos & Madas, 2006). Complex systems are systems with interdependent parts, where an individual behavior interfere on another. To study complex systems, one have to consider how its relationships affect the behavior of the whole (Bar-Yam, 2003).

The airport complexity arises from the various components which make up the airport – various systems, procedures, stakeholders, artifacts necessary for the operation of an airport, all of which have different requirements (Popovic et al., 2010). Theses components strongly interact and "the behavior of any one component depends on (and affects) the behavior of other components in a nonlinear manner" (Kleinschmidt et al., 2010, p.04).

Then, in order to planning, designing and operating an airport, decision-makers must face complex decision-making problems highly complicated because they involve many processes[3], entities processed[4] through the system, and a number of different elements[5], which are added to the large number of stakeholders with different, sometimes conflicting, objectives concerned to the airport performance (Zografos & Madas, 2006). Also, "the context in which airports operate is subject to changes in terms of aviation demand, technological developments, demography, and regulations; the uncertainties associated with these changes need to be taken into account as well" (Wijnen et al., 2008, p.13). All these airport systems changes need to be considered in an integrated way because their effects can impact airport performance and affect stakeholders objectives in different ways (Wijnen et al., 2008).

1.2 Project Management

The objective of this section is to bound the stakeholder management theory studied on this research underlining its influence on the project success. It starts by establishing the concept of stakeholder used on this study and the human aspects of conflict, trust and relationship. Then, the influence of stakeholders' engagement to the project success is pointed out, as it influences on the project efficiency. This section ends addressing aspects related to the stakeholder management in construction industry.

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[3] E. g., strategic planning, operations management.
[4] I. e., passengers, baggage, cargo, aircraft.
[5] I. e., runway system, taxiway system, apron area, terminal.

1.2.1 The concept of stakeholder management in project management

The Project Management Institute – PMI (2017, p.04) defines project as "a temporary endeavor undertaken to create a unique product, service, or result," being a solution for a social or organizational problem, a policy or a strategy, or part of a program. With specified duration, cost and performance, projects lead to uncertainty and complexity, which requires balancing all relations between the project and its parts, other projects, even with the organization. This uncertainty adds complexity to project environment and dealing with this is what defines successful project management (Bourne, 2005).

However, the concept of project as a temporary organization means that it has its own culture and structure (Project Management Institute (PMI), 2017), demanding building effective project teams and trust between the team and the project stakeholders (Grabher, 2002). This additional effort conceived stakeholder management as engagement management, where understanding the group of key stakeholders and how to manage this relationship throughout the project is the focus. "Managing a project is about managing uncertainty and managing the resulting resistance of many stakeholder groups due to their anxiety about the consequences of the change" (Bourne, 2005, p.17).

Bourne (2005) argues that a project only can exist with the consent of its stakeholder community and the relationships with all kinds of stakeholders are essential for project success, as they can benefit from or adversely be affected by its activities. Because they can cause different impacts on project activities, identifying who are the key stakeholders is strategic to project success but it is not an easy task (Bourne, 2005). There is more than one definition about whom stakeholders are, some of them including economic or social aspects, for instance. Table 1.1 below summarizes the stakeholders' definitions encountered on this study.

Table 1.1 Stakeholder definition

Author	Definition
Freeman & McVea, 2001, p.05	"… defining stakeholders as any group or individual who is affected by or can affect the achievement of an organization's objectives."
Newcombe, 2003, p.842	"Project stakeholders are groups or individuals who have a stake in, or expectation of, the project's performance and include clients, project managers, designers, subcontractors, suppliers, funding bodies, users and the community at large."
Bourne & Walker, 2005, p.650	"... stakeholder is someone affected by a project and having a moral (and perhaps a non-negotiable) right to influence its outcome. This view is very broad and its consequences unmanageable because there are so many ways in which a project can impact a very wide range of people."
Carroll & Buchholtz, 2006, p.23	"Stakeholders as individuals or groups with which business interacts who have a 'stake', or vested interest, in the firm."
Olander, 2007, p.279	"A project stakeholder can be defined as a person or group of people who has a vested interest in the success of a project and the environment within which the project operates. Vested interest is defined as having possession of one or more of the stakeholder attributes of power, legitimacy or urgency. There are essentially two categories of stakeholder: internal stakeholders, who are those actively involved in project execution; and external stakeholders, who are those affected by the project."
Walker, Bourne, & Rowlinson, 2007, p.73	"Stakeholders are individuals or groups who have an interest or some aspect of rights or ownership in the project, and can contribute to, or be impacted by, either the work or the outcomes of the project."
Rowlinson & Cheung, 2008, p.613	"External stakeholder management can involve a range of official, formal and informal groups (e.g. industry, government, non-government, public, private and education)."
Ward & Chapman, 2008, p.564	"Internal stakeholders are: project owners in the sense they have overall managerial responsibility and power, usually linked to a financial stake; and organizations, teams or individuals who have a contractual relationship with the project owner. Other stakeholders are 'external' stakeholders who may be positive or negative about a project, and who may seek to influence the project through political lobbying, regulation, campaigning or direct action. External stakeholders might include local communities, local government, potential users, regulators, environment groups and the media."
PMI, 2017, p.505	"Broader definitions of stakeholders are being developed that expand the traditional categories of employees, suppliers, and shareholders to include groups such as regulators, lobby groups, environmentalists, financial organizations, the media, and those who simply believe they are stakeholders—they perceive that they will be affected by the work or outcomes of the project."

Some definitions for who are stakeholders might be very broad. On the other hand, some are relatively narrow (Ward & Chapman, 2008). Despite existing different aspects that can be related to the stakeholder definition, based on Table 1.1 it can by said that some are present in the majority of the stakeholders can be categorized in external or internal, depending on their relation to the project itself. Also, it is stated that a stakeholder might be someone that has an

impact or is impacted by the project activities or has an expectation on project objectives. The group of stakeholders does not involve just the project team or the clients but has a wider perception that can also involve the whole community where the project is located (Newcombe, 2003). Just including stakeholder management in the project activities is insufficient, it is also fundamental to consider the values that a wider spectrum of stakeholders might have over the project success (Widén, Olander, & Atkin, 2014).

In practical terms, project management is carried out to meet the needs and expectations of stakeholders towards the objective of a specific project (Project Management Institute (PMI), 2017; Walker, Bourne, & Rowlinson, 2007). Recently, there has been an increasingly growing concern in the business world: with whom we do our business, for whom, for what purpose? It has become clear that it is not enough anymore to analyze numbers and trends to run successful projects. Because it interferes significantly in the success or failure of the project, it is urgent to understand the human nature of the stakeholders, given them "names and faces" and not just analyzing their roles in order to create options and strategies for stakeholder management (Freeman & McVea, 2001).

Stakeholders might be considered as a project asset as they can contribute with knowledge, insight and support project execution (Bourne & Walker, 2005). Although the right time to involve them is critical (Ward & Chapman, 2008), early involvement might improve the overall understanding of both sides, internal and external stakeholders (Shindler & Cheek, 1999). As stakeholders' impact is dynamic and changes during the project execution, this involvement should be seen as a continuous strategy (Olander, 2007). Their influence also might change due to the different levels of power and interest they have over the project activities (Chinyio & Akintoye, 2008). Thus, this interaction between stakeholders and project team is important to clearly identify their objectives and understand their needs (Orndoff, 2005).

The complexity of stakeholders influence is largely impacted by their project perception (Olander & Landin, 2008). Paying attention to the expectations and needs of key stakeholders exert a significant impact on their perception of project success. "A project that does not meet

expectations of influential stakeholders is not likely to be regarded as successful, even if it remains within the original time, budget and scope" (Walker et al., 2007, p.70). Thus, the project should benefit all stakeholders meeting their needs and expectations through trustee relationships built by combining their interest with the project interest to ensure its survival (Newcombe, 2003).

Successful stakeholder management strategies integrate the perspectives of all stakeholders. However, it is known that a win-win situation is not constantly present, and all stakeholders will not benefit all the time. The strategy should distribute both benefits and harms between different groups of stakeholders, developing strategies to ensure the long-term support of all the stakeholders (Freeman & McVea, 2001).

1.2.2 The human dimension within stakeholder management

The objective of this subsection is to point out the challenges faced by the project team on managing stakeholders concerning to their individual characteristics and the relational aspects between them. It begins by pointing out some aspects related to conflicts between all actors involved in the project, generated basically by the different interests. To solve these conflicting situations, trust is added to the relationships among all actors involved, internal and external stakeholders. The subsection finalizes highlighting the importance of this relationship to the project execution.

1.2.2.1 Conflict in project environment

Whenever you have a group working together, this interpersonal context might generate conflict and because conflict is so intimately present in organizational groups, it can impact the overall team's performance (Alper, Tjosvold, & Law, 2000). Conflict can occur on projects when decisions are made without taking into account the consequences it will have on different stakeholders (Olander & Landin, 2008). Frequently, conflicts are the result of different stakeholders having long-term versus short-term objectives (Newcombe, 2003), different points of view that lead to conflict (Rowlinson & Cheung, 2008).

Because different stakeholders have conflicting range of needs and wishes (Bourne & Walker, 2005) which lead to conflicting expectations (Newcombe, 2003) that sometimes are concurrent and divergent (Chinyio & Akintoye, 2008), "the stakeholder management process can thus be defined as having the aim of maintaining the desired implementation of the project and avoiding unnecessary conflict and controversy with stakeholders" (Olander & Landin, 2008, p.557).

Broadly defined as perceived incompatibility or discrepant views between stakeholders, conflict can be both destructive or beneficial to groups and organizations (Jehn & Bendersky, 2003), depending on the type of conflict (Kozlowski & Bell, 2003). Furthermore, the way team members manage their conflict can affect both, their ability to efficiently deal with conflicts, as their performance as a group (Alper et al., 2000). To be effective, a conflict management should include mutual respect and willingness to compromise, promoting cooperation and harmony within the group (Lepine, Piccolo, Jackson, Mathieu, & Saul, 2008).

Jehn and Bendersky (2003) pointed out three main types of conflict: relationships, task and processes. Those different types of conflict will impact the conflict-performance relationship in different ways, which experience will impact members' perceptions attitudes, emotions, and behaviors, influencing their interactions. Relationships conflicts are related to interpersonal incompatibility among group members. Task conflict is related to the task being performed, its content, differences in point of view, ideas and opinions. Process conflicts are generated by issues around those responsible for the tasks that need to be done (Jehn & Bendersky, 2003).

"Relationship conflict, the perception of personal animosities and incompatibility, may be described as the shadow of task conflict" (Simons & Peterson, 2000, p.03) and it is always negative, whenever it occurs during the lifecycle of the group or project, because it has a negative impact on the member morale. Relationship conflict also interferes with task-related effort, complicating consensus building and losing focus on the decision process because members attention is on reducing threats and not on building cohesion (Jehn & Bendersky, 2003). The relationship conflict might affect the group satisfaction, impacting negatively on the decisions quality and as the commitment to the group (Simons & Peterson, 2000).

On the other hand, by encouraging greater cognitive understanding of the issue being discussed, task conflict can generate better decisions and a better acceptance of the group decisions (Simons & Peterson, 2000). Also, through increased debate and discussion of alternative viewpoints, task conflict can be beneficial to performance and creativity, despite being hard to build satisfaction and consensus. "Disagreements related to the task can improve group decision-making, strategic planning, top management team success, and general task performance" (Jehn & Bendersky, 2003, p.208).

The relation between task conflict and relationship conflict is moderated by trust. When intragroup trust is established, organizations can benefit from task conflict and minimize the danger of relationships conflict. While "task conflict is usually associated with effective decisions, and relationship conflict is associated with poor decisions, the intragroup trust moderates the relationship between task conflict and relationship conflict" (Simons & Peterson, 2000, p. 01). Also, intragroup trust might prevent task conflict from escalating into relationship conflict (Simons & Peterson, 2000). "Teams with conflict efficacy believe that they can work together effectively resulting in team productivity" (Alper et al., 2000, p.628). Furthermore, trust has a significant impact over conflicting situations, especially interpersonal trust that plays an important variable when managing conflict in teams (Kozlowski & Bell, 2003).

1.2.2.2 Adding trust to stakeholder management

The term trust is applicable to a variety of contexts and levels of analysis (Costa, 2003), and there is no agreement amongst all different trust definition (Smyth & Edkins, 2007) but the idea that trust arises from all the relationships experienced, pointing out that each one of them are different. However, it is known that to manage trust as competency, two steps should be achieved: if one of the parties is ready to trust, even unknowing the other party's intent (which means, with willingness to be vulnerable) and the reaction of the second party about taking advantage of trust given or be trusting as well (Smyth, 2012). Thus, "trust is not only a psychological state based on expectations and on perceived motives and intentions of others, but also a manifestation of behavior towards these others" (Costa, 2003, p.608).

In a business-to-business relationships concept, “the primary obstacle to trust development is a lack of willingness to be vulnerable towards another party, arising from fear that other will not look after your best interests and will selfishly pursue opportunistic behavior” (Smyth, 2012, p.101). Moreover, trust can also be understood as “an issue of competence, with people trusting those that they believe can solve problems and deliver desired outcomes” (Costa, 2003, p.559).

The generation of trust is important on long-term relationships, precondition for successful learning and innovation, particularly when complex tasks are involved (Grabher, 2002). When developed on early project phases, trust will create harmony within stakeholder group that will continue into the other project phases. Trust can be linked with respect in relationship development (Davis & Walker, 2007), but also to satisfaction and commitment (Costa, 2003). Moreover, by enabling cooperation (Tyler, 2003), trust has also a positive effect to task performance (Costa, 2003).

It is the transparency between the project team and project stakeholders that might develop trustworthy relationships, increasing the willingness to collaborate and to engage on the project activities (Goleman, 1998). Transparency is an ability to maintain integrity and to behave authentically and congruently with someone’s values. Project teams who presents such competency are seen more trustworthy and can build a productive and emotional environment which presents trust, group identity, emotional capability, group efficacy and networks (Druskat & Druskat, 2012).

1.2.2.3 The importance of relationships

Projects experience a high degree of change requiring active engagement and participation with project stakeholders (Freeman & McVea, 2001). Often the client, user, and developer exchange information in a dynamic co-creative process that leads to more stakeholder involvement and higher satisfaction. Regular interactions with the stakeholder community throughout the project mitigate risk, build trust, and support adjustments earlier in the project cycle, thus reducing costs and increasing the likelihood of success for the project (Project Management Institute (PMI), 2017).

As stated by Pryke and Smyth (2006), the conceptual approaches to the management of project development are summed up as the traditional (techniques and tools), the functional (strategic), the information processing (input-output model). However, with the purpose of integrating the dynamics of relationships that permeate all project life-cycle, they added another dimension for those conceptual approaches: the relationship, which means a paradigm of project and client satisfaction (Pryke & Smyth, 2006).

Considering relationships as strategic for managing projects, Pryke & Smyth (2006, p.09) go further arguing that "people are certainly one key focus because the human relations between them are important in the effective and efficient delivery of a project or projects". For instance, they state that, as the same time people are wonderfully creative in create complex tools and systems, they behave in difficult and unpredictable ways because of their characteristics. Their behavior is realized through their continuous interactions, which means, their relationships. Thus, from their perspective, this approach should be recognized as the basis of strategy for managing projects because the project success depends on it (Pryke & Smyth, 2006).

The traditional approach to project management reveals an artificial internal separation between organization departments, where the decisions are guided by professional norms and expertise, rather than the client requirements (Pryke & Smyth, 2006). To deal with this dysfunctional way to operate, a relationship dimension must be added, offering opportunities to companies to become more efficient and gather competitive advantages (Pryke & Smyth, 2006). Besides, the traditional project management refers stakeholders as separated groups, categorized by their projects' roles and without interaction between them. Taking into account this perspective, the new approach of relationship considers the relations between stakeholders as strategic (Cova & Salle, 2012).

People and teams are assets to the organization. They add value through their relationships, being more effective when working together. In a corporate and project environment, relationships are human, organizational and information systems contexts in which personal relations occur. Relationships can be managed, and their quality is a key element in the success of a project, as both behavior and attitude can affect project performance (Pryke & Smyth,

2006). Without constructive relationships between customer, team and other stakeholders the different challenges that every new project present will be difficult to overcome (Druskat & Druskat, 2012).

Project manager, despite being the leader of the project team, may have no formal power over stakeholders and must rely on his/her ability to cultivate relationships and use influence strategies to achieve project objectives (Bourne, 2005). Then, the project manager "create[s] an environment in which quickly building relationships and trust with a diverse group of people is fundamental to job success" and "it is particularly useful when actions and decisions involve others" (Druskat & Druskat, 2012, p.79). It would be the trust and confidence existent within these relationships that is used to evaluate its strength (Smyth & Edkins, 2007).

It is communication that support the bridge between various project stakeholders (Project Management Institute (PMI), 2017). Communication is a vital component of building and maintaining relationships by stakeholders' support and engagement (Bourne, 2005). "Stakeholders are very varied and act differently throughout the project cycle phases" (Cova & Salle, 2012, p.131), being diverse the voices of internal and external stakeholders, which demand various paths. "Stakeholders want their voice to be heard, so their interests are expressed, understood and taken into account" (Smyth, 2008, p.637). Whether this does not result in fewer conflicts can open a communication channel to negotiate outcomes acceptable for all stakeholders (Smyth, 2008).

Based on Smyth (2008, p.639), the relationship management can be linked to several tenets, including:

- Developing close relationships and understanding of the client and stakeholder expectations (needs and desires), observing ethical terms and nurturing relationships;
- Developing services to match realistic expectations (value added and added value), paying attention to attempt to both, internal and external stakeholders expectations;
- Delivering services focusing on creating stakeholders' satisfaction;
- Improving the long-term maintenance of relationships to engender loyalty, repeat business and/or increased referral business, which concerns internal stakeholders;

- Maintaining and increase market reputation, which concerns external stakeholders.

All those tenets from relationship approach to manage projects bring stakeholders and their engagement to its focus.

1.2.3 Stakeholder engagement as element to project success

Stakeholders who are excluded from the decision-making process might not have their needs incorporated on the project outcomes, which may make them focus more on the negative aspects than benefiting from the positive impacts of the project (Innes & Booher, 2004). Moreover, stakeholders know when their voices are not heard, which increase frustration and can invoke greater reactions in order to be heard, understood and considered, mobilizing power in their favor (Smyth, 2008). Failing to properly engage the project stakeholders might have significant impact over the project outcomes.

Thus, the primary goal when paying attention to stakeholders is to avoid or resolve the conflicts presents on, or oppositions to, the project (Mathur, Price, & Austin, 2008). However, finding out when it is the best moment to engage stakeholders is not an easy task, especially because their influence is not static but dynamic (Chinyio & Akintoye, 2008). “Too early and there may be a lack of interest, too late and the opportunities from engaging the stakeholder may be lost” (Widén et al., 2014, p.06). Then it is necessary a combination of approaches to engage stakeholders, keeping track of their fluid interest to continuously determine their precise positions at each project phase (Chinyio & Akintoye, 2008).

Besides avoiding negative impacts over the project activities, “meaningful stakeholder engagement can be seen to enhance inclusive decision-making, promote equity, enhance local decision-making and build social capital” (Mathur et al., 2008, p.601). To achieve such level of engagement, stakeholders should be willing to participate without any fear, having their opinion respected and included on the project outcomes (Senecah, 2004). Such a collaborative process should be gaining promoting access to all involved, transferring power to make decisions to those stakeholders who will be affected by the decision made and allow that diverse points of view are being explored (Healey, 1996).

1.2.4 Efficiency of project process

Achieving efficiency through project planning process includes, but is not limited to, identifying the right stakeholders, understanding their power and influence over the project and formulating strategies to maximize stakeholders' positive influence and minimize the negative ones. However, "project managers usually have very little formal power over stakeholders outside the project organization" (Bourne, 2005, p.43) to influence their decisions. The influence over stakeholders who are not under the project manager's authority needs trusting relationships that "require constant reinforcement of ethical behavior and trustworthiness. Balancing the needs and expectations of a diverse group of stakeholders and managing any conflicts could raise issues of ethics and trust for the project manager" (Bourne, 2005, p.43). To resolve conflicts amongst different stakeholders' interests, the guidance of ethics is particularly effective (Carroll & Buchholtz, 2014).

Managing the needs and expectations of project stakeholders within an environment of uncertainty and ambiguity is one of the ways to positively influence the project success. There is no predictability on temporary knowledge organization, such a project organization, and success can be understood as the ability to manage within a complex and chaotic environment. The project's success or failure depends on the project manager capability to manage the stakeholders' expectations and perceptions of project's success. When projects fail, stakeholders are impacted negatively, as the organization performance as well, because project objectives are part of its strategy (Bourne, 2005).

Project success is based on team work, where professionals from diverse background align their work force to achieve project goals. The effectiveness of a team can be based on three main elements: coordination, cooperation and communication (Chiocchio, Grenier, A. O'Neill, Savaria, & Douglas Willms, 2012; Gully, Incalcaterra, Joshi, & Beaubien, 2002; Kozlowski & Bell, 2003). When interdependences between activities are high, as in projects, the performance of the team is strongly related to those three elements (Gully et al., 2002). Cooperation and coordination are enabled by communication, while cooperation is frequently related as opposite of conflict and generally associated with team effectiveness (Kozlowski &

Bell, 2003). These three components, joined together with synchronicity of the team actions, are the key process that influences team performance (Chiocchio et al., 2012).

Also related to the project performance, the poor quality and untrustworthy information flowing throughout the project communication process leads to a risk perception by the stakeholders that might be biased, which can contribute by itself, to a negative response to it. "Access to adequate and appropriate information is essential to empower stakeholders and enable them to contribute effectively to the risk management process" (Loosemore, 2012, p.201). With more efficient information provided by the project team, it would be easier for the community to accept project propositions (Loosemore, 2012), increasing their engagement and support to the project.

1.2.5 Stakeholder management in the construction industry

"Construction projects affect, and are affected by, a vast number of stakeholders" (Olander, 2007, p.280). In the past, the major contractors were responsible for the great majority of work, but today, they simply coordinate subcontractors, this means, manage stakeholders. It is a return to the past, when the constructions were made by smaller contractors and their relationship between organizations was based on a trust network. This large number of separate trades and the complexity of the interface among them demand very high levels of skills to organize and coordinate (Crotty, 2013) this multiple stakeholder environment where construction projects are inserted.

The definition of stakeholder management for the construction industry is evolving to integrate issues such as uncertainty, risk, ethics, empowerment and sustainability. Those are key concepts in construction project management today (Atkin & Skitmore, 2008) where stakeholders with different backgrounds, expectations and objectives have to find a common language to share values and collaborate to attain a common goal (Thomson, Austin, Devine-Wright, & Mills, 2003).

Construction projects have "clear objectives - high definition of output, and clearly defined processes to achieve them, demonstrated by a high level of structured role definition and the

application of knowledge based on previous experience" (Bourne, 2005, p.21). It is the responsibility of the construction project manager to respond to the needs and expectations of project stakeholders concerning how the decisions-making process is carried out (Olander, 2007), and by the same time, integrating "the work of many specialist team members and maintain procedures for measurement and control throughout the project" (Bourne, 2005, p.22).

Construction project stakeholders can be divided in internal (those directly involved in the decision-making process) and external (those affected by the project activities). "In construction, there has traditionally been strong emphasis on the internal stakeholder relationship" (Atkin & Skitmore, 2008, p.549) and much of this emphasis derives from the important need for understanding how to manage such a complex workflow, as the construction industry is formed by fragmented teams (Latham, 1994) and is multi-disciplinary in nature. The ultimate goal of this internal stakeholder group is to get all actors involved improving the project final product quality (Arditi & Gunaydin, 1998).

The social dynamics of a typical project team are complex and subtle, and its member's attitude is almost always positive. Respect and status in modern project teams must be earned and every member knows that their success depends on the performance of others. They know that they need to collaborate to succeed. The key challenge is the creation of a complex, dynamic organization, which must become capable of managing safely big amounts of money in its very beginnings (Crotty, 2013).

At the same time, from the construction stakeholders' perspective, the industry should involve them on earlier project phases, construction project teams need to involve external stakeholders to ensure that their needs are expressed by the proposed design (Schade, Olofsson, & Schreyer, 2011), since an undesirable perception by stakeholders of this attempting can obstruct a construction project, leading to conflicts and controversies about project implementation (Olander & Landin, 2005).

The success of stakeholder management depends mainly on how well the project team presents positive and negative impacts to external stakeholders. The aim is minimizing the negative

impacts, and maximizing the positive ones for all stakeholders, focusing on their acceptance. To achieve such outcome, a transparent relationship should be built where the alternative solutions are clearly shown, establishing the basis of the needed trust between the project team and the project external stakeholders (Olander & Landin, 2008). By clearly defining all positive and negative impacts about the proposed alternatives, showing that all alternatives were investigated, build the trustworthy relationships, especially with those negatively affected by the project activities (Olander & Landin, 2005).

Stakeholder management in all project phases should be based on transparency and trust, building the relationships that are fundamental to the project success concerning long-term issues, as presented on infrastructure projects. The aim of this strategy is to inform stakeholders and obtain their feedback about meeting their needs and expectations as inputs for collaborative project development. The dissemination of construction projects information to the external stakeholders aims to create a problem-solving channel when the project affects the community where it is located (El-Gohary, Osman, & El-Diraby, 2006).

1.3 Construction industry

The aim of this section is to highlight some aspects related to information that can impact the industry's project success. It starts by stating elements that can interfere on the performance of the industry, especially the decision-making process. Then, it presents an alternative for these issues and the required changes on the industry environment to achieve such improvements.

1.3.1 The construction industry' performance

In the last 50 years, after the Second World War, the industry started to standardize, reducing the use of craft-based working and replacing it for low-skilled but very specialized workers. The main contractor became a manager of many sub-contractors and now these specialties really do the work. The architect became focused on the design, with the design for craft work disappearing and manufacture and assembly becoming predominates (Crotty, 2013). This increased specialization and the large number of specialist firms involved on projects worsened the already complex construction industry (Fellows & Liu, 2012).Thus, the critical factors of

poor performance, low productivity and lack of competitiveness of the construction industry are results of this fragmentation (Xue, Shen, & Ren, 2010).

The delivery of a quality product, which means the delivery of value, is related to how the product characteristics meet the client needs. Thus, the value delivery is a fundamental objective of construction projects (Thomson et al., 2003). The construction industry limitations in delivering value to its clients are its poor performance and failure to generate value, and deriver from its highly complex context (Poirier, Forgues, & Staub-French, 2016), since the quality of the project is a function of the quality of its phases, design, construction, operation, maintenance, and management (Arditi & Gunaydin, 1998).

Some of the design and management inefficiencies are poor planning and avoidance of iterations, poor client specifications and requirements, poor integration of disciplines (Pikas, Koskela, Dave, & Liias, 2015). Also, Rounce (1998) identified the causes of design faults as misinterpretation of client needs, poor communication between designers, using incorrect or out-of-date information, producing inadequate specifications, and misinterpretation of design standards. As a result of those faults, the generic issue among project participants that lead to low performance on engineering projects can by summarized on the communication process and the quality of the information flowing into its process (Fellows & Liu, 2012).

With so many different parts integrating a project, and all these relations being controlled by contracts, much of the performance problems faced by the construction industry can also be addressed to the contract form traditionally used, which waste time and energy on the inter-organizational interface management and the many disputes between various contracting parties, involving an increased number of transactions, with more interacting interfaces, which result in complexities (Kumaraswamy & Rahman, 2012). Also, it is important to stress out that the excessive use of subcontracting has increased the importance of the contractual relations in the detriment of the team's long-term relationships, fundamental element to efficient working (Egan & Williams, 1998).

The defining characteristics of the modern construction industry are its inability to completing projects predictability (on time, budget and expected quality) and the chronically low level of

profitability. Unpredictability effects are: schedule overruns result in direct loss of profit to the contractor and this process disrupted good relations with clients and can be downright confrontational; distressed clients who become reluctant to repeat the experience. These two effects hit the industry by direct impairment of margins caused by overrunning projects, and by the loss of business volume caused by disaffected clients (Crotty, 2013).

Poor information in project management is the cause of the industry's strategic, predictability problems. Projects overrun budget and schedule because their target is incorrect, or their progress assessments are done inaccurately, leading to misread trends and inappropriate corrective actions. The main problem here, considering construction projects, is that the inputs to planning costs and schedule are imprecise, which lead to dependence on individual subjective judgment of planners. The inability to establish targets (costs and schedule) accurately because firms do not use actual performance data from their projects, leads them to an inability to learn. Companies learn by gathering structured data that can be analyzed, stored, evaluated and reused in future activities. Projects fail because project management methods and systems depend too much on intuitive and subjective definition of work scope, uses top-down with poor systematic connexions between levels, poor trend detections and analyses and have no effective framework for data use (Crotty, 2013).

1.3.2 Decision-making process

All conscious human action is preceded by a decision and it depends on the quality of the information used and the judgment, a slippery combination of intuition, instinct, training, experience and, above all, imagination, all applied in the decision-making process. The conventional construction system provides poor quality information to do this process, then people must compensate this with high levels of judgment. Being a human attribute, when judgment fails, decisions go wrong, and projects also fail. In construction projects, each discipline uses its own language to create, describe and analyze the project, and tends to have its own perspective of the scope and status of the project. Sometimes, this language is based simply on a user's personal judgment, which means that the data will mean whatever the user wants it to mean, because each person talks their own language. The result is inconsistent

models of all sorts. This is a reality for all stakeholders, from the client to subcontractors, being almost impossible to be totally sure about the others understanding (Crotty, 2013).

“The decision-making process may be characterized as choosing among a fairly limited number of prepared options. The support for this process should therefore focus on helping to evaluate these alternatives” (Schade et al., 2011, p.375). The ability to satisfy stakeholders requirements depends on the communication used on decision-making (Landin, 2000) and in the quality of the data used in this process, where technical information should be clearly communicated to the stakeholders (Olander & Landin, 2008). It is on the efficiency of this process that the long-term performance of construction projects lies on (Landin, 2000).

Stakeholders influence the direction and decisions for a project through power, which can be used to retain the status or to impose some change to the project (Newcombe, 2003). “Power is the main attribute in order to affect the project’s decision-making process” (Olander, 2007, p.282), because even when stakeholders do not have a formal power over the project, they might have an informal power that can press more powerful stakeholders into changing their positions (Olander & Landin, 2008). This power and influence nature, is used to contribute or to manipulate the decisions, dictating the relationships throughout the project. Power, trust/distrust and commitment are closely connected and impact the decision-making process (Walker et al., 2007). It is just with the presence of trust and commitment that the alignment of mutual goals is possible (Davis & Walker, 2007).

The decision alignment among an interdisciplinary team to fulfill multiple and often somehow contradictory objectives is not easily achieved. The performance requirements given by clients create multiple criteria for highly complex decision problems, ranging from “subjective criteria using qualitative statements to objective measurable criteria, with different dimensions or scales” (Schade et al., 2011, p.372). Then, the process itself is compounded by different elements that do not use the same language and must be interpreted and combined into a single decision by many professionals with different knowledge, among them, the clients.

Another challenge is the information gaps during the different project phases adding complexity to the alternative analysis, which interdependencies of design demand a team of

professionals to be done. It is through this analysis process that specialists explain the implications of each alternative. “Without such an objective and comprehensive performance analysis method for the design, the building’s owner as the major decision maker in the project team has to rely on discipline-specific recommendations” from the project team (Schade et al., 2011, p.373).

1.3.3 BIM solutions for communication issues

Unpredictability and low profitability are fundamental threats to the survival of construction firms and they are caused by the poor quality of information. However, the recurrent demand for information does not arise from the bad quality of work, but from the complexity and magnitude of it due to its fragmentation (Harty & Laing, 2010). The industry involves many people and documents in a very high flow, but very little of the information generated in construction is structured, systematic or trustworthy (Crotty, 2013). Clients and operators spend a lot of time searching the needed information, because it is not provided in the right way and format, and accessible to the right person (Whyte, Lindkvist, & Ibrahim, 2010). The poor understanding of the information generation and storage leads to low levels of trust amongst users of the available data (Bew & Underwood, 2010).

To interpret all this material, a very high level of human judgment and intuition is required, skills that are both rare and largely unteachable. Then, problems using drawings and conventional design communication tools arise when they require judgment or interpretation of the recipient by the client and his stakeholders, design team and construction contractors. The client and his team might not have the ability to read the drawings and, by not understanding the documents (both architectural details and spatial arrangements), this causes an uncertainty that introduces delays and revisions which reverberate throughout the entire design effort (Crotty, 2013).

The industry multiple cycles of repetitive data distribution are poorly coordinated, fragmented and distributed throughout a project network. The poor managing information flow is one of the keys amongst the communication problems between team members in construction projects. The complex web of links amongst the firms and disciplines engaged in the project

is “too difficult to manage in an effective and efficient manner” (Azouz et al., 2014, p.02). This is the biggest challenge about managing internal stakeholders.

Building information modeling (BIM) is a new approach to design, construction and facility management, a human activity that involves broad process changes in construction industry (Eastman, Teicholz, Sacks, & Liston, 2011). Information management on BIM is very similar to project information management and its success depends on the same principles: structure of the project organization and type of procurement, agreed exchange files formats and content, and implementation on agreed information exchange protocols, specifying the level of detail of each point of the project. Despite this similarity, “BIM approach to the management of project information depends heavily on the commitment of the main firms to ensuring that information flows on the project should be as efficient and as responsive as possible” (Crotty, 2013, p.101). The creating of information that think about the people that will receive it, facing the challenge of identifying the “flows of technical information around the project: who provides what information, to whom, and when? In that sense, the flows encountered on a BIM project will be essentially similar to those on any well-organized, conventional, collaborative project” (Crotty, 2013, p.102).

The information generated with BIM models has higher quality and its exchange protocols improve significantly communications between firms, by enabling this well-structured information to be used directly in different computer systems (Crotty, 2013). Consequently, BIM reduce the loss of information through the exchange during all facility’s lifecycle (Eastman et al., 2011). “In other words, BIM allow users to be more efficient in their information exchange through its centralization” (Azouz et al., 2014, p.03).

The data produced with BIM is clean, well specified and computable; it removes the need for human intervention between the architect idea to the application on the field. Verifying constantly the amount of information generated during a construction project takes time and requires a significant level of skill, discipline and judgment. BIM comes to improve the quality of the building, by improving the way the project team communicate and share information, lowering errors from codifying and re-enter the information in a drawing-based information

project. The transformative power of BIM is the high-quality design information BIM can produce and more efficiently communication amongst the systems for the project team members (Crotty, 2013).

However, just delivering data to the owner through BIM at the end of the construction phase has no value (Jordani, 2010). “Construction industry clients want to use the information from the project for the long-term value of the physical assets” (Whyte et al., 2010, p.27), which means to deliver value to clients through data. In this sense, BIM has an important role bridging “the information loss associated with handing a project from the design team, to the construction team and the building owner/operator, by allowing each group to add to, and reference back, to all information they acquire during their period of contribution” (Bew & Underwood, 2010, p.33). In doing so, BIM can provide all types of information needed by the owner and operators that are not directly concerned with the building geometry (East, 2009).

The model created with BIM tools is powerful, clear, flexible and a rich representation of the designer’s intentions, improving the way ideas can be shared with the rest of the team and offering enormous benefits to all stakeholders. Thus, the concept of ‘what you see is what you get’ model is the biggest benefit of using BIM. This method of representation enables the client to fully understand the design and enables early decision with more certainty, growing the client’s confidence. BIM allows the client to see all the solutions, what the facility will look like, its quality, how much it will cost and how long it will take to get done, for example, making possible to clients interact with the alternatives. The changes during the execution gets lower, but if necessary, it can be made quickly and precisely, lowering the impacts on the relationship between client and contractors (Crotty, 2013).

The interactive 3D models are much more understandable than the paper documents, which are very often difficult to read for many stakeholders (Kunz & Fischer, 2012). Then, visual aspect provided by BIM makes the information more easily understood (Jordani, 2010) by a wider range of stakeholders. The visualization element of BIM technologies “clarify project objectives, values, responsibilities, designs and expectations because good visualization

enables many more stakeholders to participate in project review far more meaningfully than in routine practice" (Kunz & Fischer, 2012, p.05).

Because there is a better understanding of the subject being discussed, the time required to get explanations and make decision decrease significantly, "likelihood of both design and construction rework drops because relevant stakeholders have increased ownership and timely participation in project decision-making" (Kunz & Fischer, 2012, p.08). "Data use, its accuracy, completeness and updating are the basis for expenditure decisions" (Whyte et al., 2010, p.14) and BIM is capable of delivering such accurate information, fundamental for decision-making (Jordani, 2010), creating the transparency of the design decisions concerning the project goals (Schade et al., 2011).

1.3.4 The needed changes

The industry fragmentation is one of the causes for the decreased client satisfaction due to the loss of their voices during the poorly managed cascading process that the industry represents (Nicolini, Holti, & Smalley, 2001). This complexity of construction industry has been opposed by a more collaborative way of work (Poirier et al., 2016). "Collaboration along the chain of procurement activities and developing more 'relational' forms of contracting have been recommended consistently as ways of breaking the cycle of poor communication and industry level fragmentation, and the culture of 'adversarialism'" (Nicolini et al., 2001, p.37). In the construction industry, "collaboration is imperative: it is not a matter of if organizations should collaborate but how should they collaborate" (Poirier et al., 2016, p.77).

The performance of construction industry in delivering buildings is demanding innovative project delivery approaches that aims to foster collaboration to increase the value generation (Poirier et al., 2016). The true core of the construction industry is the projects and it is where the big changes are made. The overall complexity of buildings tends to increase with the size, and with more companies joined to the project, more complicated to manage it. Consequently, innovations also tend to happen more often in larger projects than in smaller ones (Crotty, 2013).

“BIM is an innovative approach to construction, which requires a degree of collaborative intent on the part of the client, consultants and main contractor to work successfully” (Crotty, 2013, p.103). Therefore, BIM is much easier to be implemented in a collaborative environment contract form, as Integrated Project Delivery (IPD). The IPD is one of the most collaborative approaches to project organization where the designer, contractors and subcontractors enter into an agreement with each other to deliver the project as an integrated virtual organization. The relationship between partners can be arranged by various types of contracts and its objective is to achieve a sharing of goals and close collaboration amongst the main project team. From the beginning, the principal stakeholders from each of the key organizations involved on the project should agree explicitly to make information management a strategy (Crotty, 2013).

There are many definitions about the term of collaboration in the literature. D’Amour et al. (2005) found out some elements that are regularly present when conceptualizing collaboration: sharing, partnership, interdependency and power. Also, the authors stated that collaboration is a dynamic process, complex and in constant evolution in the project environment, demanding several skills. Furthermore, collaboration is a collective action so that team is focused on a common objective, in a spirit of harmony and trust (D'Amour, Ferrada-Videla, San Martin Rodriguez, & Beaulieu, 2005).

Also, Dietrich et al. (2010) identified five elements of successful collaboration: communication, coordination, mutual support, aligned efforts, and cohesion. Amongst them, is worthy notice that mutual support reinforces the achievement of common goals and provides flexibility to deal with unexpected situations. The alignment between expectations and efforts needed to accomplish the goals also prevent disappointments and limit the conflicts. Moreover, the feeling of togetherness gained by the cohesion between collaboration actors nurture its relationships and an open sharing of information and knowledge (Dietrich, Eskerod, Dalcher, & Sandhawalia, 2010).

To conceptualize collaboration, it must be observed the environment of collaboration, the processes in terms of human interactions and the outcomes. There are two main elements on

collaboration purposes: “the construction of a collective action that addresses the complexity of client needs, and the construction of a team life that integrates the perspectives of each professional and in which team members respect and trust each other” (D'Amour et al., 2005, p.127). A simple conceptualization of collaboration could be understood as the achievement of something in group that is not possible individual (Kvan, 2000). Moreover, collaboration can be seen as a relationship where project participants have a common vision to create a common goal, based on trust and transparency and shared responsibilities, risks and rewards (Schöttle, Haghsheno, & Gehbauer, 2014).

Transparency is not necessary to share information, but impact the quality of commitment to the common goals (Schöttle et al., 2014). With transparency comes trust, which improve collaboration through a better communication behavior and cohesion between actors (Dietrich et al., 2010). As a multilevel phenomenon, trust might exist in personal and organizational relationships, impacting the team performance, where collaboration is a mediator between trust and performance (Chiocchio, Forgues, Paradis, & Iordanova, 2011).

Collaboration takes time and requires relationship building (Kvan, 2000). A collaborative work environment creates relationships based on soft characteristics, as trust, communication, commitment, knowledge sharing, and information exchange, which makes the human factor a key to project success (Schöttle et al., 2014). From this perspective, it is possible to infer that “collaboration is a deeper, more personal synergistic process” (Kvan, 2000, p.411) where just bringing professionals together will not be enough to create collaboration. “Since professionals have to trust each other before collaborative processes can be established, there is a wide range of human dynamics that need to be developed within a team” (D'Amour et al., 2005, p.126).

The most important recommendation to face industry poor performance is to reduce confrontational attitudes amongst its players – stakeholders – and instead embrace collaborative methods of working (Egan & Williams, 1998), mainly because “collaborative working in design and construction can reduce waste, cut cost, rationalize processes and promote a working culture of trust and high performance” (Kumaraswamy & Rahman, 2012, p.168). However, promoting collaboration between stakeholders and project team does not just

mean work collaboratively, but also means the willingness for sharing knowledge, which depends on personal behavior to be achieved (Bourne & Walker, 2005). Then, collaboration should not be understood just as a professional endeavor, but its human dimension should be considered (D'Amour et al., 2005). "It is also important that the culture of the organization is ready to adopt change and that they have developed good supply chain relationships between those with whom they interact […] because people are the industry's key resource" (Bew & Underwood, 2010, p.38), which makes the human behavior a fundamental element to a successful collaborative work environment in construction projects, being trust, incentive, conflict and tension, main behavioral factors that affect performance through collaboration (Xue et al., 2010).

To achieve such collaborative work environment, some challenges should be faced. Chiocchio et al. (2011) identified six elements from business environment and human behavior that can interfere positively on this endeavor: collaborative arrangement, common values viewpoint on collaboration, effective communication, trust, performance measurement, and the early involvement of stakeholders. Those elements together can overcome the issues to fluency on collaboration: clear roles and processes for collaboration, trust, physical and cultural proximity, alignment of incentives, commitment, goal congruence, conflict resolution, and expectations fulfillment (Chiocchio et al., 2011).

The main outcomes of successful collaboration can be listed as project success, potential for learning and innovation, and commitment to future collaborations (Dietrich et al., 2010) because "collaboration provided focus and alignment to the team that influence the project outcome" (Davis & Walker, 2007, p.388), and because "collaboration helps create a sense-making community of practice of high-performing team members who can understand the interactions and synergy of projects through a multiperspective view of diverse knowledge competence areas" (Dietrich et al., 2010, p.68).

1.3.5 Discussion

The construction industry lacks in performance mostly because of communication issues, especially when dealing with large and complex projects, as airport engineering projects. New

technologies, like BIM, had been developed to improve the quality of the construction process, modifying the work flow and proposing a collaborative way of work. This new environment demands skills and behavior that goes beyond those abilities that project management traditionally uses to run projects successfully. Concepts like trust and collaboration had been added to this new environment, creating a positive atmosphere where the collaborative work can arise.

Airports deal with a large number of elements that impact on their efficiency. This industry changes constantly and it must be able to adjust itself quickly and efficiently to respond to those demands. To do it properly, it is necessary to join client requirements, regulatory laws and technical documents altogether to better response to it. Amongst all these issues could arise different interests between the multiple stakeholders involved. To gain and maintain their engagement is fundamental to achieve the project goals alignment.

Some elements are present in such scenario: many stakeholders with different interests, a complex infrastructure considering technical and functional issues and a dynamic environment. To run engineering projects that will deal with these elements is essential to build trustworthy relationships where engagement can emerge. The implementation of BIM technologies can add a security element to it, where trustworthy documents will be generated, arising a collaborative work environment and engagement of all involved, lowering the conflicts between those many stakeholders and increasing project performance.

If a project can only exist with the approval of its stakeholders, this task gets another dimension considering airport stakeholders. To engage them, despite the natural divergent interests, a continuous and efficient communication process is required to really understand their needs and expectations, gaining their support for the project. Getting better communication between stakeholders and project team is one of the answers to improve project performance. Communication needs trust, which is improved by BIM and its higher quality of information.

To achieve such a goal, besides the technologies, the quality of relationship amongst the team project and all stakeholders is a key for the project success, manly because the project manager will have no power over them. Then, the relationships based on trust might constitute the only

way they can to conquest stakeholder engagement through building an effective communication, which is a vital element to meet stakeholders' needs and expectations.

The communication process involves whom communicate with, when, why and about what. However, more important is the quality of the information flowing through the process. Poor information quality leads the project to a distrusted environment and all effort made by the project team in engaging the stakeholders might fail. To maintain the engagement, all main stakeholders should be confident in the actions of the project team and all involved. Their perception of risks and their behavior concerned about that depends on it. If they feel insecure, they will respond to it negatively and their support will be turned by resistance. In a complex project such in an airport, this situation could lead the project to fail.

Thus, to increase the airport project's chances of success, the stakeholder management attention should be redirected to project stakeholders and their relationship amongst themselves and to the project team. However, trustworthy relationships are needed to conquest engagement and support to the project objectives, being the poor quality of information one of the causes of stakeholder engagement rupture. If the poor quality of information generated during engineering projects is the main cause of conflicts between stakeholders, mainly because this bad quality decreases their trust in the team, the adoption of ways to improve the quality of information will increase trust, which leads to stakeholders' engagement. Then, enriching the quality of this information might advance the way the team communicate, increasing engagement. As BIM technologies make ideas be better shared and in a better quality, the whole communication process might improve.

With good quality and trustworthy information, the time required to verify the correctness of documents will be used to make decisions more accurately. Internal project stakeholders as design and construction team for example, and external ones, as airport administration, air companies or regulatory agencies, will be able to communicate with each other in an efficient manner, because all those conflicts generated by misunderstandings provoke by the poor-quality information will get lower.

Then, with documents that can be trusted, decision-makers might become more confident in their content, facilitating a more collaborative work environment, enhancing the project performance and improving the engagement on the project's goals by the airport stakeholders. This is a virtuous circle that helps construction projects productivity and predictability. Airport engineering projects involve so many factors that it must present as productivity and predictability as possible in reason of its complex and uncertainty nature.

Note that the development of project management methodology is not enough to conduct successful projects, nor the acquisition of appropriate tools and technical staff training, since methodologies can increase the chances of success, but its uses do not guarantee the successful delivery of a desired product or service. The methodologies are tools and, as such, they do not manage projects. The projects are managed by people in the same way that the tools are handled by people. The methods do not replace the person component in project management. However, they are intended to improve the people’s performance (Kerzner & Saladis, 2011).

CHAPTER 2

METHODOLOGY

2.1 Research design

To answer the research question of how being exposed to 3D visualization has influenced stakeholders' management in airport projects, this study uses the exploratory case study, recommended by Yin (2003) as the strategy that allows to understand complex real-life events. In this qualitative research it will be studied the interactions between the project team and the airport stakeholders to identify how the implementation of BIM technologies can impact stakeholders' management, reinforcing their engagement to the project activities. Those interactions between actors will be the unit of analysis of this study (Yin, 2003).

The assumption of this study is that because BIM technologies allowed better understanding of project solutions through the 3D visualization, it can lower the errors on projects documentation through the centralization and collaboration environment, leading to lower levels of conflicts and the possibility to build trustworthy relationships. With overall improved understanding and trustworthy relations, a collaborative environment can rise and the engagement on project activities and objectives can be enhanced, improving the chances of project success.

To support our assumptions, data from the project documents provided by the airport project team and from the semi-structured interviews with YQB[6] airport stakeholders and airport specialists, from inside and outside the airport organization will be analyzed.

The focus of this inquiry is the interactions between the project team and the airport stakeholders who had participated in the engineering project. These interactions will have as subject only their daily routine into the project activities; operational and administrative airport

[6] YQB – Québec City Jean Lesage International Airport

activities, as discussions about the airport structure and business, will not be the object of this research.

2.1.1 Conceptual Framework

To answer the research question – how the use of 3D visualization impact on the stakeholder management - the following framework was built, including three elements that are called here as: domains, dimensions and categories. Table 2.1 above summarizes the framework.

Table 2.1 Framework

Domains	Airport Industry
	Construction Industry
	Project Management
Dimensions	Stakeholder Management
	Communication process
	Decision-making process
Categories	Engagement
	Hierarchy / Authority
	Conflict
	Efficiency
	Community
	Relationships
	Information
	Understanding
	Experience
	Trust

Those three elements of this framework were identified due to:

- Domains: the technical domains related to the case being study
- Dimensions: the process to manage stakeholders to get the ultimate impact on the 3D visualization usage
- Categories: the concepts based on the literature review and from the interviews that explain those interactions between the stakeholders and the project team during the project execution. Those categories were used to codify the interviewee's answers.

Each element of this framework is detailed in the following sections.

2.1.1.1 The domains

The case study selected is an airport construction project, a building enlargement of a passenger terminal on the Jean Lesage International Airport at Quebec City. This project was the first to be made with BIM technologies at this airport and counted with two main phases: the construction of the new terminal area, that was isolated from the operational area, delivered on late 2017; and the second phase, which is currently running, the connection between the two terminal areas. It is worthy notice that the project team was able to deliver the first phase of the project parameters and is seen as a success for the airport stakeholders and project team.

This specific case was chosen due to comprising on the same endeavor the knowledge of three different technical domains: the airport industry, the construction industry and the project management. As a new terminal passenger area, this project presented the needed complexity of stakeholder management in a propitious scenario to study the 3D visualization impact.

Those three domains are the core of the content case, adding to the project universe their technical specificities, languages and processes that join with the uniqueness of the endeavor to form this single case. Also, these domains are the foundation where the theoretical framework was based on. Figure 2.1 above shows the case study and its content.

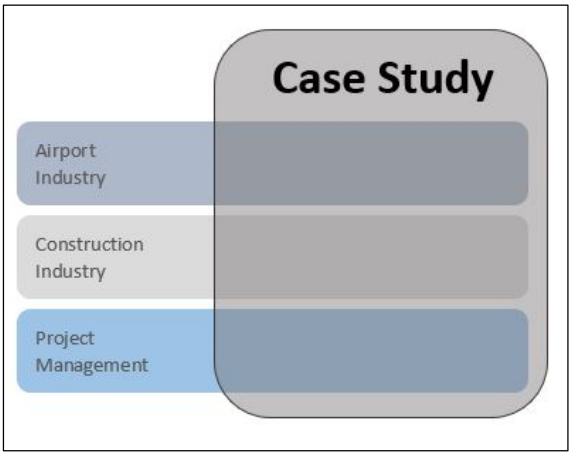


Figure 2.1 Case study content

The airport industry domain will bring to the project all requirements and specific regulations demanded for this kind of business. The construction industry domain will use its specific body

of knowledge to transform those requirements and regulations in a facility. The project management domain will add another body of knowledge to guide this endeavor into the best possible way, focusing on the project success.

All those domains have their own language and demand some expertise to get into it. Every project activity will demand from the project stakeholders to join in some degree the expertise of each of those domains to be done. This is the complexity of the case study chosen.

2.1.1.2 The dimensions

Three dimensions were identified as focus for observing the impact of 3D visualization usage, starting on the broadest, the stakeholder management itself, to end on the narrowest, the decision-making process. Bridging the first and last dimension is the communication process dimension. Figure 2.2 below exemplifies the connections amongst these dimensions: the decision-making process is part of the communication process, which is one of the stakeholder management processes.

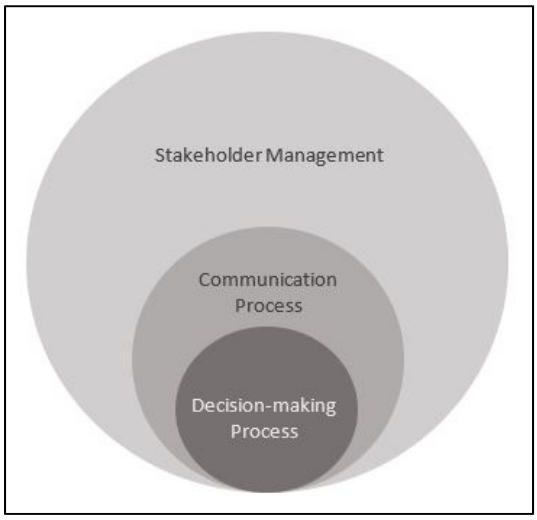


Figure 2.2 The dimensions

The ultimate impact to be observed is on the decision-making process, because its effectiveness and efficiency can interfere directly on the execution of the project activities, and to the project success at the end. To manage the decision-making process, communication takes a central role. It is due to communicating assertively the subjects of discussion that the decision-makers

will be able to decide and make the project proceed. By its term is due to the communication that the stakeholder management strategy can reach the stakeholders and manage their needs and demands.

2.1.1.3 The categories

Seven categories were previously identified from the literature review to code the interviewee's contributions. These categories help to understand the 3D visualization impacts on the stakeholder management and to better visualize the connections between the categories, the technique of the conceptual map will be used. On the conceptual maps, the categories assume the place of the concepts and the links between them summarize through the verbs (actions) how those concepts (categories) might be connected. Figure 2.3 shows the interconnections between categories through a conceptual map.

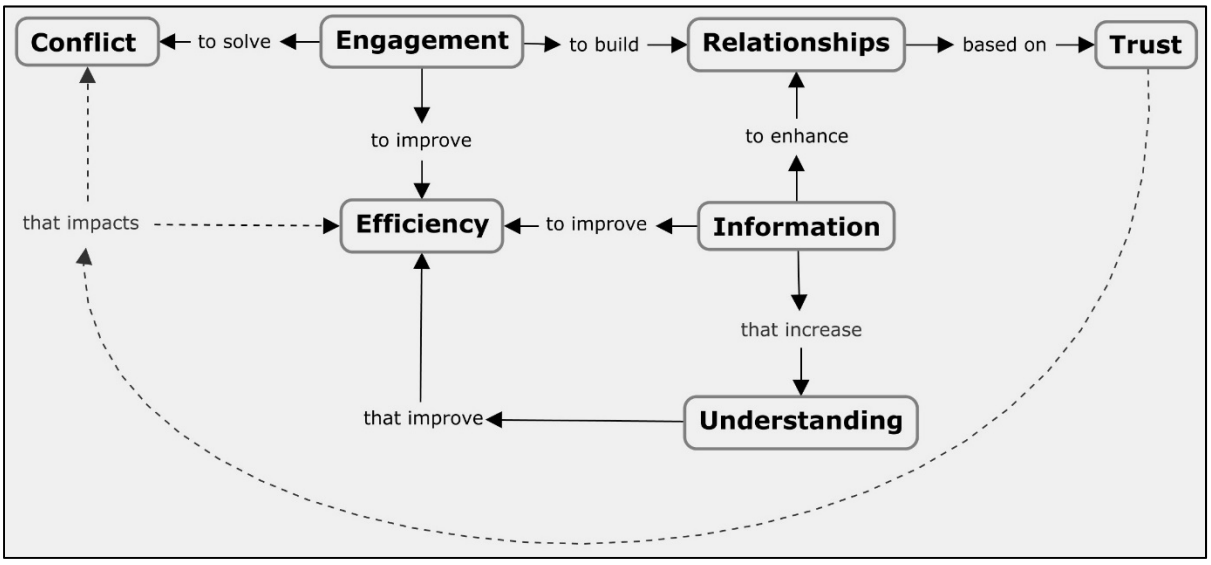


Figure 2.3 Categories from literature and their connections

The engagement and the efficiency are the central point of stakeholder management when concerning to the project success. It's due to the first that the second can be reached. The relationships built through stakeholders' engagement will be responsible for the needed interactions to run the project. Also, engaging stakeholders is a strategy to deal with divergent opinions, requirements, interests, that lead to conflicting situations. When based on trust, those

relationships might impact the way the actors will lead with those conflicts, reflecting on the project activities efficiency.

Running projects is about managing information. Its quality, quantity, specificity, the way is organized and transmitted, all these aspects interfere on the efficiency of the communication process. With the right information, considering all aspects cited above, comes an increased understanding of the subject being communicated, improving the efficiency of this process.

Table 2.2 brings the theoretical references for the categories (Figure 2.3, page 45) and which domain (subsection 2.1.1.1, page 43) they are part of.

Table 2.2 Categories theoretical references[7]

Categories	Theoretical references	Domains
Engagement	Shindler & Cheek, 1999	Construction Industry
	Thomson, Austin, Devine-Wright, & Mills, 2003	Construction Industry
	El-Gohary, Osman, & El-Diraby, 2006	Construction Industry
	Olander & Landin, 2008	Construction Industry
	Chinyio & Akintoye, 2008	Construction Industry
	Wijnen, Walker, & Kwakkel, 2008	Airport Industry
	Schade, Olofsson, & Schreyer, 2011	Construction Industry
	Widén, Olander, & Atkin, 2014	Construction Industry
Efficiency	Alper, Tjosvold, & Law, 2000	Project Management
	Gully, Incalcaterra, Joshi, & Beaubien, 2002	Project Management
	Costa, 2003	Project Management
	Jehn & Bendersky, 2003	Project Management
	Kozlowski & Bell, 2003	Project Management
	Chiocchio, Forgues, Paradis, & Iordanova, 2011	Construction Industry
	Chiocchio, Grenier, A. O'Neill, Savaria, & Douglas Willms, 2012	Project Management
	Pabedinskaitė & Akstinaitė, 2014	Airport Industry
Understanding	Koch, 2004	Airport Industry
	Wijnen, Walker, & Kwakkel, 2008	Airport Industry
	Emmitt, 2010	Construction Industry
	Kunz & Fischer, 2012	Construction Industry
	Toledo, González, Villegas, & Mourgues, 2014	Construction Industry

[7] The definitions extracted from theses theoretical references can be observed on APPENDIX V, page 151.

Table 2.2 Categories theoretical references (Continuation)

Categories	Theoretical references	Domains
Information	Pryke, 2004	Construction Industry
	Wijnen, Walker, & Kwakkel, 2008	Airport Industry
	Whyte, Lindkvist, & Ibrahim, 2010	Construction Industry
	Kleinschmidt, Goonetilleke, Fookes, & Yarlagadda, 2010	Airport Industry
	Emmitt, 2010	Construction Industry
	Jordani, 2010	Construction Industry
	Loosemore, 2012	Construction Industry
	Crotty, 2013	Construction Industry
Trust	Simons & Peterson, 2000	Project Management
	Tyler, 2003	Project Management
	Costa, 2003	Project Management
	Davis & Walker, 2007	Project Management
	Smyth & Pryke, 2009	Construction Industry
	Emmitt, 2010	Construction Industry
	Smyth, 2012	Project Management
Conflict	Alper, Tjosvold, & Law, 2000	Project Management
	Simons & Peterson, 2000	Project Management
	Jehn & Bendersky, 2003	Project Management
	Wijnen, Walker, & Kwakkel, 2008	Airport Industry
	Kleinschmidt, Goonetilleke, Fookes, & Yarlagadda, 2010	Airport Industry
	Emmitt, 2010	Construction Industry
Relationships	Arditi & Gunaydin, 1998	Construction Industry
	Simons & Peterson, 2000	Project Management
	Smyth & Edkins, 2007	Construction Industry
	Walker, Bourne, & Rowlinson, 2007	Construction Industry
	Smyth & Pryke, 2009	Construction Industry
	Pryke & Smyth, 2006	Project Management

2.1.2 The framework validation

The theoretical framework was validated with two specialists on the airport domain through semi-structured interviews. The Validation Protocol (see APPENDIX IV, page 147) was presented to the specialists without any further explanation about the methodology, except the adoption of the three domains and dimensions, and the categories were validated through the findings, as can be seen on the protocol. Also, any theoretical reference upon which the framework was build was presented, letting the validators using their own references and experiences to guide their analysis and answers.

The validator profiles are as follow:

- Validator 1 – Ph.D. on airport design with international experience working on airport industry, dealing with infrastructure development.
- Validator 2 – over than 25 years of work experience on the airport industry developing projects to airports all over the world.

2.2 The semi-structured interviews

Based on the long interview method described by McCracken (1988), the interview protocol was developed in two steps. In the first step, a draft questionnaire for the semi-structure interview (see APPENDIX I, page 141) was tested with two airport specialists, one from the director level, and one from the project delivery team. Their contributions were aggregated to the final interview protocol, adding one final question to the conclusion section. The final version (see APPENDIX II, page 143) was translated into French to give to the interviewees the possibility to choose their preferred language.

The interview protocol is organized in three main sections: the first one consisted of the research subject and interviewer presentation, followed by the interviewee identification and two questions about the interviewee last experience on airport projects. The second section is composed of the three dimensions focus of the interview. The last section is composed by a conclusion question, where the interviewees were asked to give their overall perception about the impacts of 3D visualization on stakeholders' management.

The second part of the interview protocol was the core of the gathering data and composed by three dimensions to guide the interviewee's reflection about the 3D visualization impacts. The interrelation amongst the three dimensions is described in Figure 2.4.

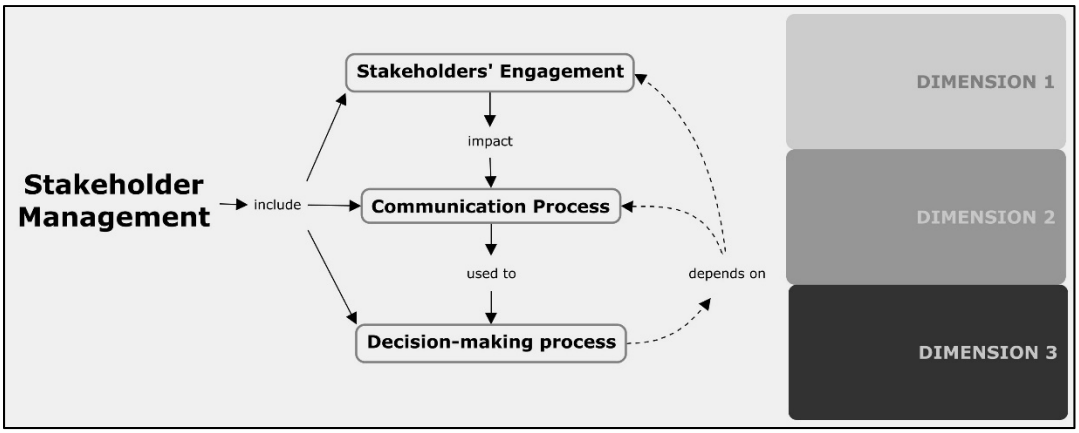


Figure 2.4 The dimensions interrelations

The objective of the interview was to identify, through the narrative of the interviewees' experience being exposed to the 3D visualization, the impacts perceived on the stakeholder management, mainly to the decision-making process. Thus, the three dimensions used to organize the subject focus of the interview were:

- **Dimension 1 - The Stakeholder Management:** due to the multiple stakeholders' environment airport projects are inserted, this dimension is focused on, through the interviewee experience and perception, what are the challenges to manage stakeholders through the project activities and what would be a good strategy to manage them during the project execution.
- **Dimension 2 - The Communication Process:** to manage stakeholders, communication is essential. The focus of this dimension was the relevance of the quality information to this process and effects of 3D visualization to the communication process between project team and airport stakeholders.
- **Dimension 3 - The decision-making process:** the main role to involve stakeholders on the project activities is due to their role as decision makers, as given the requirements, to the design approval and change approval. The communication process discussed on the previous dimension is the tool without the decision-making process cannot proceed. The focus of this dimension was how to engage airport stakeholders to the decision-making process and the impacts when using 3D visualization as a format to provide the needed information to the process.

2.3 Sampling

The sampling for the interviews was focused on airport stakeholders, including the engineering professionals with work experience on the airport industry. There were three main groups of interests for interviews: the director level from YQB[8], LAX[9], and YUL[10], all of them with experience in BIM projects; the project delivery team from YQB, that had worked with BIM in their last project; and the clients, YQB airport stakeholders that were exposed to BIM during the project activities. Were invited 22 stakeholders to participate in the interview, receiving 3 negative answers, 15 positive answers and 4 stakeholders did not answer the contact. From that invitation list, were made 13 interviews. Table 2.3 summarizes the interviewee's profile.

Table 2.3 Interviewee profile

Interviewee	Current position	Airport industry experience	Link to the industry
1	Director	11 years	YUL (work/worked)
2	Project Manager	3 years	YQB (work/worked)
3	*c*BIM Program Manager	11 years	LAX (work/worked)
4	CAD/BIM Supervisor	10 years	YQB (contract)
5	BIM/VDC Manager	2 years	YQB (contract)
6	Director	10 years	YQB (work/worked)
7	Project Manager	15 years	YQB (work/worked)
8	Director	11 years	YQB/YUL (External partner)
9	Head of Service	2 years	YQB (work/worked)
10	Project Manager	5 years	YQB (work/worked)
11	Director	7 years	YQB (work/worked)
12	Director	3 years	YQB (work/worked)
13	Director	5 years	YQB (work/worked)

The intention with the sampling construction was to search for the point of view of all levels of involvement on the project activities. Although it has approximately 60% success on the invitations, the sampling kept its intention to be composed by a consistence balance between

[8] YQB – Québec City Jean Lesage International Airport
[9] LAX – Los Angeles Internacional Airport
[10] YUL - Montréal–Pierre Elliott Trudeau International Airport

each of the levels: Director and Delivery level from the project side, and clients. Table 2.4 summarizes this proportion.

Table 2.4 Interviewees' participation

Interviewee group		Total
Project side	Director level	4
	Delivery level	5
Client side		4

The relevance of this proportion lies on the heterogeneity of the possible contributions, which is preferred instead of being focused on just one of those groups. Composed by this heterogeneity, this sampling might bring to the research an overall perception of 3D visualization impact to the management of airport project stakeholders, which are the main focus of this study.

2.4 Data collection

The interviews were made in 3 phases: on the first one, 3 interviews were made; on the second one, 4 interviews; on the last one, 6 interviews. The contact with the interviewees was made by email, presenting the researcher and the research subject and its objectives. Also, a copy of the interview protocol was sent within the first email, providing to the interviewee an upfront preparation. The interviews were made in person on the workplace of the interviewees, by web conference or telephone call. The interviews took on average 45 min to 1h to complete all dimensions and none of the questions was avoided by the interviewees. All the interviews were recorded for further analysis with the interviewee permission.

2.4.1 Coding

After each data collection phase, the interview audios were transcribed, and the data was joined together with the previous data. The answers were analyzed and classified on one of the categories described in subsection 2.1.1.3, page 45. To those seven categories extracted from the literature review, three more categories were added extracted from the interviewees'

answers, inspired by the grounded theory from Strauss and Corbin (1990). Figure 2.5 shows the interconnections amongst these three new categories extracted from the interviews and those categories extracted from the literature.

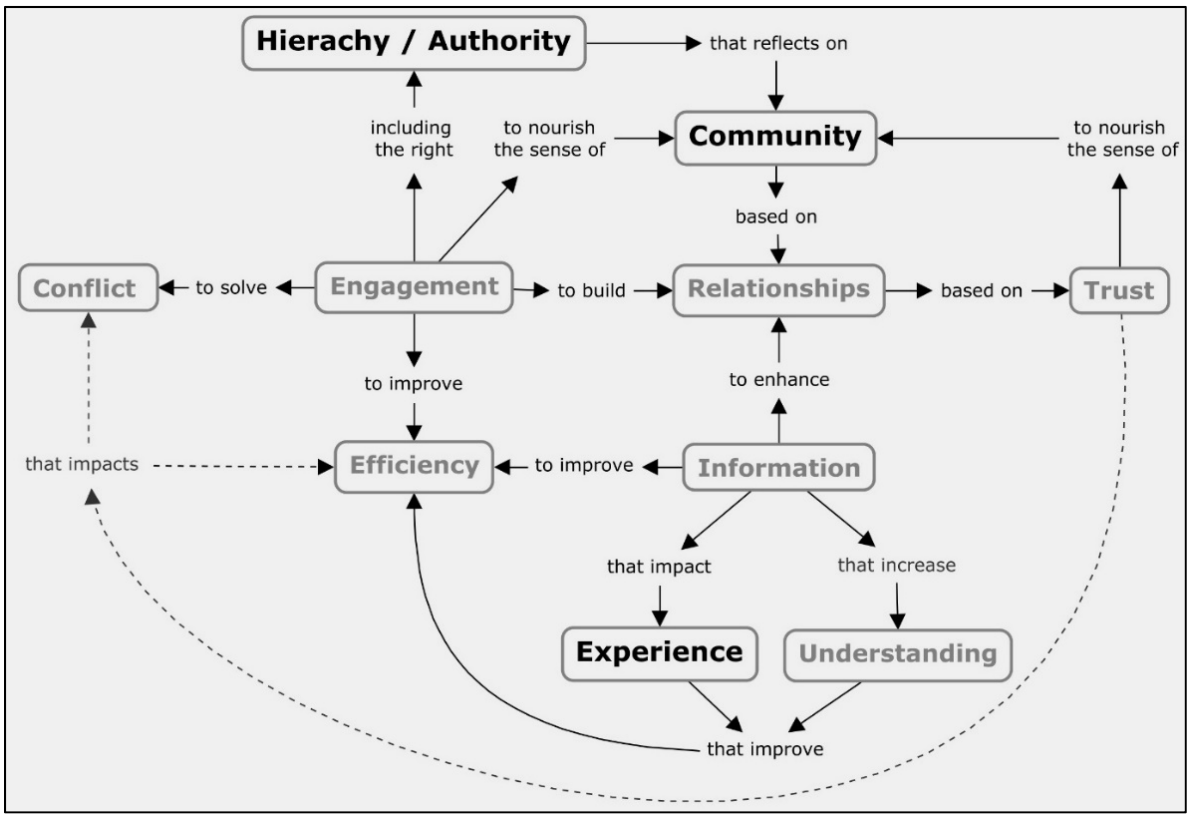


Figure 2.5 Final coding

The three categories that follow emerged from the interviewee's speech, having not been configured as focus of research in any of the three domains reviewed: airport industry, construction industry and project management theory. The literature review made by this study did not include any other area except the three already cited. The three categories added to the coding extracted from the literature is listed above with their meanings:

- **Hierarchy / Authority:** The needed engagement stated by the interviewees is the participation of the right stakeholders including the right level of authority to make decisions. Having those responsible for making decisions on board might impact the decision-making process and the project pace itself.

- **Community:** The inclusion of all stakeholders on the project environment might create a sense of community and its relationships. The project ownership perception that comes with belonging to this community improves their alignment to the project objectives, increasing its chance of success.
- **Experience:** Airports are complex by nature and participating on engineering projects demands knowledge not easily acquired. For those engineering actors on their first experience on airports, or for airport stakeholders facing for the first time an engineering project, talk the same language and break the barriers from one domain to the other is a challenge. Then, the interviewees stated that this gap on having experienced previously a similar professional challenge brings elements that impact the efficiency of the project process.

As a final coding list, the answers were analyzed and codified using ten categories. Table 2.5 shows, for each category, a brief definition used on this study, as examples extracted from the interviews that better reflect the category meaning.

Table 2.5 List of categories, their definitions and examples from the interviews

Categories	Definition	Example
Engagement	The early and active participation on the project activities, working to improve the chances of project success.	*"... mais surtout leur faire comprendre qu'on a besoin de leur participation". "Je pense qu'il faut intégrer le client, le constructeur, les professionnels au niveau de la participation et des connaissances."*
Efficiency	Any aspect that improves the efficiency of project processes and the chances of project success itself.	*"Having the opportunity to collect the information during the project and associate it with things that have end-up project delivery, efficiency is something easy to understand." "C'est peut-être de s'approprier l'espace, ça donne un meilleur résultat, en fait, une meilleure qualité de projet."*
Experience	Being used to the domains (airport industry, construction industry, project management process). Englobe the previous experience on these domains and the knowledge and tools to understand its particularities.	*"Mais là, on a davantage d'informations claires et simples dans la maquette 3D, ça rend ça beaucoup plus accessible à quelqu'un qui n'est pas habitué." "Souvent tu vas avoir des gens qui ne connaissent absolument rien de ça, tu as une éducation à faire aussi, un langage commun qu'on peut partager."*
Understanding	The comprehension of the ideas being discussed, or the project design itself.	*"Being able to understand. Take someone that doesn't work with drawings every day and provide visualization outside the 2D drawing and you gonna get a huge increase in the understanding quickly."*

Table 2.5 List of categories, their definitions and examples from the interviews (Continuation)

Categories	Definition	Example
Information	Quotes referring to how the information is generated and its flow in the communication process.	*"C'est important que la qualité de l'information soit adaptée selon la personne à laquelle elle s'adresse. Il n'est pas nécessaire que l'information ait le même niveau de profondeur et d'expertise pour tous".*
Trust	Related to the trust on the information circulating on the communication process and its effects on the relationships amongst all involved.	*"On perd confiance en nos données ... on fait, on travaille deux fois parce qu'on doit valider quelques modifications au projet, alors on perd de l'argent, on perd du temps, si on n'a pas confiance, on n'a pas d'argent, on n'a pas du temps."*
Conflict	The different stakeholders' interests on the project objectives.	*"Bien souvent il y a des conflits personnels, les gens ne sont pas capables bien s'entendre avec tout le monde." "Les intérêts divergent ... la façon de minimiser ça, c'est vraiment de trouver quel angle avec lequel on doit approcher telle partie prenante."*
Relationships	How all these multiple stakeholders relate each other, their connections and the impacts that theses links have over the project.	*"C'est sûr que ça va créer une meilleure cohésion, une meilleure collaboration entre tout le monde".*
Community	The sense of the ownership of the project integrating all airport stakeholders.	*"... aller les impliquer, les embarquer dans le projet, pour que ça devienne leur projet aussi, c'est aussi leur projet, ce n'est pas le projet de l'aéroport, c'est le projet de la communauté".*
Hierarchy Authority	The levels of stakeholders' hierarchy/authority participating on the project activities, specially to the decision-making process, and its impact over the project.	*"Avoir autour de table le bon niveau hiérarchique... un certain niveau d'autorité pour prendre des décisions".*

CHAPTER 3

DATA ANALYSIS

On Chapter 3, the interviewees' contributions for every dimension are detailed based on the same categories stated on section 2.4, page 51. As explained on subsection 2.2, page 48, the interviews contain four distinct parts, three dimensions and a final question. Every dimension was compounded by two questions, here designated as questions 1 and 2.

3.1 Dimension 1 – Stakeholder Management

In this dimension are discussed the challenges and the strategy to engage the stakeholders on the project objectives under the knowhow of the stakeholder management theory. Figure 3.1 shows the interconnections amongst the most relevant categories extracted from the interviewees' answers to this dimension.

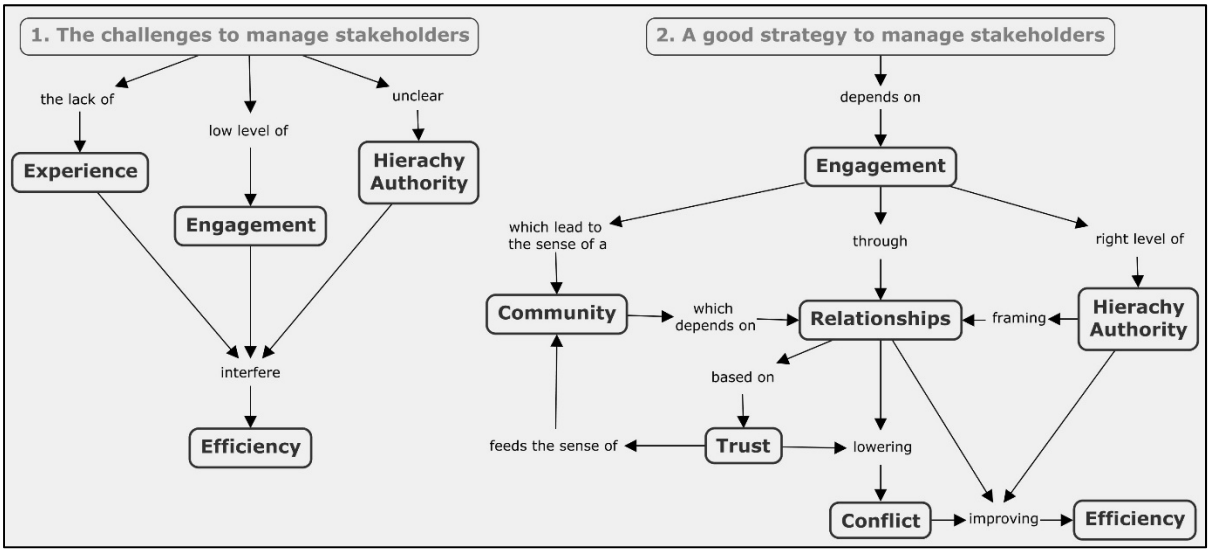


Figure 3.1 Relationships between the categories emphasized on Dimension 1

The conceptual map above segregates the categories for each question related to this dimension:

- Question 1: what are the challenges to engage stakeholders in the project activities?

- Question 2: what would be the good strategy to engage stakeholders in the project activities?

From the interviewees' perspectives, the main challenges to manage stakeholders through the project activities (Question 01) pass by the project team lack of experience in the airport industry, and the lack of experience of construction industry and project management by those airport stakeholders involved in the project. Also, the wrong level of hierarchy/authority to make decisions of those involved in the decision-making process, and the airport stakeholders' lower level of engagement, especially in the early stages of the project.

The strategy to manage stakeholders, from the interviewees' perspectives, depends on the engagement of those with the right level of hierarchy/authority to make decisions, which will create a sense of community based on trustworthy relationships, decreasing the conflicts amongst them.

Those concepts and their connections are discussed in the following sections.

3.1.1 The challenges to engage stakeholders

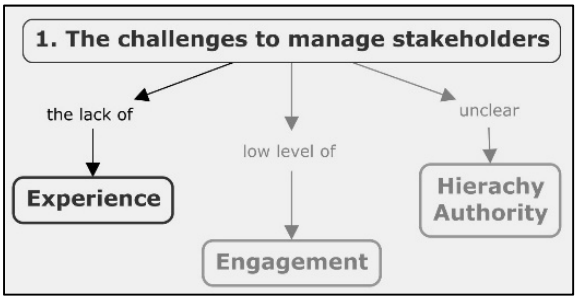
Table 3.1 summarizes the main challenges cited by the interviewees when answering question 01, what are the challenges to engage stakeholders in the project activities?

Table 3.1 Summary of the main challenges

Category	Definition
Experience	The lack of experience from both sides: the airport industry to the project team; the engineering project process to the clients.
Hierarchy / Authority	To have more than one person from each department or group of stakeholders with different levels of power over the decision process.
Engagement	The stakeholders are not very often aware of their engagement's impacts on the project efficiency.

The challenges were categorized considering the most important concept being used by the interviewees to express their ideas. The interconnections from all categories are explained in the Figure 3.1, page 55. Each of these three challenges is detailed below.

Challenge: Experience



The activities that take place on airports involve not only passengers and air companies. To be operational, an airport demands a variety of services to process passengers and luggage, providing security and comfort, which require diverse professionals with diverse knowledge. Taking place on this already complex environment, an engineering project will add several professionals to the airport stakeholders involved, what can be called airport community.

This community involved on the engineering project is made by a variety of professionals and not just architects, engineers or all sorts of technical engineering professionals. Can be assumed that many of them are not familiar with the processes used in engineering projects. However, for those used to construction endeavors, *"les membres de l'équipe du bureau de projet partagent cette façon de penser, mais pour eux* [stakeholders' clients], *c'est un peu difficile de comprendre, parce qu'ils ne sont pas habitués à cette manière de travailler*"[11] [Delivery level]. Thus, from the client side, as *"ce n'est pas l'expertise de la haute direction"*[12] [Client side], for example, and they will have difficulties to follow the pace of the project. As they do not deal with construction projects normally, they don't have the knowledge of how it works. "*Puisque les parties prenantes ne connaissent rien à ce sujet*"[13] [Director level] and "*elles ne*

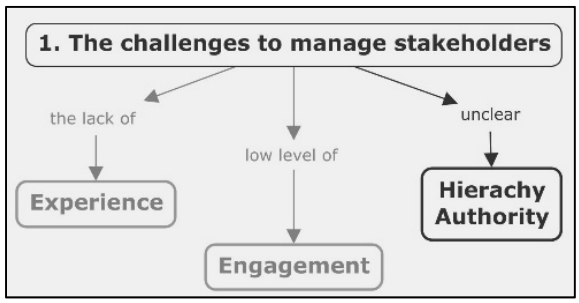
[11] *"The members of the project office team share this way of thinking, but for them [stakeholders' clients], it's a bit difficult to understand, because they are not used to this way of working".* [Delivery level]
[12] *"It is not the expertise of senior management."* [Client side]
[13] *"Since stakeholders do not know anything about it."* [Director level]

sont pas capables d'interpréter la documentation technique ou du moins, elles l'interprètent, mais difficilement"[14] [Delivery level].

From the project side, you may have *"people that don't necessarily work at the airport or have worked at the airport"* [Director level] that *"don't know how it operates"* [Director level] and consequently, how the project activities can impact these operations or how they can avoid the negative impacts to maintain the operations and to complete the project activities at the same time. As airports consist of an environment with its very specific rules and structure, it might take some time to engage all the new stakeholders from the project side, having them understanding the organization and having the familiarity needed with the organization itself and the people that work on it. Find out to whom project actors should talk to early in the project is key when searching stakeholders' engagement.

Considering these two large groups that must learn how to run the project together, *"finding out whom to engage with"* [Director level] is a challenging aspect to manage the airport project stakeholders from both sides. This knowledge misalignment of airport, construction and project management domains amongst the project team and the stakeholder's clients represents a weakness into this relationship, bringing another element to this already complex environment that the engineering airport projects are.

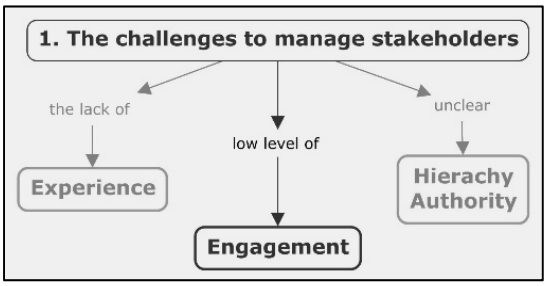
Challenge: Hierarchy/Authority



[14] *"They are not able to interpret the technical documentation or at least they interpret it but with difficulty."* [Delivery level]

Another challenge for the client side is trying to establish the links of communication, where the right ones participate with the right roles and responsibility. However, *"il faut surtout se demander qui est la meilleure personne pour détecter ce qui peut affecter les services et les opérations"*[15] [Client side]. Usually are not just one person from each airport department or group of stakeholders bridging the project team and the organization. *"Ça commencera avec deux ou trois personnes de la même organisation qui n'ont pas le même pouvoir au sein de l'organisation. Tu parles avec un, c'est une réponse, avec l'autre c'est une autre réponse, même eux n'étaient pas très au courant de la décision de leurs collègues, ça devient un peu plus compliqué à gérer"*[16] [Delivery level]. Furthermore, while the project needs a person with decision-making power dedicated to the project, the organizations usually do not have the resources to fully dedicate someone. This difficulty in engaging the right person from every department or institution can add negative effects to the efficiency of the decision-making process and consequently, to project itself.

Challenge: Engagement



The engagement *"c'est l'élément essentiel qu'il faut réussir à obtenir des parties prenantes, sinon le projet sera difficile à réaliser"*[17] [Director level]. Thus, managing stakeholders is the key to engage them on the project activities and it has a significant effect on the project efficiency. Their engagement is essential to the project success and it is something that must

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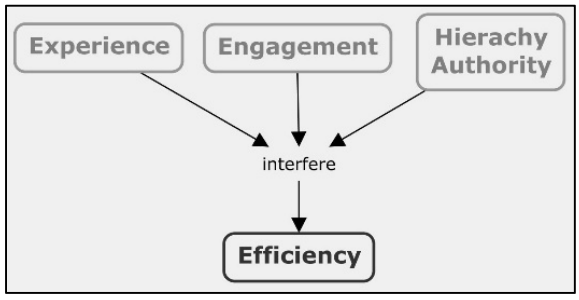
[15] *"The question is, who is the best person to detect what can affect services and operations."* [Client side]
[16] *"It will start with two or three people from the same organization who do not have the same power within the organization. You talk with one, it's an answer, with the other it's another answer, even though they were not very aware of the decision of their colleagues, it becomes a little more complicated to manage."* [Delivery level]
[17] *"It is the essential element that must be successful in obtaining stakeholders, otherwise the project will be difficult to achieve."* [Director level]

be done due to its possibility of interfering on the project execution, decreasing or even avoiding difficult situations during all project phases.

However, *" ... that initial engagement is the serious challenge"* [Director level], and if stakeholders are "*not engaged correctly to the beginning to the middle, to redo it in the last part of the project is almost impossible and the consequences are the client will basically get to everything that he is not aware of it or he doesn't want"* [Director level]. If one of the sources of project success is to meet the stakeholders' requirements, this low engagement at the beginning could cost the endeavor accomplishment.

Another aspect of the engagement challenge is how the stakeholders will participate on the project activities. *"Il faut que les gens comprennent et qu'ils se sentent comme un membre de l'équipe, et non juste comme un spectateur situé à l'extérieur de l'équipe"*[18] [Director level], but participating actively on the project activities, being also responsible for its success. *"Eux aussi, ils font partis de l'équipe, ils sont dans l'équipe, leur «input» est important et contribue à améliorer le projet"*[19] [Director level]. Eventually, all of them will suffer the impact of the project activities and the moment they comprehend that they are part of if, that they have the responsibility of it, they can see the good well.

The Challenge Consequences



[18] *"People need to understand and feel like a member of the team, not just a spectator outside the team."* [Director level]
[19] *" They, too, are part of the team, they are in the team, their input is important and help to improve the project."* [Director level]

The result of those three challenges – Experience, Hierarchy/Authority and Engagement - can be seen on the project efficiency. Participants showing lower levels of experience in some of the domains will require more involvement from those that have the knowledge, delaying the project pace. Also, the lack of involvement of those with the right level of hierarchy/authority to make decisions will also delay this process due to the increased time to make those decisions, or even to rethink about decisions made before without the proper authority. The stakeholders' engagement, the third challenge, will also be affected by the first two challenges and impact the efficiency of the project due to lack of support of project objectivity or even by the efforts against it.

Table 3.2 summarizes the evidence extracted from the interviews' answers.

Table 3.2 Evidences for the challenges to engage stakeholders[20]

DIMENSION 1 - PART 1: What are the challenges managing stakeholders?			
Categories	**ID**	**Evidences**	
Experience	2	08'39"	*"Les membres de l'équipe du bureau de projet partagent cette façon de penser, cette manière de penser, mais pour eux* [stakeholders' clients], *c'est un peu difficile de comprendre, parce qu'ils ne sont pas habitués à cette manière de travailler*"
	12	07'56"	*"Ce n'est pas l'expertise de la haute direction"*
	6	26'02"	"*Puisque les parties prenantes ne connaissent rien à ce sujet.*"
	10	08'30"	*"Elles ne sont pas capables d'interpréter la documentation technique ou elles l'interprètent difficilement*"
	3	10'34"	*"From project delivery step points, engagement early is the challenge, finding out how to engage with, so typically in the large capital project its staffed by the people that don't necessarily work at the airport or have had work at the airport."*
	3	12'09"	*"They're new to airport, they don't know how it operates or the people that do it ... so how do you take two relatively large groups that do not understand each other, that is a huge challenge."*

[20] On this table is possible to observe extracts from the interviews demonstrating each interviewee contribution to the findings for this discussion. Also, it is indicated where the evidence can be found on the interview audios and the category to which evidence was categorized. These categories and their interconnections can be seen also on the Figure 3.1, page 55.

Table 3.2 Evidences for the challenges to engage stakeholders (Continuation)

DIMENSION 1 - PART 1: What are the challenges managing stakeholders?			
Categories	**ID**	**Evidences**	
Hierachy Authority	9	11'01"	*“Il fait surtout se demander qui est la meilleure personne pour détecter ce qui peut affecter les services et les opérations.”*
	2	12'49"	*"Ça commencera avec deux ou trois personnes de la même organisation qui n'ont pas le même pouvoir au centre de l'organisation. Tu parles avec un, c'est une réponse, avec l'autre c'est une autre réponse. Même eux, n'étaient pas très au courant de leur décision, ça devient un peu plus compliqué à gérer."*
Engagement	1	14'07"	*“c'est l'élément essentiel qu’il faut réussir à obtenir des parties prenantes, sinon le projet sera difficile à réaliser.”*
	3	11'28"	*" Just that initial engagement is the serious challenge".*
	3	19'16"	*"So, if it's not engaged correctly to the beginning to the middle, to redo in the last part of the project is almost impossible and the consequences are the client will basically get to everything that he is not aware of it or he doesn't want".*
	1	12'41"	*"Il faut que les gens comprennent et qu'ils se sentent comme un membre de l'équipe, pas juste comme un spectateur situé à l’extérieur de l’équipe "*
	1	13'36"	*“Eux aussi, ils font partis de l'équipe, ils sont dans l'équipe, leur «input» est important et ils contribue à améliorer le projet”*

3.1.2 The strategy to engage stakeholders

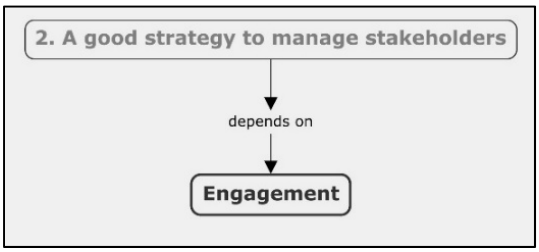
Table 3.3 summarize the main strategies cited by the interviewees and their respective categories.

Table 3.3 The resume of the main strategies

Category	Definition
Engagement	To let them understand that they are part of the project, not just observers, and their contribution is important to have a better final product.
Hierarchy / Authority	To have just the right person from each department or group of stakeholders with the right level of decision-making power.
Relationships	To create a bridge between the clients and the project team through its relationship.
Trust	To build mutual trust amongst all involved.
Community	To involve them on the project in a way that creates an ownership environment.
Conflict	To search for the right angle to approach each stakeholder in order to satisfy their requirements as much as possible.

The strategies were categorized considering the most important concept being used by the interviewees to express their ideas. The interconnections from all categories are explained in the Figure 3.1, page 55 above. Each of these three challenges is detailed below.

Strategy: Engagement



The strategy to manage airport stakeholders is *"les impliquer dès le début"*[21] [Delivery level] "*le plus tôt possible"*[22] [Director level] and "*surtout pour la prise de décision initiale, où l'on s'entent sur les besoins du client*"[23] [Client side], *"pour que les gens soient là pour le démarrage du projet, ce qui est important [...] c'est d'avoir la vision de tout le monde"*[24] [Delivery level], especially *"c'est important d'avoir une personne par chaine d'exploitation aéroportuaire"*[25] [Delivery level].

Involving them on the process "*pour leur faire comprendre qu'on a besoin de leur participation"*[26] [Delivery level] is an active engagement: stakeholders as players, actively participating on the project activities. They should understand that they are part of the project, that they have an important role and they must involve themselves on the project decisions, participating actively to the project execution. It is fundamental "*les faire embarquer dans le projet dès le départ, dès la prise de décision initale. Si t'attends trop longtemps avant d'impliquer tes parties prenantes, il y a trop de travail à faire pour les amener dans le projet,*

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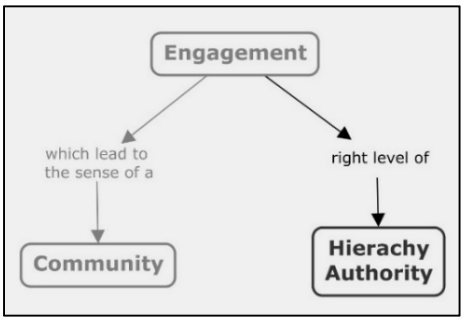
[21] *"We involve them from the beginning."* [Delivery level]
[22] *"As soon as possible."* [Director level]
[23] *"Especially for the initial decision-making, where we agree on the client requirements".* [Client side]
[24] *"That people are there for the start of the project, which is important ... to have the vision of everyone".* [Delivery level]
[25] *"It's important to have one person per airport operating chain."* [Delivery level]
[26] *"Making them comprehend that the project needs their participation."* [Delivery level]

donc si tu ne les fais pas participer dès le début, ils vont moins se sentir impliquées. À partir du moment où les gens se sentent impliqués ils vont porter le projet pour toi"[27] [Director level].

Strategy: Hierachy / Authority



If it is crucial for the project success *"impliquer des parties prenantes"*[28] [Delivery level], especially *"ça prend la bonne personne au bon moment"*[29] [Client side]. It is also important to pay attention to include *"les gens du bon niveau hiérarchique, car ces gens se sentent automatiquement investis, ils sentent la responsabilité, l'obligation de faire correctement leur travail"*[30] [Director level]. It is fundamental to have *"autour de la table le bon niveau hiérarchique... un certain niveau d'autorité pour prendre des décisions"*[31] [Director level] compounded by a representative from every airport department and institution, embedded with the right level of hierarchy and with the authority to make decision, *"bridging the large project delivery group to the stakeholder consumers"* [Director level] as *"un point de contact entre parties prenantes ... avec une voix décisionnelle"*[32] [Delivery level]. *"On doit s'assurer d'avoir une représentante pour chaque partie prenante"*[33] [Delivery level], *"un intervenant pour*

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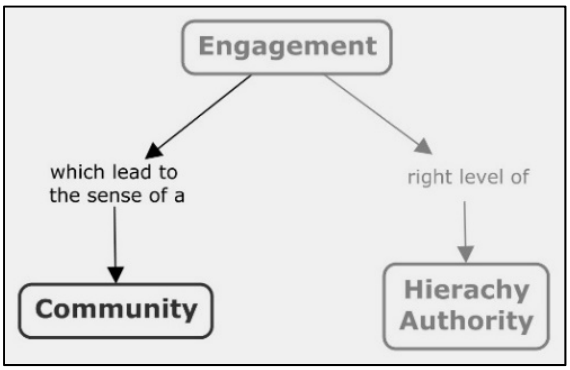
[27] *"Get them into the project right from the start, right from the initial decision-making process. If you wait too long to involve your stakeholders, there is too much work to do to bring them into the project, so if you do not involve them from the beginning, they will feel less involved. From the moment people feel involved they will carry the project for you."* [Director level]
[28] *"To involve stakeholders."* [Delivery level]
[29] *"It takes the right person at the right time."* [Client side]
[30] *"The people of the good hierarchical level, because these people feel automatically invested, they feel the responsibility, the obligation to do their work properly."* [Director level]
[31] *"... around the table the right hierarchical level ... a certain level of authority to make decisions."* [Director level]
[32] *"A point of contact between stakeholders ... with a decision-making voice."* [Delivery level]
[33] *"We have to make sure we have one representative per stakeholder."* [Delivery level]

chaque groupe, chaque communauté"[34] [Client side] with decision-making power working as a point of contact between the project structure and the airport organization as those decisions will have an impact over the other stakeholders and over the project success as well.

Strategy: Community



By the same time that the stakeholders might understand that they are part of the project, which means that the project is also their project, they need to see the project as a community project. While should exist a sense of ownership over the project, there should also be present the responsibility of being part of something that will have an overall impact because inserted on a complex environment.

Thus, the project is a community endeavor, and a community is made by its relationships. It has a common objective and it is challenging for everyone, but its goals are for the common good. *"Il n'y a pas de petite partie prenante et une fois que les gens ont compris ça, ils voient le bénéfice commun"*[35] [Director level]. The impacts over the stakeholders are not necessarily focused on one or two stakeholders or groups of stakeholders. If the project activities interfere on one stakeholder, it will also cause some impact over the other because all of them are part of the same environment, the same community. When your decision can cause an impact on one stakeholder, it will impact others. Thus, *"il faut essayer de les impliquer, les embarquer*

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[34] *"... one speaker for each group, each community."* [Client side]
[35] *"There is no small stakeholder and once people understand that, they see the common benefit."* [Director level]

dans le projet, pour que ça devienne aussi leur projet. Ce n'est pas le projet de l'aéroport, c'est le projet de la communauté"[36] [Director level].

This strategy can represent *"beaucoup de travail, mais les parties prenantes seront fières de participer, parce que la nouvelle aérogare sera leur aérogare"*[37] [Client side], *"les gens étaient impliqués, ils n'ont pas sentis qu'ils s'étaient fait imposer des choses, mais plutôt qu'ils ont pris des décisions en commun"*[38] [Delivery level]. It is *"une planification stratégique commune, une vision globale, la communication entre les différents intervenants pour s'assurer d'avoir la même compréhension des enjeux"*[39] [Client side] where *"les acteurs viennent de toutes les sphères de l'organisation"*[40] [Delivery level] because *"il faut savoir utiliser les forces de chacun"*[41] [Client side]. This sense of community will *"réussir à arrimer tous ces gens vers une mission commune jusqu'à la fin du projet"*[42] [Client side] because *"si on a une équipe qui est plus alignée sur des objectifs communs, le projet sera mieux fait"*[43] [Director level].

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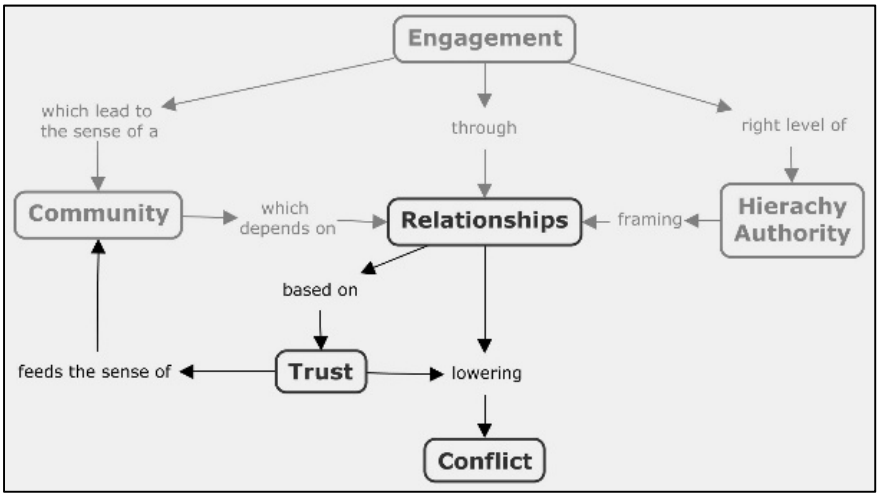
[36] *"Try to reach their involvement, make them get on board, so the project will also be their project, it is not just an airport's project, but an airport community project."* [Director level]
[37] *"A lot of work, but the stakeholders will be proud to participate, because the new terminal will be their terminal."* [Client side]
[38] *"People were involved, they did not feel that they had imposed things on themselves, but rather that they made decisions in common."* [Delivery level]
[39] *"A common strategic planning, a global vision, communication between the various stakeholders to ensure that we have the same understanding of the issues."* [Client side]
[40] *"Actors come from all spheres of the organization."* [Delivery level]
[41] *" You have to know how to use the strengths of each."* [Client side]
[42] *" To secure all these people to a common mission until the end of the project."* [Client side]
[43] *"If we have a team that is more aligned with common goals, the project will be better done."* [Director level]

Strategy: Relationships, conflict and trust



The engagement of the stakeholders with the appropriate level of hierarchy/authority to make decisions might create a sense of community which make them participate actively on project activities, depends on and will be framed by its relationships.

During its long-term process, the project will deal with multiple changes and misunderstandings between the design team and the clients about their requirements and the project propositions. The solution for these conflicting situations *"dépend de la relation humaine entre le chargé de projet et les différentes entreprise"*[44] [Delivery level]. It will be through the relationships built with the stakeholders' clients that the project team will deal with those conflicts. *Une des façons de diminuer un peu les conflits, c'est vraiment avoir tout le monde au début à la phase de préconception et de conception aussi"*[45] [Director level] and also *"de prendre en considération les besoins de chacun"*[46] [Director level], observing *"quel angle on doit approcher telle partie prenante"*[47] [Director level].

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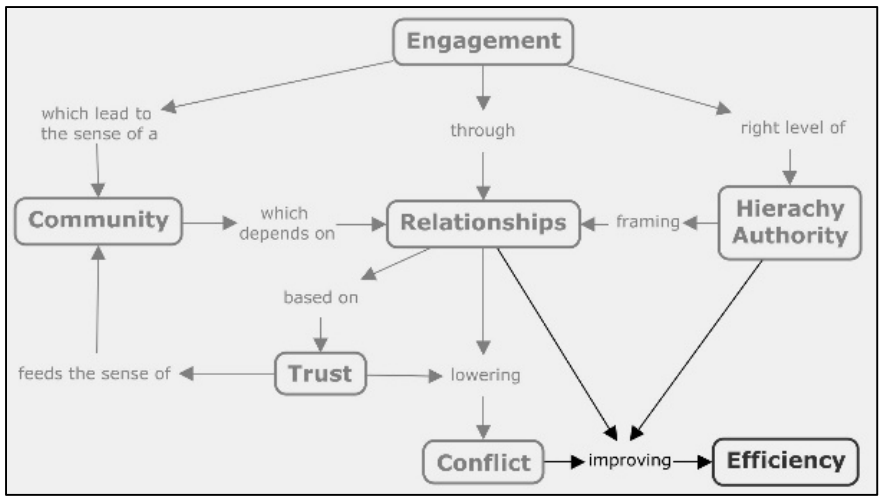
[44] *"… depends on the human relationship between the project manager and the different companies."* [Delivery level]
[45] *" One of the ways to reduce conflicts a little bit is to have everyone at the beginning of the preconception and design phase."* [Director level]
[46] *"Take into consideration the needs of each one."* [Director level]
[47] *" To what angle should we approach this stakeholder."* [Director level]

Nevertheless, the human relations that might be the answer to solving the conflicting situations between stakeholders can be challenging. A response to minimize this difficulty is to ground these relationships on *"respect et confiance"*[48] [Delivery level] among the stakeholders and the project team, in a way that they can take for granted the information receiving about the project and the decision made base on it. Then, these relationships should be based on mutual trust to reinforce the sense of community and the relationship itself. *"S'il n'y a pas une confiance mutuelle qui s'installe, le projet ira nécessairement mal"*[49] [Director level].

The challenge is to build these trustworthy relationships in a complex environment made by groups that do not have necessarily the experience required or that don't know each other or do not have the expertise in each other domains making difficult to dialog without a common language. Besides, sometimes there is not even the right person with the authority to make decisions involved in the process, impacting even more the efficiency of it. All these elements will interfere on the project success and demand a strategy to deal and to improve the chances of project success.

The Consequences on the Project Efficiency



[48] "*... respect and trust".* [Delivery level]
[49] *"If there is no mutual trust that sets in, the project will necessarily go badly."* [Director level]

With engagement, all stakeholders involved on the project activities can contribute with their expertise, helping to anticipate future problems and finding the best solutions for each one. When the project count with the right ones to solve the problems, the issues might not impact significantly on the project pace, because the process to solve them will be more efficient. When all involved feel that the project ownership, they will collaborate to the project goals, because the project success is their own success. Also, the relationships among stakeholders and project team based on mutual trust will help to solve the conflicting situations. All these strategies together will enhance the efficiency of project processes, improving its efficiency and the chances of project success.

Table 3.4 summarizes the evidences extracted from the interviews.

Table 3.4 Evidences for the strategy to manage stakeholders[50]

DIMENSION 1 - PART 2: What would be a good strategy to engage stakeholders?			
Categories	**ID**	**Evidences**	
Engagement	6	15'57"	*"Pour moi, ce que j'essaie de faire le plutôt possible, c'est d'impliquer les parties prenantes, d'impliquer les partenaires, les employées aussi."*
	9	17'22"	T: La stratégie? *I: "Qu'on soit consulté, surtout pour la prise de décision des besoins initiaux, et non une fois que le design est complété, juste avant de le fabriquer, de la réaliser".*
	4	14'46	*"Pour que les gens soient là pour le démarrage du projet, ce qui est important ... c'est d'avoir la vision de tout le monde"*
	4	23'16"	*"C'est important d'avoir une personne par chaine d'exploitation aéroportuaire."*
	2	20'48"	*"... mais surtout leur faire comprendre qu'on a besoin de leur participation".*
	6	15'26"	*"Les faire embarquer dans le projet dès le départ, dès la prise de décision initiale. Si t'attends trop longtemps avant d'impliquer tes parties prenantes, il y a trop de travail à faire pour les amener dans le projet, donc si tu ne les fais pas participer dès le départ, elles vont se sentir moins impliquées. À partir du moment où les gens se sentent impliqués, ils vont porter le projet pour toi."*
	1	21'09"	*"... s'il n'y a pas une confiance mutuelle qui s'installe, le projet ira nécessairement mal".*

[50] On this table is possible to observe extracts from the interviews demonstrating each interviewee contribution to the findings for this discussion. Also, it is indicated where the evidence can be found on the interview audios and the category to which evidence was categorized. These categories and their interconnections can be seen also on the Figure 3.1, page 55.

Table 3.4 Evidences for the strategy to manage stakeholders (Continuation)

DIMENSION 1 - PART 2: What would be a good strategy to engage stakeholders?			
Categories	**ID**	**Evidences**	
Hierachy Authority	2	20'06"	T: une bonne stratégie pour engager les parties prenantes sur les objectifs du projet? *I: "Les impliquer".*
	9	12'04"	*"Ça prend la bonne personne au bon moment."*
	1	26'27"	*"C'est important d'avoir des gens du bon niveau hiérarchique, et que ces gens se sentent automatiquement investis, qu'ils sentent une responsabilité, l'obligation de faire correctement leur travail".*
	1	24'19"	*"Avoir autour de la table le bon niveau hiérarchique... un certain niveau d'autorité pour prendre des décisions".*
	3	22'40"	*"The fact they have a much longer time perspective they're priorities are a little bit different, which is good, I believe, for delivering the stakeholders' requirements, in this case, the clients. They are an organizational management key the way we operate that group, that plays bridging the large project delivery to the stakeholder consumers."*
	2	21'21"	*"Je pense qui est important c'est d'avoir un point de contact entre les parties prenantes. Chaque fonction, chaque organisation qui travaille sur l'aéroport doit avoir un représentant avec une voix décisionnelle, et ce n'est pas si simple."*
	4	22'54"	*"On doit s'assurer d'avoir un représentant pour chaque partie prenante. "*
	9	11'01"	*"La manière la plus efficace, c'est aller chercher un intervenant pour chaque groupe, chaque communauté"*
Community	1	16'29"	*"Il n'y a pas de petite partie prenante, une fois que les gens comprennent ça, ils voient le bénéfice commun".*
	1	18'50"	*"Il faut essayer de les impliquer, de les embarquer dans le projet, pour que ça devienne aussi leur projet. Ce n'est pas le projet de l'aéroport, c'est le projet de la communauté"*
	11	11'57"	*"Beaucoup de travail, mais les parties prenantes seront fières de participer parce que la nouvelle aérogare sera leur aérogare."*
	7	26'00"	*"Les gens étaient impliqués, ils n'ont pas sentis qu'ils s'étaient fait imposer des choses, mais plutôt qu'ils ont pris des décisions en commun."*
	12	06'32"	*"Une planification stratégique en commun, une vision globale, la communication entre les différents intervenants pour s'assurer d'avoir la même compréhension des enjeux."*
	10	05'52"	*"La clé, s'était de prendre une équipe de projet dont les acteurs, les chefs du projet provenaient de toutes les sphères de l'organisation."*
	8	22'02"	*"Il faut savoir utiliser les forces de chacun"*
	12	06'57"	*"Réussir à arrimer tous ces gens vers une mission commun jusque à la finalité."*
	13	35'40"	*"Si on a une équipe qui est plus alignée sur les objectifs en commun, le projet sera mieux fait."*

Table 3.4 Evidences for the strategy to manage stakeholders (Continuation)

DIMENSION 1 - PART 2: What would be a good strategy to engage stakeholders?			
Categories	**ID**	**Evidences**	
Relationship	2	15'09"	Je pense que tout dépend de la relation humaine entre le chargé de projet et les différentes entreprises".
Conflict	2	14'48"	*"La résolution des conflits revient un peu au client et aux parties prenantes, ce sont eux qui doivent satisfaire leurs besoins autant qu'ils peuvent.*
	1	18'04"	*"Une des façons de diminuer un peu les conflits, c'est vraiment d'avoir tout le monde au début, à la phase de préconception et de conception aussi."*
	1	18'40"	*"Apprendre à considérer les besoins de chacun."*
	1	15'05"	*"Les intérêts divergents... la façon de minimiser ça, c'est vraiment de trouver l'angle selon lequel on doit approcher telle partie prenante".*
Trust	2	15'13"	T: La relation humaine, c'est comme une relation de confiance, tu penses? *I: "Tout est basé sur le respect et la confiance ".*
	1	21'09"	*"... s'il n'y a pas une confiance mutuelle qui s'installe, le projet ira nécessairement mal".*

3.1.3 Dimension 1 discussion

The interviewees were asked to answer two questions:

- Question 1: what are the challenges to engage stakeholders in the project activities?
- Question 2: what would be the good strategy to engage stakeholders in the project activities?

Figure 3.2 shows the answers' classification that embrace just the main idea for each answer.

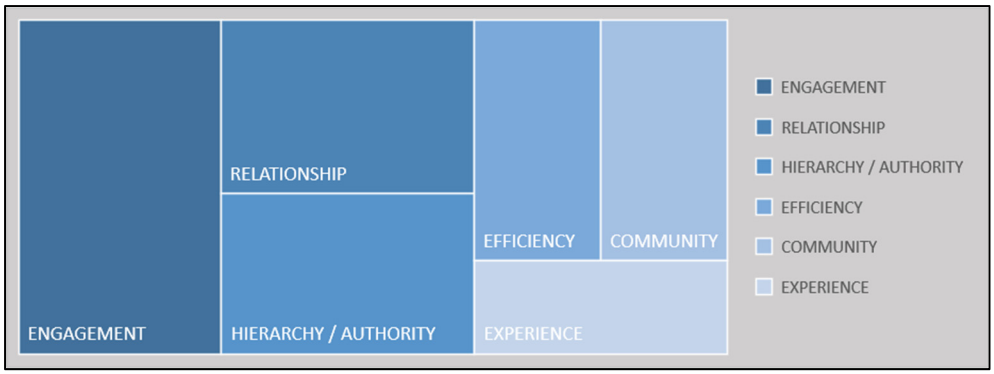


Figure 3.2 Categories emphasized on Dimension 1' answers[51]

When referring to stakeholder management, it is possible to observe the relevance of "Engagement", "Relationship", "Hierarchy / Authority", "Efficiency", "Community" and "Experience" concepts have over the answers. For the interviewees, by the same time that the challenges for managing stakeholders on the project activities involve the categories described on subsection 3.1.1, page 56, the strategies pass through trustworthy relationships necessary to engage the stakeholders, considering the right level of hierarchy and authority to make decisions, which improve the efficiency of the process, subsection 3.1.2, page 62. Also, the sense of community must be enhanced to engage them on the project activities, making them understand that they are also responsible for the project success.

It is worthy notice that, despite the "Conflict" category configures as a good strategy component, it is the absence of the answers relating to challenges to manage stakeholders. The concept of conflict is largely cited on the literature as a relevant aspect to be dealt with when managing stakeholders on project activities. In this case study, the fact that participants did not include this concept as challenge, but as strategy, confirm this relevance. Also, this absence

51 Despite every answer may refer to more than one category is always possible to give for each one the category that better reflects the interviewee ideas being discussed. Most of the time because they used a specific word, or the meaning of their speech led to one category. The size and the color of each part of the graphic represent the most cited category (bigger and darker) to the less cited one (smaller and lighter), reveling those concepts that are more present on the interviewees' answers for this dimension. The same will be used on subsections 3.2.3, page 90, 3.3.3 on page 108, 3.4.3 on page 120.

can be explained by the perception of success that all participants demonstrated on the interviews.

3.2 Dimension 2 – Communication Process

This dimension discusses the relevance of the information quality to the communication process and its impact on the relationship amongst the stakeholders and the project team. Figure 3.3 below shows the interconnections amongst the most relevant categories extracted from the interviewee's answers.

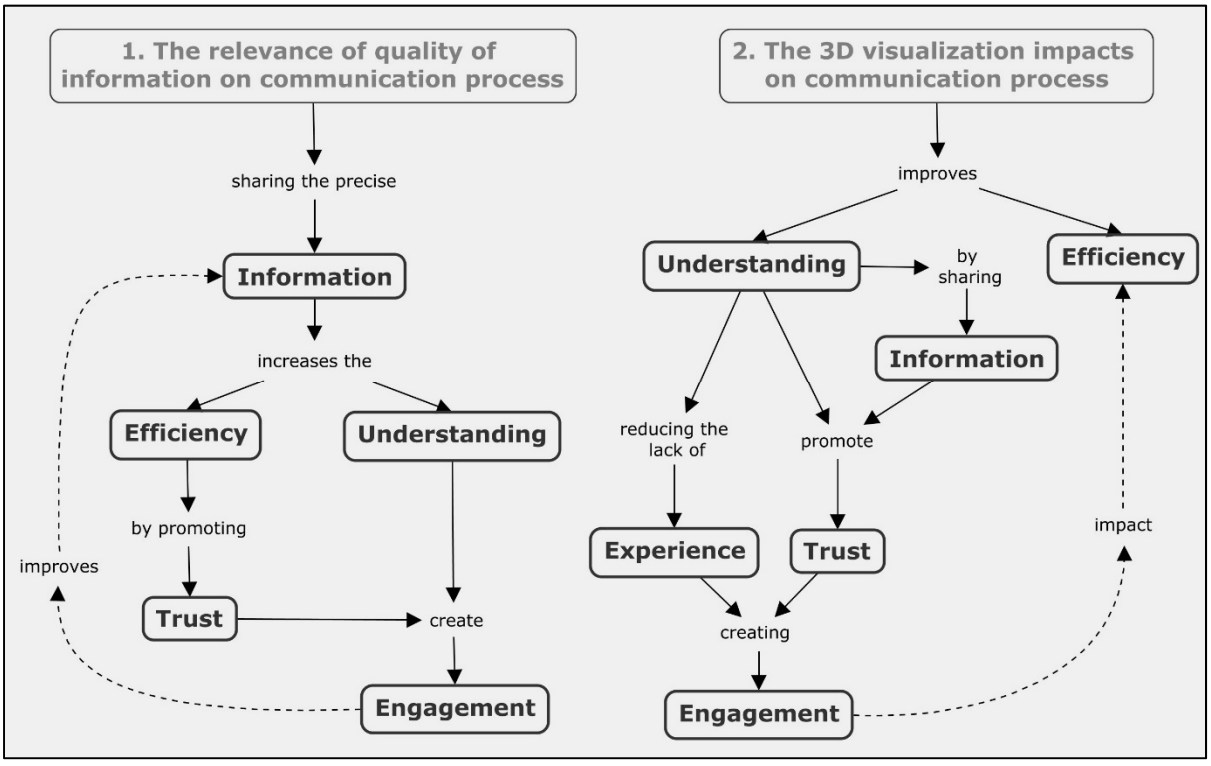


Figure 3.3 Relationships between the categories emphasized on Dimension 2

The conceptual map above segregates the categories for each question related to this dimension:

- Question 1: what is the relevance of quality information to the communication process?
- Question 2: what are the 3D visualization impacts over the communication process?

The interviewees stated that the relevance of the information quality is on sharing a precise information to the stakeholders, considering the one that will receive it, its content, format and time. This sharing will increase the efficiency of the communication process as the information understanding, establishing trustworthy relationships among all involved, that lead to increased levels of engagement.

When asked what would be the impacts on this process by providing the 3D visualization of the information being communicated, the interviewees argued that it will improve the efficiency of the communication process by promoting a better understanding. This better comprehension will reduce the lack of experience in the construction process and it will allow to increase the quality of the information by promoting and trustful documents. With alignment of understanding and increased trust, their level of engagement will improve, which impact the efficiency of the project process.

Those concepts and their connections are discussed in the following sections.

3.2.1 The relevance of quality information on the communication process.

Table 3.5 summarizes the relevance of quality information concepts most cited by the interviewees and each respective category.

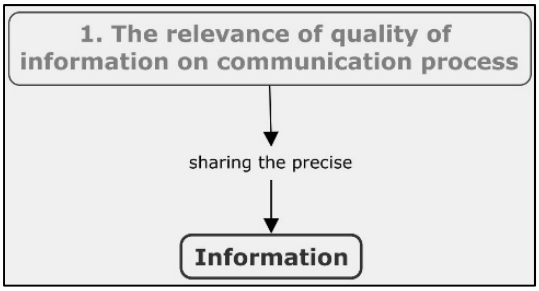
Table 3.5 The relevant aspects of quality information to the communication process

Categories	Definition
Information	It confers efficiency to the process when shared the right information to the right person at the right moment.
Efficiency	It enhances the efficiency of project processes.
Understanding	It improves the design understanding.
Trust	It can generate trustworthy relationships.

The aspects listed as relevant to the quality information to the communication process were categorized considering the most important concept being used by the interviewees to express their ideas. The interconnections from all categories cited by the interviewees for this dimension are explained in the Figure 3.3, page 73. Each of those concepts is detailed below.

To gain and maintain the airport community engagement to the project objectives, an efficient communication with them and the project team is fundamental, especially considering the complexity of the airport environment and its multiple actors. For example, when reporting the pace of execution of project activities or presenting a design solution for some construction issue, everyone involved should get the same understanding about the information being communicated to be able to align ideas and solutions.

Relevant Aspect: Information



The quality information can be analyzed through its *"pertinence"*[52] [Client side]. *"C'est donner l'information précise"*[53] [Client side] *"au bon moment"*[54] [Director level]. It is important *"de savoir ce qui est important de fournir comme information à cette personne-là, car tu as différents auditoires, tu as la direction, la haute direction, les gens à l'extérieur, les compagnies aériennes. Donc ton message ne peut pas être le même pour tous"*[55] [Delivery level]. To get this precise information, it is important *"d'aller chercher toutes les contributions (inputs) des différents stakeholders, d'avoir une bonne écoute et la sensibilité pour fournir la bonne information"*[56] [Director level].

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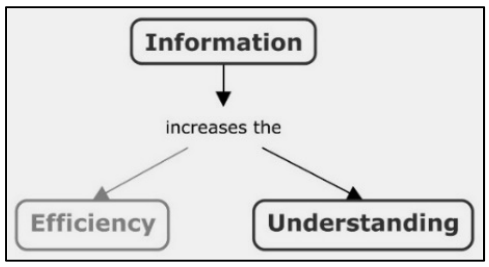
[52] *"Relevance"* [Client side]
[53] *"It is giving accurate information."* [Client side]
[54] *"In the good moment".* [Director level]
[55] *"To know what is important to provide information to this person, because you have different audiences, you have the direction, the senior management, the people outside, the airlines. So, your message cannot be the same for everyone."* [Delivery level]
[56] *"To get all the inputs from the different stakeholders, to have a good listening and sensitivity to provide the right information."* [Director level]

These aspects of what a good quality of information is to improve the efficiency of the communication process. *"It's not a technical thing, it's a leveraging of communication, a clear communication to extract early flags that you wouldn't get otherwise, questions that you wouldn't get otherwise"* [Director level]. If the communication process is clear enough, it will stimulate the willingness to participate in the process, promoting a productive sharing information, avoiding misunderstanding and unclear points over the project that could raise conflicts in the following project phases.

Moreover, a clear communication process brings a significant benefice to the project as *"obtenir de l'information qui permette de prendre des décisions"*[57] [Delivery level]. Thus, establishing a precise communication process by sharing the good information is essential to the project achievement, because it will impact the *"prise de décision, l'exécution du projet, le respect de la date de fin, donc l'échéancier du projet"*[58] [Director level]. The needed information on the right moment means to make better decisions. It also means the specific information needed for each decision-making process, considering the person or group that will use it in the process.

Relevant Aspect: Understanding



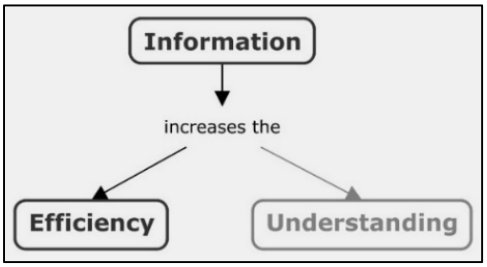
Likewise, so important than give the right information is its understanding. *"Il y a beaucoup de perceptions différentes sur les informations qu'on communique, donc il faut s'assurer que*

[57] *"Obtain information to make decisions."* [Delivery level]
[58] *"... decision-making, project execution, respect of the end date, so the project schedule."* [Director level]

les gens ont compris parce que parfois les gens les interprètent mal"[59] [Delivery level] in very different ways. It is why *"il faut s'assurer que l'information soit non seulement transmise, mais bien comprise"*[60] [Director level].

"Il ne faut pas donner trop de détails, il ne faut pas entrer les micro détails, mais juste donner les détails importants et essentiels pour que les gens sortent de la réunion avec la même vision du projet"[61] [Client side]. Just when stakeholders truly understand the project propositions they can feel confident in participating in the discussions. By contributing they will improve not just their own knowledge about the project propositions, but also the overall comprehension, forcing the project team to complete the gaps of information or clarifying any point that reminds unclear. This is a virtual cycle that improve the quality of information and the efficiency of the project process itself.

Relevant Aspect: Efficiency



On this complex and fast pace environment, sharing the right information is fundamental to the project success and *"la qualité de cette information est primordiale, c'est ce qui fait le succès du projet"*[62] [Delivery level]. *"La qualité ... de la communication c'est la base, c'est*

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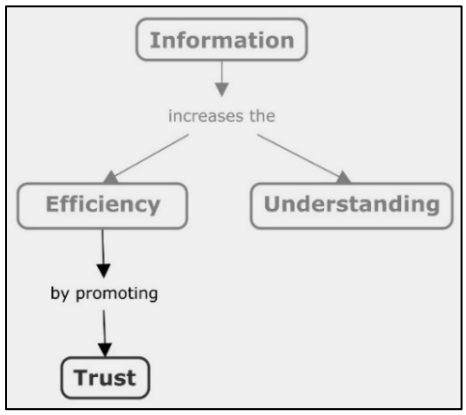
[59] *"There are a lot of different perceptions about what information is being communicated, so you have to make sure people understand because sometimes people misunderstand them."* [Delivery level]
[60] *"To ensure that information is not only transmitted but understood."* [Director level]
[61] *"Do not give too much detail, do not enter the micro details, but just give the important and essential details so that people come out of the meeting with the same vision of the project."* [Client side]
[62] *"The quality of information is primordial, it is what is done the success of it."* [Delivery level]

très pertinent"[63] [Delivery level] and it is why *"il faut partager l'information toujours et il faut la donner clairement"*[64] [Director level].

Relevant aspect: Trust



The efficiency of the communication process is linked to the quality of information being used in the process. However, *"si la confiance est perdue entre la partie prenante et toi, ce sera difficile et long à regagner"*[65] [Director level], impacting the communication process efficiency. *"Sans qualité de l'information il n'y a pas de confiance dans l'information. Tout ça est relié car le manque de qualité va entrainer un manque de confiance dans l'information, et il y aura un manque de confiance entre les entreprises qui travaillent ensemble, donc ça réduira la collaboration entre elles"*[66] [Delivery level]. Without quality information, there is no trust in it, which leads to no collaboration between all involved.

Thus, the quality of information is primordial because without it there is not trust on the information. *"C'est essentiel d'avoir une information de qualité, et ce peu importe le mode (type) de communication, l'information communiquée doit être claire, de qualité et*

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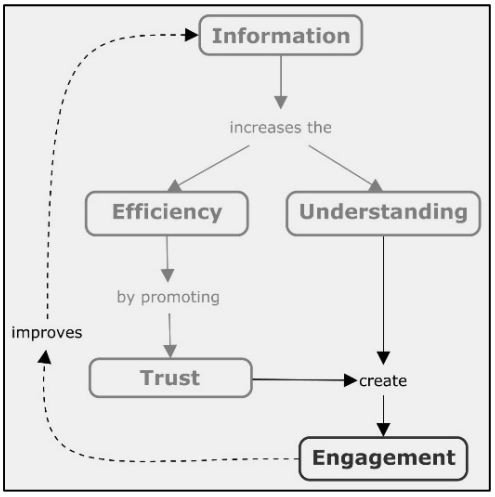
[63] *"The quality ... of the communication is the base, it is very relevant".* [Delivery level]
[64] *"It's fundamental to share the information in clarity and precisely way."* [Director level]
[65] *" If the trust is lost between the stakeholder and you, it will be difficult and slow to regain."* [Director level]
[66] *"Without quality of information there is no confidence in the information. All of this is connected because the lack of quality will cause a lack of trust in the information, and there will be a lack of trust between the companies that work together, so it will reduce the collaboration between them."* [Delivery level]

véridique"[67] [Delivery level]. More than that, there should be just a *"single source of truth"* [Delivery level], where the exchange information among the project team could happen in a safer way which can *"augmente le niveau de confiance des échanges d'informations"*[68] [Delivery level]. Then, *"la confiance se développe aussi pendant l'exécution du projet, quand petit à petit tu es capable de garder le contrôle des coûts, de livrer le projet tel que prévu. A ce moment-là, le niveau de confiance augmentera si tu es capable de gérer les imprévus et qu'il n'y a pas de surprises"*[69] [Director level].

The Effects of the Relevant Aspects of Quality Information



"Si les informations que tu communiques aux parties prenantes sont non pertinentes, elles n'adhéreront pas au projet et la confiance entre vous sera affectée"[70] [Director level] to the project activities. Then, there is *"pas d'engagement, s'il n'y a pas de confiance*"[71] [Delivery level], which provide a poor collaborative environment. Otherwise, with trust on the

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[67] "*It is essential to have quality information, regardless of the mode (type) of communication, the information communicated must be clear, of quality and truthful."* [Delivery level]
[68] *"It increases the level of trust in information exchanges."* [Delivery level]
[69] *"The trust also develops during the execution of the project, when little by little you are able to keep control of costs, to deliver the project as planned. At that time, the confidence level will increase if you are able to handle the unexpected and there are no surprises."* [Director level]
[70] *"If the information you provide to stakeholders is irrelevant, they will not stick to the project and trust between you will be affected."* [Director level]
[71] *"... no engagement, if there is no trust."* [Delivery level]

documents, those involved on the communication process based on this trustworthy documentation will be more willing to engage on the project activities and the collaborative environment will thrive. More than that, with trust comes *"plus de liberté, c'est-à-dire une liberté de choix de prendre tes décisions, donc il y a moins d'ingérence sur le projet"*[72] [Director level] and its activities can follow the planning pace. *"Il faut que l'équipe du projet parle avec toute cette communauté-là, il faut que ce soit une communication efficace, une communication de qualité ... mais une communication interactive, avec un meilleur feedback, un meilleur suivi"*[73] [Delivery level]. With good communication process comes a virtual cycle that can raise the stakeholders' engagement on the project activities. With more engagement, they will be willing to collaborate, which means they will actively participate asking the questions they should ask, increasing the overall understanding of the project propositions. With better knowledge, the project team can clarify any unclear points on the project that could provoke problems during the execution or on the clients' requirement meeting, which has a direct impact over the project success.

Table 3.6 summarizes the evidences extracted from the interviews.

Table 3.6 Evidences for the relevance of quality information[74]

DIMENSION 2 - PART 1: What is the relevance of quality information on the communication process?			
Categories	**ID**	**Evidences**	
Understanding	7	15'13"	*"Il y a beaucoup de perceptions différentes sur les informations qu'on communique, donc il faut s'assurer que les gens ont compris parce que parfois les gens les interprètent mal."*
	1	36'37"	*"Il faut s'assurer que l'information soit non seulement transmise, mais bien comprise".*

[72] *"More freedom, that is, freedom of choice to make decisions, so there is less interference with the project."* [Director level]

[73] *"The project team must speak with this whole community, it must be an effective communication, a quality communication ... but an interactive communication, with better feedback, better follow-up."* [Delivery level]

[74] On this table is possible to observe extracts from the interviews demonstrating each interviewee contribution to the findings for this discussion. Also, it is indicated where the evidence can be found on the interview audios and the category to which evidence was categorized. These categories and their interconnections can be seen also on the Figure 3.3, page 73.

Table 3.6 Evidences for the relevance of quality information (Continuation)

DIMENSION 2 - PART 1: What is the relevance of quality information on the communication process?			
Categories	**ID**	**Evidences**	
Understanding	8	16'02"	*"Il ne faut pas donner trop de détails, il ne faut pas entrer dans des micro détails, mais juste donner les détails importants et essentiels pour que les gens sortent de la réunion avec la même vision du projet."*
Efficiency	2	29'31"	*"Oui je crois que la qualité de cette information est primordiale, c'est ce qui fait le succès du projet".*
	4	26'57"	*"La qualité ... de la communication c'est la base, c'est très pertinent".*
	1	31'06"	*"Il faut partager l'information toujours et il faut la communiquer clairement".*
Information	8	16'02"	*"Il ne faut pas donner trop de détails, il ne faut pas entrer dans des micro détails, mais juste donner les détails importants et essentiels pour que les gens sortent de la réunion avec la même vision du projet."*
	11	19'07"	*"La qualité et la pertinence c'est important."*
	8	15'34"	*"La qualité de l'information c'est donner une information précise. "*
	6	24'50"	*T: C'est la bonne information au bon moment?* *I: "Exactement."*
	10	10'22"	*"De savoir ce qui est important de fournir comme information pour cette personne-là ... car tu as différents auditoires, tu as la direction, la haute direction, les gens à l'extérieur, les compagnies aériennes, ton message ne peut pas être le même pour tous."*
	13	27'35"	*"D'aller chercher toutes les contributions (inputs) de différents stakeholders, d'avoir une bonne écoute et la sensibilité pour fournir la bonne information."*
	3	32'47"	*"It's not a technical thing, it's a leveraging of communication, a clear communication to extract early flags that you wouldn't get otherwise, questions that you wouldn't get otherwise".*
	2	34'50"	*"Obtenir l'information qui me permet de prendre des décisions, en ce moment on n'a pas d'information qui me permette de prendre des décisions, c'est ça qui manque".*
	1	35'40"	T: La qualité aura un impact sur l'exécution du projet ou sur la prise de décision? "*I: prise de décision, exécution du projet, respecter la date de fin".*
Trust	6	19"59"	*"Si la confiance est perdue entre la partie prenante et toi, ce sera difficile et long à regagner."*
	2	29'40"	*"Sans qualité de l'information il n'y a pas de confiance dans l'information. Tout ça est relié car le manque de qualité va entrainer un manque de confiance dans l'information."*
	2	26'07"	*"La qualité de l'information il faut qu'elle soit là, peu importe le mode de communication, il faut qu'elle soit de qualité, claire et véridique"*
	2	26'40"	*"D'avoir un single source of truth".*
	2	29'16"	*"Moi, personnellement, comme représentant du client, ça augmente un peu le niveau de confiance les échanges d'informations qu'on a eus."*
	13	30'44"	*"La confiance se développe aussi pendant l'exécution du projet, quand petit à petit tu es capable de garder le contrôle des coûts, de livrer le projet tel que prévu. A ce moment-là, le niveau de confiance augmentera si tu es capable de gérer les imprévus et qu'il n'y a pas de surprises"*

Table 3.6 Evidences for the relevance of quality information (Continuation)

DIMENSION 2 - PART 1: What is the relevance of quality information on the communication process?			
Categories	**ID**	**Evidences**	
Engagement	6	17'13"	*"Si les informations que tu communiques aux parties prenantes sont non pertinentes, elles n'adhéreront pas au projet et la confiance entre vous sera affectée"*
	2	29'59"	*T: Donc, pas d'engagement? I: "Exactement, pas d'engagement, s'il n'y a pas de confiance".*
	13	30'44"	*"More freedom, freedom of choice, make your decisions, there is less interference on the project."*
	5	30'50"	*"Il faut que l'équipe du projet parle avec toute cette communauté-là, il faut que ça soit une communication efficace, une communication de qualité ... mais une communication interactive avec un meilleur feedback, un meilleur suivi".*

3.2.2 The 3D visualisation impacts on the communication process

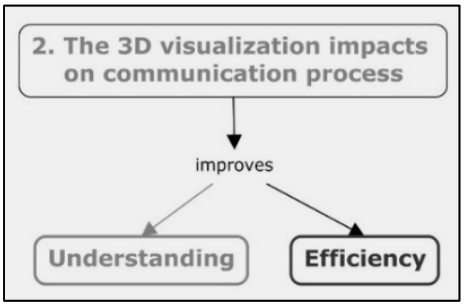
Table 3.7 summarizes the relevance of quality information concepts most cited by the interviewees and each respective category.

Table 3.7 The 3D visualization impacts to the communication process

Categories	Definition
Efficiency	It increases the efficiency of the project processes.
Understanding	It improves the design understanding.
Information	It provides the information sharing.
Trust	It confers confidence to the data.
Experience	It lows the effects of the lack of experience.

The 3D visualization impacts to the communication process were selected considering the most important concept being used by the interviewees to express their ideas. Despite referring to more than one category, every answer was categorized in that one most relevant. The interconnections from all categories used to synthesize the answer to this question are explained in Figure 3.3, page 73. Each of these impacts are detailed below.

Impact: Efficiency



Presenting information in 3D visualization is a way to improve the communication process. It would be *"plus efficace"*[75] [Director level, Delivery level] because *"...avoir le 3D augmente énormément la qualité de l'information, la coordination entre les disciplines"*[76] [Delivery level] and *"donc quand il y a une décision à prendre, avec la modélisation BIM, tu es capable de convaincre les gens plus rapidement avec un matériau de plus haute qualité"*[77] [Delivery level]. Also, there is an impact *"même pour le coût, c'est possible économiser beaucoup avec la maquette, beaucoup de temps et beaucoup d'argent"*[78] [Delivery level]. It will make the project *"gagner du temps"*[79] [Delivery level] because the decisions will be faster. With faster and assertive decisions, fewer problems ate the execution phase, which will also save time. With better decisions and fewer errors, the project will save money.

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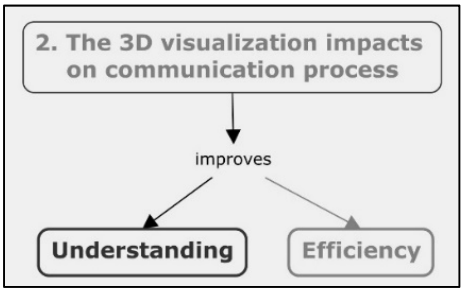
[75] *"More efficient."* [Director level]
[76] *"Having the 3D greatly increases the quality of information, the coordination between disciplines."* [Delivery level]
[77] *"So when there is a decision to make, with BIM modeling, you can convince people faster with higher-quality material."* [Delivery level]
[78] *"Even for the cost, it is possible to save a lot with the model, a lot of time and a lot of money."* [Delivery level]
[79] *"Save time."* [Delivery level]

Impact: Understanding



The alignment of understanding is due to *"l'aspect visual, car tout le monde comprendre le 3D"*[80] [Delivery level], because it is *"un outil qui est simple à comprendre, qui est parlant, qui est communicant pour des personnes qui ne sont pas habituées à la construction, c'est vraiment un gros plus"*[81] [Director level]. By using it, they will have *"vraiment une meilleure compréhension"*[82] [Director level], instantly increasing their understanding about the project prepositions, lowering the effects of their inexperience on construction industry.

"Avec le BIM, le Revit, les gens comprennent beaucoup mieux"[83] [Director level]. BIM is the common language that brings transparency to the process. It allows the right information to be presented to the right group of stakeholders because *"ça permet de montrer plus rapidement aux parties prenantes de quoi on parle"*[84] [Delivery level]. *"Il faut trouver le langage commun et avec BIM en général ... les gens voient, les gens comprennent et c'est ça la grande qualité d'un produit comme le BIM"*[85] [Director level], providing the right information that allows to make decisions. Also, the use of 3D visualization represents *"la meilleure compréhension du projet, un meilleur transfert des besoins du client versus la conception, vers la construction"*[86]

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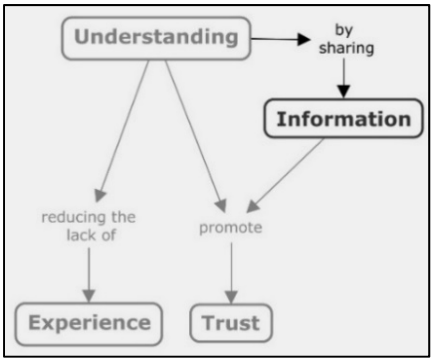
[80] *"The visual aspect ... everyone understands 3D*". [Delivery level]
[81] *"A tool that is simple to understand, that speaks, that is communicating for people who are not accustomed to building, it's really a big plus."* [Director level]
[82] *"Really a better understanding."* [Director level]
[83] *"With BIM, with Revit, people have a much better comprehension."* [Director level]
[84] *" It allows to show faster to stakeholders what we are talking about."* [Delivery level]
[85] *"We have to find common language and with BIM in general ... people see, people understand and that's the great quality of a product like BIM."* [Director level]
[86] *"It's the best understanding of the project, a better transfer of client requirements versus design, towards construction".* [Delivery level]

[Delivery level] because *"BIM c'est un langage commun, les gens voient tous la même information"*[87] [Director level], increasing the efficiency of the communication processes and the chances of project success by better meeting the clients' requirements. Thus, *"l'aspect 3D, l'aspect visuel a apporté quelque chose de plus tangible aux différents intervenants dans un projet ... ça les aide à faire des meilleurs commentaires, à prendre de meilleures décisions pour bien comprendre le projet"*[88] [Delivery level].

Impact: Information



When the stakeholders are exposed to the information in 3D visualization, improving their understanding, *"the consequence of that is having some of the stakeholders ... asking questions they wouldn't ask otherwise"* [Director level]. By being encouraged to ask more about the points unclear for them, they stimulate the sharing, improving the project comprehension for all, not just them, but the project team itself, that must better formulate their explanations, improving their understanding about the subjects, what increase the quality of the project and decrease possible changes during the construction because *"a question asked earlier is way better than a question asked late"* [Director level]. Having a better understanding through the ability to make the right questions, stakeholders help grows the quality of communication process enlightening those aspects that were not totally clear.

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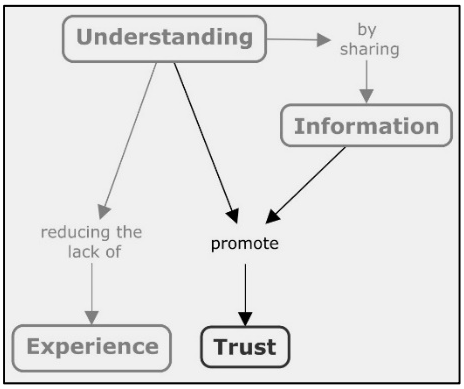
[87] *"BIM is a common language, people see all the same information."* [Director level]
[88] *"The 3D aspect, the visual aspect has brought something more tangible to the various stakeholders in a project ... it helps them to make better comments, to make better decisions to fully understand the project".* [Delivery level]

With more detailed information comes another aspect to the quality information that the 3D visualization brings: the information availability. *"La maquette dans la plateforme web est disponible pour tous et elle reste archivée également. C'est merveilleux parce que ça donne accès immédiatement à l'information"*[89] [Delivery level] et *"un outil commun que tous peuvent lire en tout temps. De cette façon, personne n'a l'impression qu'on garde de l'information"*[90] [Director level]. More than that, *"la qualité de l'information avec le 3D c'est mieux, c'est plus tangible, c'est plus concret qu'avec le plan papier"*[91] [Delivery level]. This transparency and availability of information have the trustworthy information which impact positively the communication process. The information is available to everyone involved in the project to check, to verify, to analyze and approve.

Impact: Trust



By lightening the unclear points and aligning the understanding building a common language to analyze the project, the quality of this information is increased, improving the overall trust on it. The use of 3D visualization *"augmente le niveau de confiance, le sentiment de contrôle du projet"*[92] [Director level]. If you lose the trust on your data, you work at least twice to

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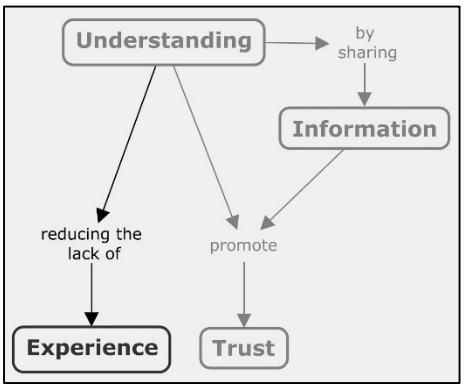
[89] *"The model in the web platform is available to all and it remains archived as well. It's wonderful because it gives immediate access to information."* [Delivery level]
[90] *"It's a common tool that everyone can read at any time. In this way, no one has the impression that we keep information."* [Director level]
[91] *"The quality of information with 3D is better, it is more tangible, it is more concrete than with the paper plan."* [Delivery level]
[92] *"Increases the level of trust, the sense of control of the project."* [Director level]

validate it. *"Si on n'a pas confiance, on n'a pas d'argent, on n'a pas du temps"*[93] [Delivery level]. With a trustworthy information, the quality of the communication process gain efficiency, improving the chances of project success.

Impact: Experience



Client stakeholders usually are not used to construction and the traditional techniques to develop engineering projects are, in certain circumstances, usefulness to communicate with them. Even the project team, the design or the construction team could have difficulties when reading the information in 2D drawings. *"Ce n'est pas simple de lire un plan 2D, mais en faisant du 3D, la compréhension devient plus tangible, même pour quelqu'un qui n'est pas habitué en construction"*[94] [Delivery level].

When stakeholders feel encouraged by better understanding what is being discussed, they ask more questions, sharing and getting answers that decrease their lack of experience on constructions. Thus, the 3D visualization *"aide énormément, parce que les personnes qui sont là ne sont pas des chargés de projet, ne sont pas habituées de faire de la construction"*[95] [Delivery level] and with the 3D visualization *"les gens peuvent visualiser, il n'y a pas*

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[93] *"If there is no trust on the information, there is no money, there is no time."* [Delivery level]
[94] *"It's not easy to read a 2D plan, but by doing 3D, understanding becomes more tangible, even for someone who is not used to building."* [Delivery level]
[95] *"It helps a lot, because the people who are there are not project managers, are not used to doing construction."* [Delivery level]

beaucoup de gens qui sont capables de visualiser mentalement quelque chose en 2D"[96] [Delivery level] and with the 3D visualization they have *"la chance de « vivre» le bâtiment, de mieux le percevoir avant qu'il soit construit, comme s'ils y étaient"*[97] [Delivery level].

"Il y a beaucoup de gens qui ne sont pas capables de lire des plans, donc avec l'information 3D ils ont une meilleure information"[98] [Delivery level] because it is a format that better communicate with all interlocutors. *"Il faut entrer dans un certain niveau de détails pour que les gens comprennent mieux le projet, parce qu´il y a des gens qui vont capter le projet beaucoup plus vite que les autres"*[99] [Client side]. Thus, *"la qualité de l'information doit être adaptée selon la personne à qui elle s'adresse, car l'information n'a pas la même importance pour tous, et surtout il n'est pas nécessaire qu'elle ait le même niveau de profondeur et d'expertise"*[100] [Director level]. In this perspective the utilization of 3D visualization format can create the universal understanding, lowering the different levels of expertise in all domains.

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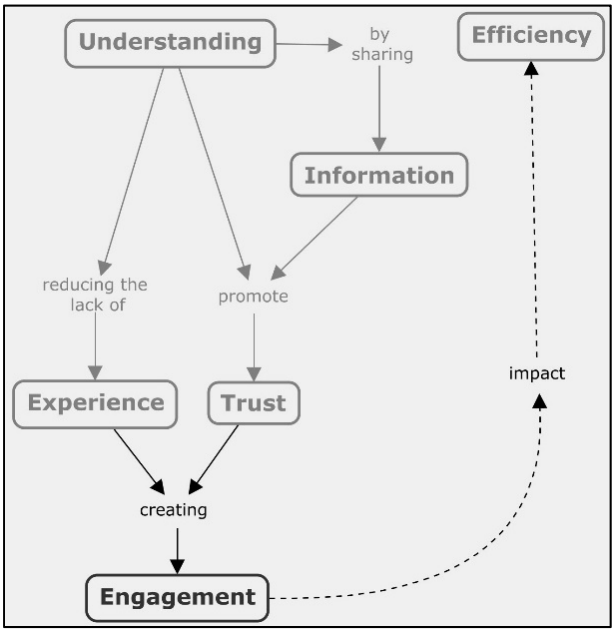
[96] *"People can visualize, there are not many people who are able to mentally visualize something in 2D."* [Delivery level]
[97] *"The chance to "live" the building, to better perceive it before it is built, as if they were there."* [Delivery level]
[98] *"There are many people who are not able to read plans, so with 3D information they have better information."* [Delivery level]
[99] *"You have to go into a certain level of detail so that people understand the project better, because there are people who will capture the project much faster than the others."* [Client side]
[100] *"The quality of the information must be adapted according to the person to whom it is addressed, because the information does not have the same importance for all, and especially it is not necessary that it has the same level of depth and expertise."* [Director level]

The Effects of 3D Visualization Impacts



The use of 3D visualization can impact the efficiency of project processes by bringing agility and assertiveness to the decision-making process. The increase on understanding will be achieved through sharing information on this easily comprehensive format, which can reduce the lack of experience and promote trust on that information. When all involved can see themselves as being part of the project, participating actively of its process due to a better comprehension and trusting on the information being communicated and used to make decisions, they engage on these decisions more easily and more consistently, improving the efficiency of the process itself.

Table 3.8 summarizes the evidence extracted from the interviews.

Table 3.8 Evidences for the 3D impacts on the communication process[101]

DIMENSION 2 - PART 2: What are the impacts on the communication process when using 3D visualization?			
Categories	**ID**	**Evidences**	
Efficiency	11	28'16"	T: Donc, penses-tu que la communication va être plus efficace? I: *Oui.*
	4	30'04"	*"C'est beaucoup plus efficace et rapide."*
	2	31'52"	*"Avoir le 3D augmente énormément la qualité de l'information ... la coordination entre les disciplines".*
	10	12'24"	*"Donc quand il y a une décision à prendre, avec la modélisation BIM, tu es capable de convaincre plus rapidement les gens avec un matériau de plus haute qualité."*
	7	21"12"	*"Même pour le coût, c'est possible économiser beaucoup avec la maquette, beaucoup de temps et beaucoup d'argent."*
	4	30"28"	*"On gagne du temps."*
Information	3	31'16"	*"The consequences of that is having some of the stakeholders ... asking questions they wouldn't ask otherwise".*
	3	33'08"	*"A question asked early is way better than a question asked late".*
	4	29'00"	*"La maquette dans la plateforme web est disponible pour tous et elle reste archivée également. C'est merveilleux parce que ça donne accès immédiatement à l'information."*
	6	20"54"	*"Un outil commun que tous peuvent lire en tout temps. De cette façon, personne n'a l'impression qu'on garde l'information."*
	7	27'20"	*"La qualité de l'information avec le 3D c'est mieux, c'est plus tangible, c'est plus concret qu'avec le plan papier."*
Trust	13	32'56"	*"On avait développé des petites applications pour être capable de naviguer avec des lunettes 3D, mais ça l'a plus servi pour nous les ingénieurs qu'à la direction, on avait fait des shows avec ça, et ça l'a permis d'augmenter le niveau de confiance.*
	2	34'32"	*"On perd confiance en nos données ... on fait, on travaille deux fois parce qu'on doit valider quelques modifications au projet, alors on perd de l'argent, on perd du temps, si on n'a pas confiance, on n'a pas d'argent, on n'a pas du temps".*

[101] On this table is possible to observe extracts from the interviews demonstrating each interviewee contribution to the findings for this discussion. Also, it is indicated where the evidence can be found on the interview audios and the category to which evidence was categorized. These categories and their interconnections can be seen also on the Figure 3.3, page 73.

Table 3.8 Evidences for the 3D impacts on the communication process (Continuation)

DIMENSION 2 - PART 2: What are the impacts on the communication process when using 3D visualization?			
Categories	**ID**	**Evidences**	
Efficiency	11	28'16"	T: Donc, penses-tu que la communication va être plus efficace? I: *Oui.*
	4	30'04"	*"C'est beaucoup plus efficace et rapide."*
	2	31'52"	*"Avoir le 3D augmente énormément la qualité de l'information ... la coordination entre les disciplines".*
	10	12'24"	*"Donc quand il y a une décision à prendre, avec la modélisation BIM, tu es capable de convaincre plus rapidement les gens avec un matériau de plus haute qualité."*
	7	21"12"	*"Même pour le coût, c'est possible économiser beaucoup avec la maquette, beaucoup de temps et beaucoup d'argent."*
	4	30"28"	*"On gagne du temps."*
Experience	2	30'50"	*"Ce n'est pas simple de lire un plan 2D, mais en faisant du 3D la compréhension devient tangible, même pour quelqu'un qui n'est pas habitué en construction".*
	2	30'10"	T: Quand on ajoute la visualisation 3D, qu'est-ce que tu penses que sont les impacts sur les parties prenantes du côté clients ? *I: "Je crois que ça aide énormément, parce que les personnes qui sont là ne sont pas des chargés de projet, ne sont pas habituées de faire la construction".*
	4	31'16"	T: tu penses qu'avoir l'information sur cette plateforme a un impact sur la gestion des parties prenantes? *I: "C'est sûr que ça va bien ... les gens peuvent visualiser, il n'y a pas beaucoup de gens qui sont capables de visualiser mentalement quelque chose 2D en 3D".*
	7	18'20"	*"Ils avaient la chance de «vivre» le bâtiment, de mieux le percevoir avant que soit construit, comme s'ils y étaient."*
	7	18'56"	*"Il y a beaucoup de gens qui ne sont pas capables de lire des plans, donc avec l'information on 3D ils ont une meilleure information"*
	8	16'37"	*"Il faut entrer dans un certain niveau de détails pour que les gens comprennent mieux le projet, parce qu´il y a des gens qui vont capter le projet beaucoup plus vite que les autres."*
	12	11'37"	*"La qualité de l'information doit être adaptée selon la personne à qui elle s'adresse, car l'information n'a pas la même importance, et surtout il n'est pas nécessaire qu'elle ait le même niveau de profondeur et d'expertise."*

3.2.3 Dimension 2 discussion

The interviewees were asked to answer two questions:

- Question 1: what is the relevance of quality information to the communication process?
- Question 2: what are the impacts of the 3D visualization over the communication process?

Figure 3.4 shows answers' classification that embrace just the main idea for each answer.

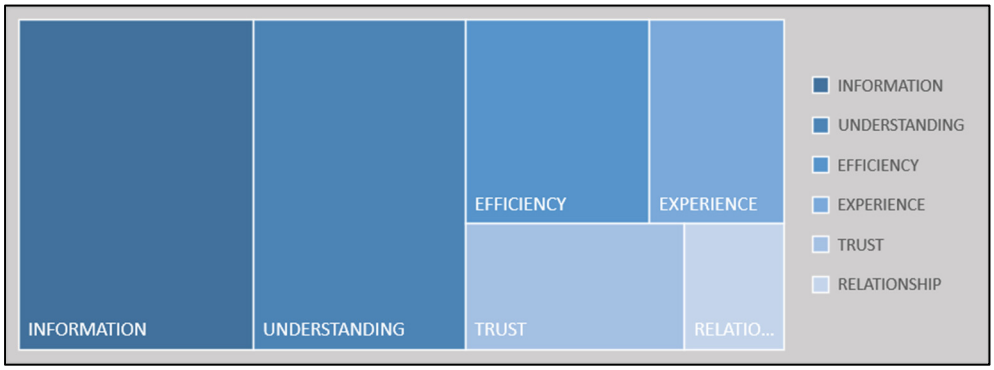


Figure 3.4 Categories emphasized on Dimension 2' answers

When considering just the principal idea for every answer, it is possible to observe the relevance of "Information", "Understanding", "Efficiency", "Experience", "Trust" and "Relationships" concepts have over the answers related to the communication process. All those concepts can be linked directly to the information being transmitted, being its characteristics very significant to the process and correlated to the understanding of what is being communicated.

An interesting aspect of the first question answers is that the interviewees more than answer what the relevance of the quality information is, which means, why it is important to have good quality information, they focus on how a quality information is, its characteristics. Maybe the reasons for this skip from the question focus could be similar to why they didn't talk about conflicts on the first question of Dimension 1, subsection 3.1.1, page 56. If they are going to say why it is important to have a good quality information, they will probably refer to problems they encounter on the project, a subject that they are more likely to avoid.

Furthermore, with better understanding comes a stronger level of engagement. With engagement comes a more collaborative environment where the actors share more information, improving its process. It is a significant virtuous cycle that helps the project achieve its goals due to the application of the main strategy to manage stakeholders (subsection 3.1.2, page 62), which is gathered their engagement.

3.3 Dimension 3 – Decision-making Process

It is discussed on this dimension the challenges to engage stakeholders on the decision-making process and the impacts that providing 3D visualization to the project propositions will have on this engagement. Figure 3.5 shows the interconnections amongst the most relevant categories extracted from the interviewees' answers.

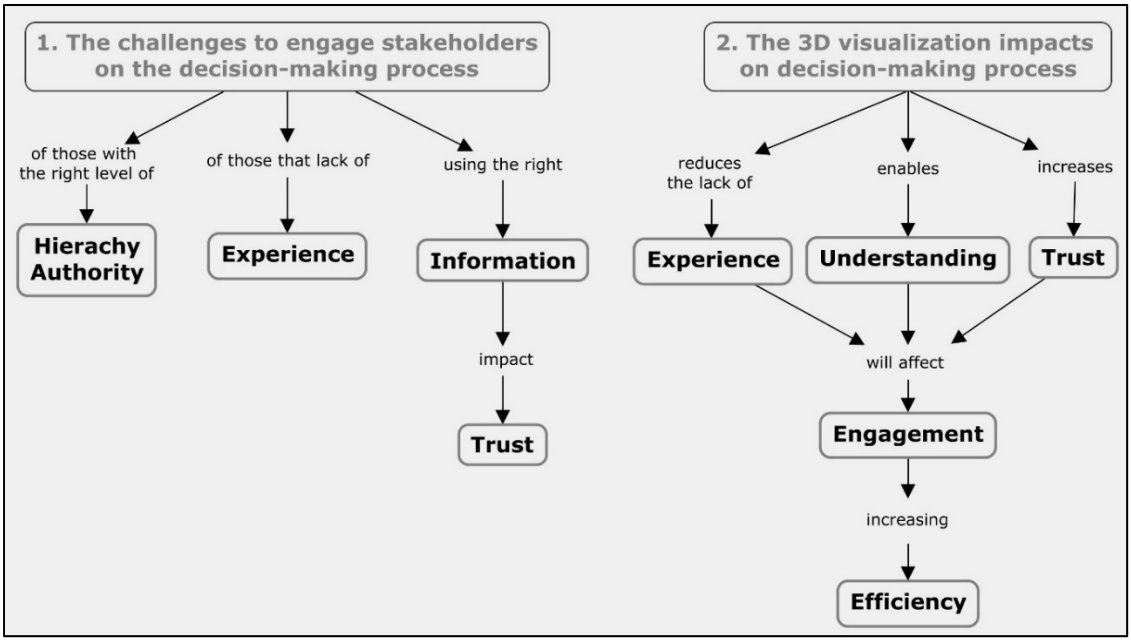


Figure 3.5 Relationships between the categories emphasized on Dimension 3

The conceptual map above segregates the categories for each question related to this dimension:

- Question 1: what are the challenges to engage stakeholders in the decision-making process?
- Question 2: what are the 3D visualization impacts to engage stakeholders in the decision-making process?

The interviewees stated that the challenges to engage stakeholders on the decision-making process – question 1 – were the level of the hierarchy/authority of those involved in the process, their lack of experience on the domains (mainly construction) and the use of the right

information, which impact the level of experience, as can also increase trustful relationships among all involved and to the documents being generated.

From the interviewees' perspective, the 3D visualization can reduce the lack of experience on the domains (airport and construction), it enables a better understanding of the subject being discussed, and it increases the level of trust on the information being given. Those three concepts will affect the stakeholders' engagement, which can increase the efficiency of the decision-making process.

Those concepts and their connections are discussed in the following sections.

3.3.1 The challenges engaging stakeholders on the decision-making process

Table 3.9 summarizes the most relevant challenges to engage stakeholders on the decision-making process cited by the interviewees and each respective category.

Table 3.9 The challenges to engage stakeholders on the decision-making process

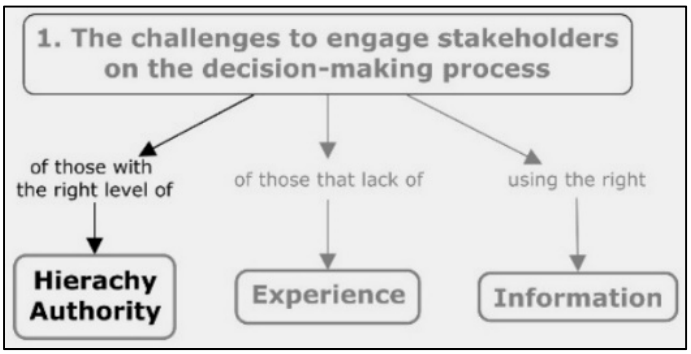
Categories	Definition
Hierarchy / Authority	To have on board those with the right level of hierarchy/authority to make decisions.
Experience	To have on board those without expertise in construction endeavors.
Information	To use the right information.
Trust	To establish a trustworthy relationship.

The challenges to engage stakeholders to the decision-making process were selected considering the most important concept being used by the interviewees to express their ideas. Despite referring to more than one category, every answer was categorized in that one the most relevant. The interconnections from all categories used to synthesize the answers to this question are explained in the Figure 3.5, page 92. Each of those concepts is detailed below.

Airports need to get an efficient and effective decision-making process due to its complex and fast pace environment. When conducting an engineering project to improve its infrastructure, *"souvent, les parties prenantes (stakeholders) ont des intérêts différents par rapport au projet*

et ça complique la prise de décisions"[102] [Director level], making difficult to follow the project planned activities on its own pace. It is why an improved decision-making process is so important in this kind of project.

Challenge: Hierarchy / Authority



"Souvent, la grande difficulté c'est qu'il y a toujours un patron du patron et quand une décision est prise, elle n'est pas nécessairement la meilleure décision pour le projet"[103] [Director level]. To pursue the best decision-making process possible, it is fundamental *"d'avoir du monde qui sera imputable directement par rapport à leurs décisions, et qui a l'autorité de prendre des décisions"*[104] [Delivery level]. This also means *"d'avoir des rôles et des responsabilités qui soient claires dès le départ. De s'assurer que tout le monde comprend bien les rôles et les responsabilités de chacun est essentiel, parce que ça aura un impact majeur sur le chantier"*[105] [Director level].

One of the aspects related to having the right one involved in the decision-making process with the authority to make decisions is due to common practice of having *"les rôles et les*

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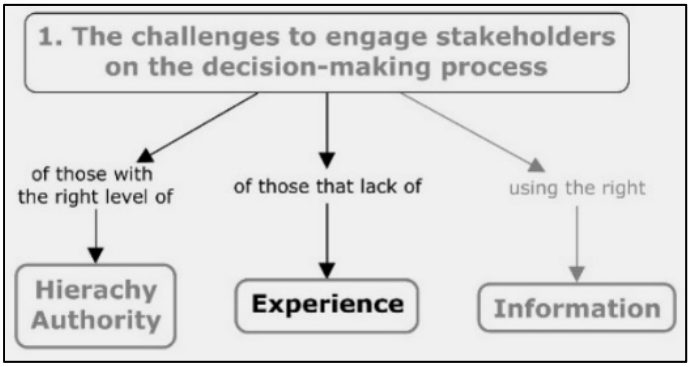
[102] *"Often, stakeholders have different interests in the project and it complicates the decision-making process."* [Director level]
[103] *"Often, the great difficulty is that there is always a boss of the boss and when a decision is made, it is not necessarily the best decision for the project."* [Director level]
[104] *"To have people who will be directly accountable for their decisions, and who have the authority to make decisions."* [Delivery level]
[105] *"Have roles and responsibilities that are clear from the start. Ensuring everyone understands everyone's roles and responsibilities is essential because it will have a major impact on the job site."* [Director level]

responsabilités bien définis dès le départ, mais le pouvoir décisionnel revient toujours à la personne qui a la plus haute hiérarchie dans le projet"[106] [Client side]. *"C'est sûr que si tu impliques tout le monde tout le temps dans toutes les décisions, tu n'avanceras jamais. Tu as une hiérarchie à respecter"*[107] [Delivery level]. Thus, *"il ne faut pas impliquer tout le monde. C'est important bien choisir la meilleure partie prenante, la plus pertinente"*[108] [Client side].

Challenge: Experience



Another challenge is having those not used to the construction industry directly responsible for project decisions as clients. It is normal to them to have the thinking that if they gave their requirement in the beginning, they will receive exactly that on the end – they don't assume that it will occur changing during the all project phases and they are not prepared for the unexpected during the project execution. *"Celui qui est moins habitué en construction, je pense que c'est facile pour lui de penser quand tu n'es pas habitué en construction, de croire que j'ai dit mes besoins au début, donc c'est ça que je vais avoir à la fin, ils ne comprennent pas qu'il y a tellement d'impondérables qui font en sorte que ça va complètement changer"*[109] [Delivery

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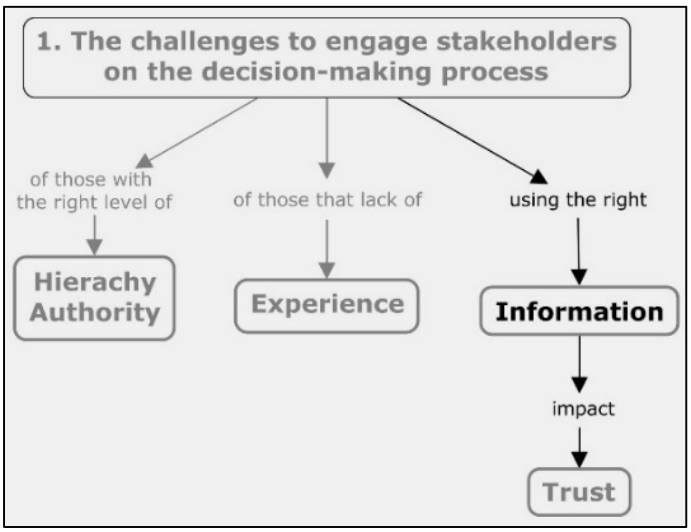
[106] *"… clearly defined roles and responsibilities from the start, but decision-making power always comes back to the person with the highest hierarchy in the project."* [Client side]
[107] *"Of course, if you involve everyone all the time in all decisions, you will never advance. You have a hierarchy to respect."* [Delivery level]
[108] *"We must not involve everyone. It's important to choose the best stakeholder, the most relevant."* [Client side]
[109] *"Whoever is less used to building, I think it's easy for him to think when you're not used to building, to believe that I said my requirements at the beginning, so that's what I'm going to have in the end, they do not understand that there are so many imponderables that make it completely change."* [Delivery level]

level]. Without this previous knowledge, they feel insecure and uncomfortable to make decision, making difficult to engage them in the process.

Considering the information of engineering-related decision, *"le plan 2D, ça n'explique rien à personne"*[110] [Director level] and it doesn't say much to those that are not normally involved on engineering projects. So, using the good tools and the good communication process that truly communicate with all stakeholders is the key to minimize *"le défi d'avoir du monde habitué sur la construction, pis ce n'est pas le cas"*[111] [Delivery level] "*parce qu'ils* (client's stakeholders) *ne sont pas des experts, il faut le prendre en considération"*[112] [Delivery level].

Challenge: Information



To engage those not used to construction on the decision-making process, the information being used has also an important role. It should be used *"l'information qui est plus vulgarisée pour les gens qui ne sont pas dans le domaine de la construction. Il faut que l'information soit validée et bien intégrée par tout le monde"*[113] [Delivery level]. Also, *"d'avoir des parties*

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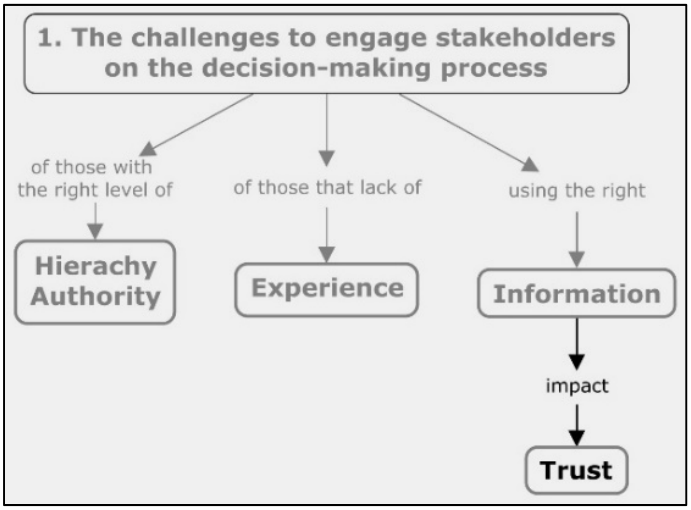
[110] *"The 2D drawings, it explains nothing to anyone."* [Director level]
[111] "The *challenge of having people used to building, and that's not the case."* [Delivery level]
[112] *"Because they (client's stakeholders) are not experts, you have to take it into consideration."* [Delivery level]
[113] *"Information that is more vulgarized for people who are not in the field of construction. The information needs to be validated and well integrated by everyone."* [Delivery level]

prenantes à la table qui nous donnent leurs contraintes nous aide à trouver la bonne information et à prendre la meilleure décision. Les décisions sont souvent plus faciles à prendre dans ce contexte-là"[114] [Client side], but it is not easy to get this kind of information. Then, the challenge is *"d'avoir l'information qui a une valeur, qui est vulgarisée, qui facilite la compréhension pour toutes les parties prenantes"*[115] [Delivery level].

Challenge: Trust



To have an assertive decision-making process, the trustful relationship between the project team and the stakeholders might be built considering that *"la confiance est très importante"*[116] [Director level]. The quality of information makes easier to build this trustful link because as soon as they can see the solutions, *"les gens comprennent, ils sont en confiance"*[117] [Director level]. The decisions made without truly understanding all the aspects being discussed can decrease the trust on that for both sides, stakeholders' client and project team. They will not be sure about what they had decided, and the project team will not be sure if when delivering

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[114] *"Having stakeholders at the table who give us their constraints helps us find the right information and make the best decision. Decisions are often easier to make in this context."* [Client side]
[115] *"To have information that has value, that is vulgarized, that facilitates understanding for all stakeholders."* [Delivery level]
[116] *"Trust is very important."* [Director level]
[117] *"People understand, they trust."* [Director level]

the project, the clients receive what they think they had demanded. This creates a distrusted environment that can undermine even the collaboration and impact significantly the project success.

Table 3.10 summarizes the evidence extracted from the interviews.

Table 3.10 Evidences for the challenges to engage stakeholders[118]

DIMENSION 3 - PART 1: What are the challenges to engage stakeholders on the decision-making process?			
Categories	**ID**		**Evidences**
Hierachy Authority	13	25'13"	*"Souvent, la grande difficulté c'est qu'il y a toujours un patron du patron et quand la décision est prise, elle n'est pas nécessairement la meilleure décision pour le projet"*
	2	36'16"	*"D'avoir du monde qui sera imputable directement par rapport aux décisions, d'avoir l'autorité de prendre des décisions, ce n'est pas toujours le cas".*
	6	30'38"	*"D'avoir des rôles et des responsabilités qui soient claires dès le départ. De s'assurer que tout le monde comprend bien les rôles et les responsabilités de chacun est essentiel, parce que ça aura un impact majeur sur le chantier."*
	9	36'06"	*"Les rôles et les responsabilités définis, mais le pouvoir décisionnel revient toujours à la personne qui a la plus haute hiérarchie dans le projet."*
	10	15'05"	*"C'est sûr que si tu impliques tout le monde tout le temps dans toutes les décisions, tu n'avanceras jamais. Tu as une hiérarchie à respecter".*
	11	29'59"	*"Il faut ne pas impliquer tout le monde. C'est important bien choisir la meilleure partie prenante, la plus pertinente."*
Experience	2	36'55"	*"Celui qui est moins habitué en construction, je pense que c'est facile pour lui de penser quand tu n'es pas habitué en construction, de croire que j'ai dit mes besoins au début, donc c'est ça que je vais avoir à la fin, ils ne comprennent pas qu'il y a tellement d'impondérables qui font en sorte que ça changera complètement le projet"*
	1	42'50"	*"Le plan 2D ça n'explique rien à personne".*
	2	36'04"	*"Le défi ... c'est d'avoir du monde habitué sur la construction, pis ce n'est pas le cas".*
	2	39'16"	*"Ils (stakeholders clients) sont pas des experts, il faut le prendre en considération".*
Trust	1	43'27"	*"La confiance c'est très important".*
	1	46'49"	*"Les gens comprennent, ils sont mis en confiance."*

[118] On this table is possible to observe extracts from the interviews demonstrating each interviewee contribution to the findings for this discussion. Also, it is indicated where the evidence can be found on the interview audios and the category to which evidence was categorized. These categories and their interconnections can be seen also on the Figure 3.5, page 92.

Table 3.10 Evidences for the challenges to engage stakeholders (Continuation)

DIMENSION 3 - PART 1: What are the challenges to engage stakeholders on the decision-making process?			
Categories	**ID**		**Evidences**
Information	5	45'49"	*"L'information qui est plus vulgarisée pour les gens qui ne sont pas dans le domaine de la construction. Il faut que l'information soit validée et bien intégrée par tout le monde."*
	9	34'20"	*"D'avoir des parties prenantes à la table qui nous donnent leurs contraintes nous aide à trouver la bonne information et à prendre la meilleure décision. Les décisions sont souvent plus faciles à prendre dans ce contexte-là."*
	5	46'02"	*"D'avoir l'information qui a une valeur, qui est vulgarisée, qui facilite la compréhension pour toutes les parties prenantes."*

3.3.2 The 3D visualization impacts engaging stakeholder on the decision-making process

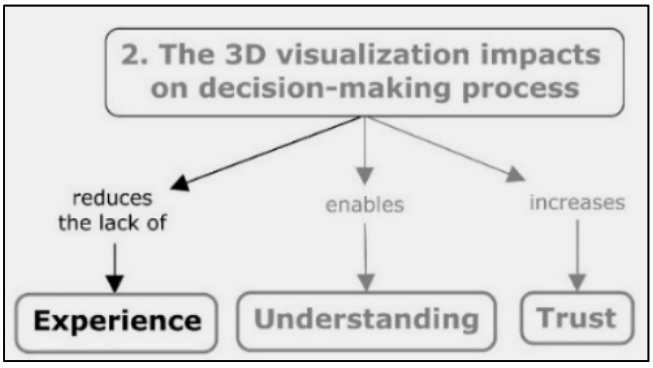
Table 3.11 summarizes the 3D visualization most relevant impacts to engage stakeholders on the decision-making process cited by the interviewees and each respective category.

Table 3.11 The 3D visualization impacts to engage stakeholders

Categories	Definition
Experience	It lows the effects of the lack of experience.
Understanding	It improves the design understanding.
Information	It allows sharing the good quality information.
Trust	It confers confidence to the data.
Efficiency	It increases the efficiency of the project processes.

The 3D impacts to engage stakeholders to the decision-making process were selected considering the most important concept being used by the interviewees to express their ideas. Despite referring to more than one category, every answer was categorized in the most relevant one. The interconnections from all categories used to synthesize the answers to this question are explained in Figure 3.5, page 93. Each of those concepts is detailed below.

Impact: Experience



"Le 3D nous permet de faire comprendre à des gens qui ne font pas des projets sur une base régulière. Il faut toujours recommencer à expliquer à nouveau, car les intervenants changent toujours, surtout dans le projet, il y a des nouveaux intervenants qui ne comprennent jamais c'est quoi ça"[119] [Delivery level]. Thus, *"les impacts du modèle 3D sont principalement positifs pour la compréhension du projet pour les personnes qui sont moins techniques, qui ont moins l'habitude de lire des plans"*[120] [Director level]. *"Il y a plusieurs personnes qui ne sont pas capables de visualiser des plans, la volumétrie, la grandeur"*[121] [Delivery level], thus *"c'est certain que d'avoir une image 3D c'est beaucoup plus facile à comprendre"*[122] [Director level]. *"La visualisation 3D permet aux gens de mieux percevoir la grandeur de l'espace"*[123] [Delivery level], *"ça donne la chance à tous les joueurs, qui n'ont pas la vision volumétrique, qui ne sont pas capables de schématiser un dessin dans leur tête"*[124] [Client side] mentally, from technical documents, what the new facility will be.

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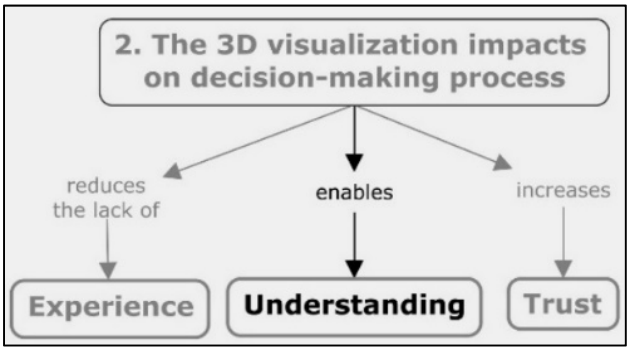
[119] *"The 3D allows us to communicate to people who do not do projects on a regular basis. Always have to explain again, because the stakeholders are always changing, especially in the project, there are new stakeholders who never understand what it is."* [Delivery level]
[120] *"The impacts of the 3D model are mainly positive for the understanding of the project for people who are less technical, who are less used to reading plans."* [Director level]
[121] *"There are many people who are not able to visualize plans, volumetry, size."* [Delivery level]
[122] *"It is certain that having a 3D image is much easier to understand."* [Director level]
[123] *"The 3D visualization allow people to experience the space."* [Delivery level]
[124] *"It gives the chance to all players, who do not have volumetric vision, who are not able to schematize a drawing in the head."* [Client side]

Impact: Understanding



One of the most relevant effects of the visualization comes *"avec l'image, la compréhension est plus facile"*[125] [Director level]. In fact, *"le 3D c'est la compréhension"*[126] [Delivery level]. It helps on all levels, since the clients to the direction, passing by the professionals working on the project themselves. *"Le gain qu'on gagnera c'est que la compréhension sera plus rapide, ce sera plus facile d'expliquer le problème et plus facile faire comprendre le problème"*[127] [Delivery level]. *"We will be all on the same path because the stakeholders can see it, they know what you are talking about"* [Client side] avoiding *"la majorité des erreurs sont des erreurs d'interprétations qui sont différentes selon les personnes"*[128] [Delivery level].

"La visualisation 3D permet une compréhension visuelle très facile pour tous les interlocuteurs"[129] [Client side]. However, when considering those that will use that information to make decisions, one should prepare it the better way to help them make better decisions to the project. So, the 3D visualization can *"aide à préparer la demande et à la vulgariser le plus rapidement pour le niveau supérieur"*[130] [Client side]. *"Plus on monte dans la hiérarchie, plus il faut que l'information soit vulgarisée et compréhensible*"[131] [Client side].

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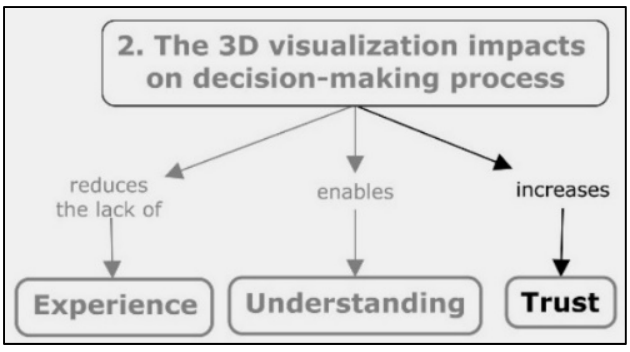
[125] *"With the image, understanding is easier."* [Director level]
[126] *"The 3D is understanding."* [Delivery level]
[127] *"The gain we will win is that the understanding will be faster. Will be easier to explain the problem will be easier to understand the problem."* [Delivery level]
[128] *"The majority of errors are interpretation errors that are different for different people."* [Delivery level]
[129] *"The 3D visualization allows a very easy visual understanding for all interlocutors*." [Client side]
[130] *"Help prepare the application and popularize it as quickly as possible for the higher level."* [Client side]
[131] *"The higher up the hierarchy, the more information needs to be vulgarized and understandable."* [Client side]

In this sense, *"l'impact de la visualisation 3D est énorme, parce qu'on sait de quoi on parle"*[132] [Delivery level] and the decision makers *"ne peuvent pas dire qu'ils prendront une décision sans savoir. Les gens comprennent mieux la question, donc ils sont plus à l'aise de prendre une décision"*[133] [Client side].

The decision will be more accurate due to the better understanding because the 3D visualization *"donne une vision égale à tous pour comprendre le projet avec facilité et simplicité"* [134] [Client side]. It is where we have "*l'avantage dans la maquette 3D, c'est justement de rendre ça beaucoup plus accessible à quelqu'un qui n'est pas habitué"*[135] [Delivery level]. *"Parce que des fois, c'est seulement une incompréhension, ils peuvent voir les plans, mais ils les perçoivent difficilement… c'est juste une question d'avoir une bonne compréhension"*[136] [Delivery level]. Through increasing their understanding, they will enhance the quality of their decisions. This means that the project team has a role as a guide to those that are not used to the industry by using the 3D visualization to help them to comprehend the project propositions, becoming willing to make decisions.

Impact: Trust



[132] *"The impact of 3D visualization is huge, because we know what we're talking about."* [Delivery level]
[133] *" … cannot say they will make a decision without knowing. People understand the question better, so they are more comfortable making a decision."* [Client side]
[134] *" … gives equal vision to all to understand the project with ease and simplicity."* [Client side]
[135] *"The advantage in the 3D model is to make it much more accessible to someone who is not used to.*" [Delivery level]
[136] *"Because sometimes, it's only a misunderstanding, they can see the plans, but they can hardly see them ... it's just a matter of having a good understanding."* [Delivery level]

As an easier way to communicate information, the 3D helps with *"l'importance de les mettre au courant de l'avancement et des implications des changements"*[137] [Delivery level]. With BIM you have information updated on a daily basis with increase the safety of making decision, especially on the financial aspect. Having the right information allows both the sides *"to make decisions in a safer way, also your risk factor of the unknown goes down quite a bit, you have fewer unknowns, that's the bottom line"* [Director level]. By having decision to be made in a safer and faster way, the efficiency of this process will increase and impact positively the chances of project success.

Besides, its quality information *"facilite le lien de confiance"*[138] [Director level] between the stakeholders and the project team, improving the efficiency of this process, especially *"au niveau de la haute direction, parce que plus la confiance est forte, plus l'équipe aura les moyens de réaliser ce qu'elle veut. Plus la confiance est faible, plus les gens entreront dans le micro détails et prendront des décisions qu'ils ne devraient pas prendre parce qu'ils ne connaissent pas tous les impacts"*[139] [Director level]. When *"la haute direction voient la maquette, elle sait ce que l'équipe du projet fait, donc ça nous donne un sentiment, l'impression qu'on était en contrôle de notre projet. Après ça, c'était beaucoup plus facile de gérer le projet"*[140] [Director level].

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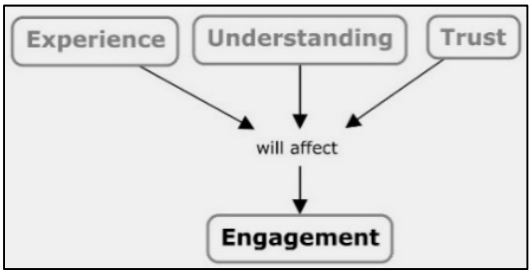
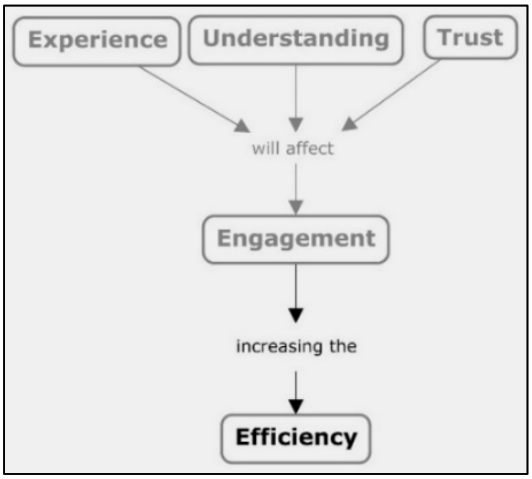
[137] *"The importance of keeping them informed of the progress and implications of the changes."* [Delivery level]
[138] *"It facilitates the link of trust."* [Director level]
[139] *"At the senior management level, because the stronger the confidence, the more the team will have the means to achieve what they want. The lower the confidence, the more people will go into the micro details and make decisions that they should not take because they do not know all the impacts."* [Director level]
[140] *"The senior management sees the model, she knows what the project team is doing, so it gives us a feeling, the impression that we were in control of our project. After that, it was a lot easier to manage the project."* [Director level]

Impact: Engagement



When they comprehend the design, *"l'impact est qu'on doit être plus impliqué"*[141] [Delivery level] and this has an impact over the decision-making process. With more information, *"il y a plus d'implication et tu es plus imputable aussi, c'est un engagement"*[142] [Director level]. So, to have an efficient decision-making process, you must *"aller chercher l'engagement des gens avec des bon outils et la bonne communication, mais surtout avec les bons outils"*[143] [Director level], in order to improve their comprehension about the project propositions, which will improve their engagement to the project activities, as consequence.

Impact: Efficiency



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[141] *"The impact is that we have to be more involved."* [Delivery level]
[142] *"There is more involvement and you are more accountable too, it is an engagement."* [Director level]
[143] *" To seek the commitment of people with good tools and good communication, but especially with the right tools."* [Director level]

The decision-making process based on 2D drawings can bring questionable decisions because the stakeholders cannot make informed decisions if they cannot read the documents and truly comprehend what the design means. However, *"avec la maquette 3D c'est un moyen d'avoir une réponse plus officielle et mieux comprise"*[144] [Delivery level]. *"Quand on le présente à l'écran tout le monde voit la même chose"*[145] [Director level], *"les prises de décision sont un peu plus éclairées"*[146] [Delivery level, Client side], because *"ils seront plus sûrs de leur décision, plus certains"*[147] [Client side], improving significantly and instantly the efficiency of this process.

By being prepared to make decisions through their engagement, their trust on the documents and more familiarized with the process by using the 3D visualization, the process will *"permettre d'avoir une réponse qui répond vraiment à la vraie question"*[148] [Delivery level]. When the stakeholders understand the design, they can make decisions faster because they better understand the solutions. When using the 3D, *"les prises de décision sont plus rapides et plus précises, sont plus ciblées et mieux comprises"*[149] [Director level].

"Juste à cause d'avoir cette compréhension de façon visuelle, ça permettra de prendre une décision plus éclairée ... et de prendre la meilleure décision possible... il n'y aura de problème d'interprétation possible"[150] [Delivery level]. Once their comprehension becomes faster and easier, the answer to the questions on the decision-making process becomes the right ones. *"C'est sûr que s'ils comprennent mieux ils seront capables de prendre une décision plus éclairée sur le sujet"* [151] [Delivery level]. This process *"sera beaucoup plus rapide et facile"*[152] [Director level, Delivery level, Client side] because the time needed to fully comprehend the

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[144] *"With the 3D model is a way to have a more official answer and better understood."* [Delivery level]
[145] *"When presented on the screen everyone sees the same thing."* [Director level]
[146] *" Decision-making is a little more enlightened."* [Delivery level]
[147] *"They will be surer of their decision, more certain."* [Client side]
[148] *"It allows to have an answer that really answers the real question."* [Delivery level]
[149] *"Decision-making is faster and more accurate is more targeted is more understood."* [Director level]
[150] *"Just because of this understanding when we have them visually ... that will make a decision more informed ... you make the best decision possible ... there is no interpretation possible."* [Delivery level]
[151] *"Of course, if they understand better, they will be able to make a more enlightened decision on the subject".* [Delivery level]
[152] *"Will be much faster and easier."* [Delivery level]

point being discussed will decrease. The point will be exposed in a better way by the project team, given that they have a better comprehension about the project themselves through working with the model. The stakeholders will feel secure to ask questions, increasing the overall knowledge about the point. The time required to comprehend the point being discussed will decrease. After that, they will take the same time their organization requires to make decisions, depending on its importance and impacts.

Table 3.12 summarizes the evidence extracted from the interviews.

Table 3.12 Evidences for the 3D visualization impacts on engaging stakeholders[153]

DIMENSION 3 - PART 2: What are the impacts when using 3D to engage stakeholders on the decision-making process?			
Categories	**ID**	**Evidences**	
Experience	4	52'29"	*"Le 3D nous permet de faire comprendre ça et il y a bien des gens qui ne font pas des projets sur une base régulière. Il faut toujours recommencer à expliquer de nouveau, les intervenants changent toujours, surtout dans le projet, il y a des nouveaux intervenants qui ne comprennent jamais c'est quoi ça".*
	13	39'25"	*"Les impacts du modèle 3D sont principalement positifs pour la compréhension du projet pour les personnes qui sont moins techniques, qui ont moins l'habitude de lire des plans."*
	10	20'34"	*"Il y a plusieurs personnes qui ne sont pas capables de visualiser des plans, la volumétrie, la grandeur."*
	13	39'51"	*"C'est certain que d'avoir une image 3D c'est beaucoup plus facile à comprendre."*
	10	21'22"	*"La visualisation 3D permet aux gens de mieux percevoir la grandeur de l'espace."*
	8	27"26	*"Ça donne la chance à tous les joueurs, qui n'ont pas la vision volumétrique, qui ne sont pas capables de schématiser un dessin dans leur tête."*
Engagement	2	42'15"	T: Quand on utilise le 3D, qu'est-ce que c'est l'impact sur de prise de décision avec le client? *I:"l'impact est qu'on doit être plus impliqué".*
	6	35'54"	*"Il y a plus d'implication et tu es plus imputable aussi, c'est un engagement."*
	1	42'19"	*"Aller chercher l'engagement des gens avec des bon outils, la bonne communication, mais le bon outil".*
Understanding	1	49'44"	*"Avec l'image, la compréhension est plus facile."*
	2	40'35"	*"En fait le 3D c'est la compréhension".*

[153] On this table is possible to observe extracts from the interviews demonstrating each interviewee contribution to the findings for this discussion. Also, it is indicated where the evidence can be found on the interview audios and the category to which evidence was categorized. These categories and their interconnections can be seen also on the Figure 3.5, page 92.

Table 3.12 Evidences for the 3D visualization impacts on engaging stakeholders (Continuation)

DIMENSION 3 - PART 2: What are the impacts when using 3D to engage stakeholders on the decision-making process?			
Categories	**ID**	**Evidences**	
Understanding	2	43'18"	*"Le gain qu'on gagnera c'est que la compréhension sera plus rapide, il sera plus facile d'expliquer la problématique, il sera plus facile faire comprendre la problématique".*
	8	28'48"	*"We will be all on the same path because the stakeholders can see it, they know what you are talking about"*
	5	51'58"	*"La majorité des erreurs sont des erreurs d'interprétation qui sont différentes selon les personnes."*
	12	12'58"	*"La visualisation 3D permet une compréhension visuelle très facile pour tous les interlocuteurs."*
	9	39'05"	*"Ça peut aider à préparer la demande et à la vulgariser le plus rapidement pour le niveau supérieur."*
	12	11'49"	*"Plus qu'on monte dans la hiérarchie, plus il faut que l'information soit vulgarisée et compréhensible.*
	10	19'33"	*"L'impact de la visualisation 3D c'est énorme, parce qu'on sait de quoi on parle."*
	11	32'26"	*"Ils ne peuvent pas dire qu'ils prendront une décision sans savoir. Les gens comprennent mieux la question, donc ils sont plus à l'aise à prendre une décision"*
	8	28'19"	*"Ça donne une vision égale à tous pour comprendre le projet avec facilité et simplicité."*
	2	39'23"	*"Mais là qu'on a un avantage dans la maquette 3D, c'est justement de rendre ça beaucoup plus accessible à quelqu'un qui n'est pas habitué".*
	5	46'02"	*"Parce que des fois, c'est seulement une incompréhension, ils peuvent voir les plans, mais ils ne sont pas perçus comme il faut… c'est juste une question d'avoir une bonne compréhension, d'avoir l'information qui a une valeur, qui est vulgarisée, qui facilite la compréhension pour toutes les parties prenantes."*
Trust	5	43'49"	*"L'important, de les mettre au courant de l'avancement du projet et des changements".*
	3	43'58"	T: Probably they will be able to decide in a way more assertive, or we can say faster? *I: "Way faster and your risk factor of the unknown goes down quite a bit, you have fewer unknowns, that's the bottom line".*
	1	45'17"	T: … et tu penses que cette confiance on peut l'avoir sur les documents qu'on produit avec le BIM? *I: "C'est sûr que ça facilite le lien de confiance".*
	13	41'05"	*"Au niveau de la haute direction, parce que plus la confiance est forte, plus l'équipe aura les moyens de réaliser ce qu'on veut. Plus la confiance est faible, plus les gens entreront dans le micro détail et prendront des décisions qu'ils ne devraient pas prendre parce qu'ils ne connaissent pas tous les impacts"*
	13	33'22"	*"La haute direction voient la maquette, elle sait ce que l'équipe du projet fait, donc ça nous donne le sentiment, l'impression qu'on était en contrôle de notre projet. Après ça, c'était beaucoup plus facile de gérer le projet"*

Table 3.12 Evidences for the 3D visualization impacts on engaging stakeholders (Continuation)

DIMENSION 3 - PART 2: What are the impacts when using 3D to engage stakeholders on the decision-making process?			
Categories	**ID**	**Evidences**	
Efficiency	2	39'42"	*"Avec le partage d'information, avec la maquette 3D, on ajoute des plans dans le processus de prise de décisions, mais là tu as un moyen d'avoir une réponse qui est plus officielle et mieux comprise".*
	1	48'58"	*"Tout le monde voit la même chose, quand on leur présente à l'écran".*
	5	50'09"	*"Les prises de décision sont un peu plus éclairées."*
	7	29'23"	*"Elles sont des décisions plus éclairées."*
	10	21'55"	T: … les a aidés à prendre une décision plus éclairée? *I: "Oui, parce qu'ils comprennent le contexte, ils voient le contexte".*
	11	32'28"	T: On peut dire que c'est une décision plus éclairée? *I: "Oui, définitivement."*
	11	31'57"	*"Ils seront plus sûrs de leur décision, plus certains."*
	2	43'53"	*"Ça permet d'avoir une réponse qui répond vraiment à la vraie question".*
	1	47'23"	*"Je pense que l'impact c'est que les prises de décision sont plus rapides et plus précises, elles sont plus ciblées, mieux comprises."*
	5	51'10"	*"D'avoir cette compréhension plus visuelle, ça permet de prendre une décision plus éclairée ... tu prends la meilleure décision possible ... il n'y a pas d'autres interprétations possibles."*
	5	49'24"	*"C'est sûr que s'ils comprennent mieux ils seront capables de prendre une décision plus éclairée sur le sujet".*
	4	53'28"	T: Quels sont les impacts dans les décisions avec le 3D? *I: "Elles sont beaucoup faciles, plus rapides".*
	7	29'34"	T: Ça aide à prendre une décision plus rapidement? *I: "Oui, beaucoup plus facile."*
	11	32'49"	T: Les décisions seront plus rapides? *I: "Oui"*

3.3.3 Dimension 3 discussion

The interviewees were asked to answer two questions:

- Question 1: what are the challenges to engage stakeholders in the decision-making process?
- Question 2: what the 3D visualization impacts have to engage stakeholders in the decision-making process?

Figure 3.6 shows the answers' classification that embrace just the main idea for each answer.

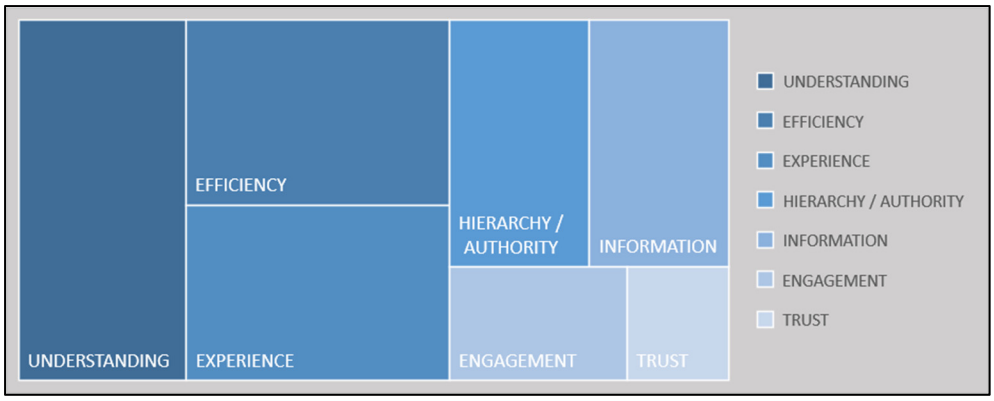


Figure 3.6 Categories emphasized on Dimension 3' answers

When considering just the principal idea for every answer, it is possible to observe the relevance of "Understanding", "Efficiency", "Experience", "Hierarchy / Authority", "Information", "Engagement" and "Trust" concepts have over the answers related to the decision-making process.

It is interesting notice that when answering about the decision-making process, the three main concepts link the efficiency of this process to experience and understanding. The less experience one has on the domains (most cited being the construction, but also the airport is present), the less is their level of understanding about the question being discussed. The three concepts are directly related: more experience on construction projects, more understanding about the subjects in discussion, more efficient the process to make decisions.

3.4 The overall BIM impact on stakeholders' management

In this final debate, the interviewees were asked to give their overall perception about the impacts that 3D visualization might have over the stakeholders' management. Figure 3.7 shows the interconnections amongst the most relevant categories extracted from the interviewees' answers.

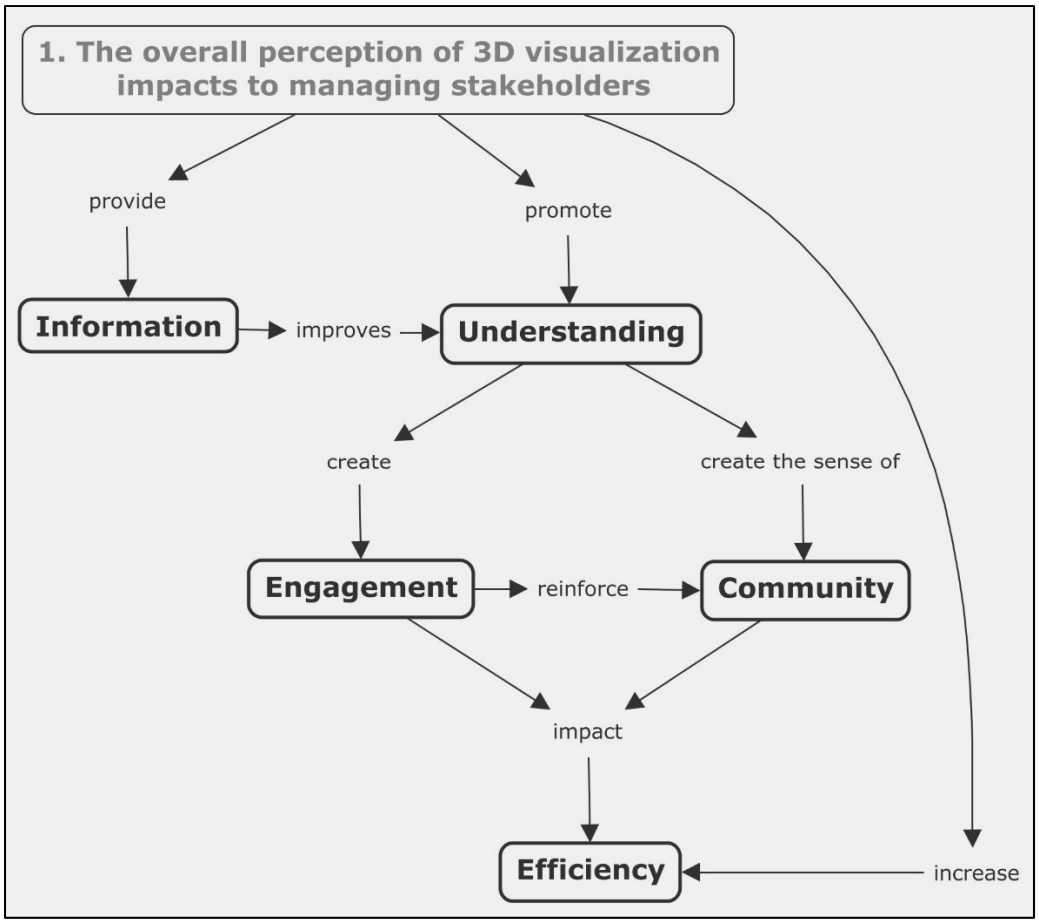


Figure 3.7 Relationships between the categories emphasized on the final debate

The conceptual map above segregates the categories for each question related to this dimension:

- Question 1: what your overall perception of 3D visualization impact over the stakeholder management on the project activities are?
- Question 2: If your last airport project experience would be redone, how would you like to be involved in?

From the interviewees' perspective, the 3D visualization provides good quality information, enabling a better understanding of the subject being discussed, creating stakeholders' engagement and a sense of belonging, a community. Also, as the 3D visualization builds a common language that everyone can understand, it can reduce the lack of experience on the domains (airport, construction, project management) of all involved allowing them to share

their points of view when discussing a subject. Besides, the efficiency of the project process is improved, especially the decision-making process.

Those concepts and their connections are discussed in the following sections.

3.4.1 The final debate

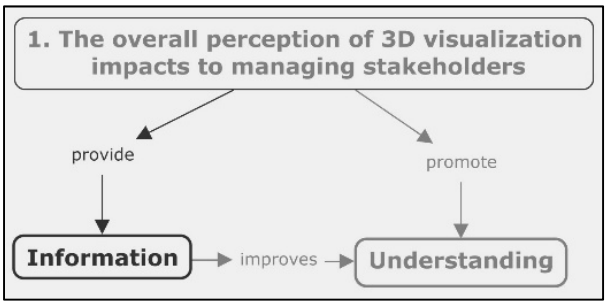
Table 3.13 summarizes the 3D visualization most relevant impacts to stakeholders' management cited by the interviewees and each respective category.

Table 3.13 The most relevant impacts of 3D visualization to stakeholder management

Categories	Definition
Information	It provides good quality information.
Understanding	It increases the project propositions understanding.
Engagement	By understanding better, it promotes engagement to the project objectives.
Community	By understanding better, it can create a sense of being part of a community.
Efficiency	It increases the efficiency of project processes.

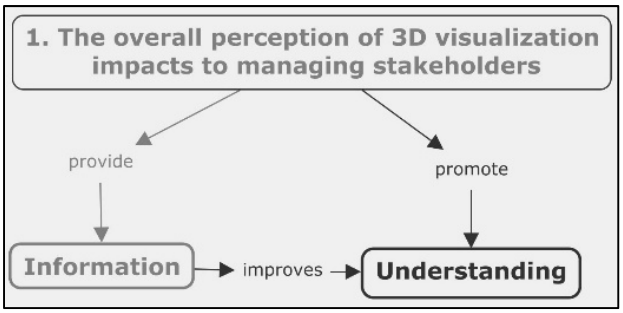
The interviewees' perception of the 3D visualization impact on the stakeholder management was selected considering the most important concept being used by the interviewees to express their ideas. Despite referring to more than one category, every answer was categorized in that one the most relevant. The interconnections from all categories used to synthesize the answers to this question are explained in the Figure 3.7, page 111. Each of those concepts is detailed below.

Impact: Information



"La visualisation 3D c'est juste un aspect. Être capable de chercher l'information est la plus-value de l'intégration BIM en général"[154] [Delivery level], mainly *"la facilité d'accès à l'information parce qu'elle est regroupée ensemble"*[155] [Client side]. *"La maquette, les processus BIM en général, viennent chercher un peu plus d'informations pertinentes, ils amènent une information claire, ils amènent une rigueur aux informations"*[156] [Delivery level]. With BIM process the client knows better when he needs some specific information, what type and at what detail level. And it also promotes *"the opportunity to collect the information during the project and associate it with things that have end-up project delivery"* [Director level]. *By going to "step by step, en impliquant les parties prenantes très tôt, il se construit un bagage de connaissances pendant la période du projet. Après ça, ce sera plus facile"*[157] [Director level] to them to appropriate themselves to the new facility.

Impact: Understanding



A very important aspect about using the 3D visualization is to allow everyone to have the same understanding of project propositions, being at the same level of comprehension. *"L'impact de l'utilisation du 3D est énorme au niveau de ... c'est un outil merveilleux qui permet à tout le*

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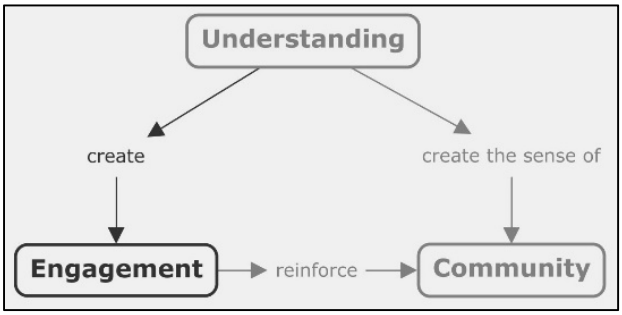
[154] *"The 3D visualization is just an aspect. Being able to search for information is the added value of BIM integration in general."* [Delivery level]
[155] *"… ease of access to information because it is grouped together."* [Delivery level]
[156] *"The model, the BIM processes in general, come for a little more relevant information, they bring clear information, they bring rigor to the information."* [Delivery level]
[157] *"Step by step, en impliquant les parties prenantes très tôt, il se construit un bagage de connaissances pendant le période du projet. Après ça, ce sera plus facile."* [Director level]

monde d'être au même niveau"[158] [Director level]. More than helping with the stakeholders' management, the presence of the 3D model also helps the project team *"à bien définir leur questionnement, pour bien l'expliquer, être capable d'avoir une compréhension claire de la partie prenante"*[159] [Delivery level] because *"ça enlève des interprétations"*[160] [Delivery level].

Besides, for those not used to construction, the biggest impact is *"to be able to understand. Take someone that doesn't work with drawings every day and provide visualization outside the 2D drawing and you gonna get a huge increase in the understanding quickly"* [Director level], *"même s'il ne navigue pas à l'intérieur de la maquette, ça aide beaucoup comme support de compréhension"*[161] [Client side]. When better presenting the questions and better explain it to the stakeholders, better decision-making processes will take place.

Impact: Engagement



"Il faut que chacun comprenne que c'est son projet, que la contribution de chacun est importante et essentielle pour la réalisation du projet"[162] [Director level]. *"L'engagement est très important pour être capable d'aller chercher les informations, d'aller chercher quand*

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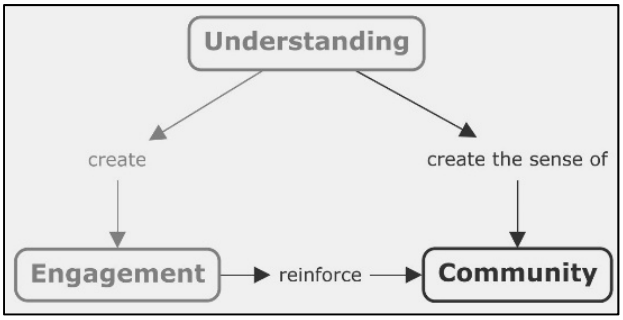
[158] *"The impact of using 3D is huge at the level of… it's a wonderful tool that allows everyone to be at the same level."* [Director level]
[159] *"… to clearly define their questioning, to explain it well, to be able to have a clear understanding of the stakeholder."* [Delivery level]
[160] *"It takes away interpretations."* [Delivery level]
[161] *"Even if he does not navigate inside the model, it helps a lot as a support for understanding*." [Client side]
[162] "*Everyone must understand that it is his project, that the contribution of each is important and essential for the realization of the project."* [Director level]

même une bonne participation des parties prenantes"[163] [Delivery level]. Thus, it is important *"d'intégrer les parties prenantes dès le début du projet"*[164] [Director level, Delivery level] to *"sensibiliser les gens à tout ce qui devait être fait pour améliorer le projet"*[165] [Delivery level]. In this sense, BIM *"c'est un outil qui est vraiment très utile pour impliquer toutes les parties prenantes"*[166] [Director level] because being exposed to the model, *"augmente l'engagement de la partie prenante, ça crée un engagement supplémentaire"*[167] [Delivery level].

Impact: Community



It is worthy to notice that engaging the stakeholders on the project brings the sense of being part of a community, where *"tout le monde est porteur du projet, tout le monde veut avoir une partie du mérite du projet"*[168] [Director level], helping the project to achieve its objectives, helping the project activities to be more efficient. *"Naturellement, tout le monde souffrira un petit peu, mais globalement, ils savent que c'est pour le bien commun"*[169] [Director level] and the effort will be supported by everyone on the community, as the benefits as well. When engaging them to the project, *"ça leur appartiendra, ils diront: ça c'est mon idée"*[170] [Client side]. This sense of belonging is *"une appropriation parce qu'ils vont utiliser les nouvelles*

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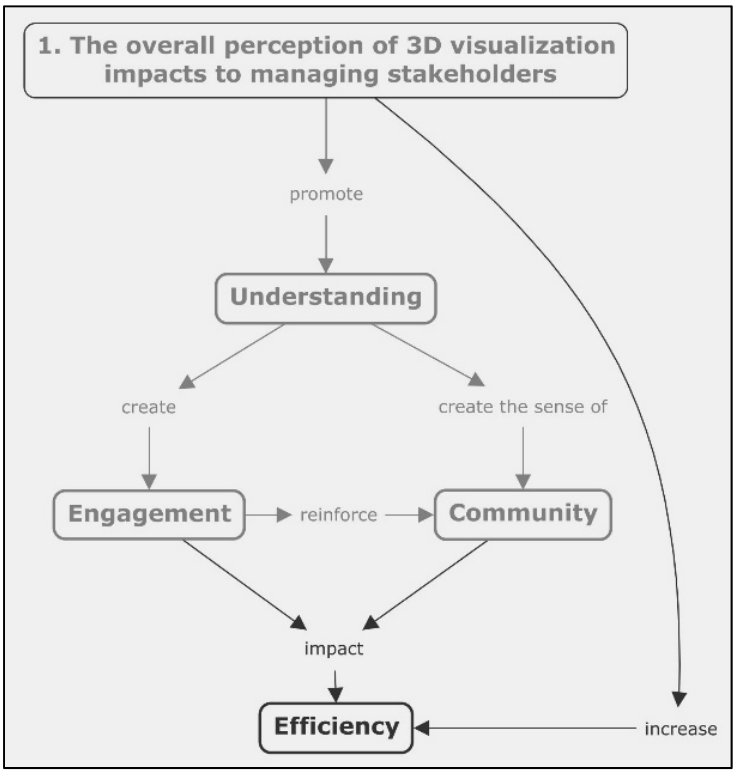
[163] *"The engagement is very important to be able to get the information, to still seek a good stakeholder participation."* [Delivery level]
[164] *"To integrate stakeholders from the beginning into a project."* [Delivery level]
[165] *"To make people aware of everything that needs to be done to improve the project."* [Delivery level]
[166] *"It is a tool that is really very useful to involve all stakeholders."* [Director level]
[167] *"Increases the engagement of the stakeholder, it creates an additional commitment."* [Delivery level]
[168] *"Everyone is carrying the project, everyone wants to have some of the merit of the project."* [Director level]
[169] *"Naturally, everyone will suffer a little bit, but overall they know it's for the common good."* [Director level]
[170] *"It will belong to them, they will say: this is my idea."* [Client side]

infrastructures" [171] [Delivery level, Client side]. Thus, *"ce n'est pas mon projet, ce n'est pas ton projet, c'est leur projet"*[172] [Director level].

Impact: Efficiency



The impact on the *"efficiency is something easy to understand"* [Director level] just because, by using the 3D visualization, the project will take *"plus d'efforts au départ pour finir gagnant, pour avoir moins d'extraits"*[173] [Delivery level]. Also, a *"meilleure cohésion entre les différents intervenants"*[174] [Delivery level] *"facilite la dynamique entre l'équipe du projet"*[175] [Delivery level], as *"utiliser du 3D, ça facilite l'avancement du projet, car c'est plus facile de*

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[171] *"… appropriation because they will use the new infrastructure."* [Client side]
[172] *"It's not my project, it's not your project, it's their project."* [Director level]
[173] *"More effort at the start to win, to have fewer excerpts."* [Delivery level]
[174] *"Better cohesion between the different speakers."* [Delivery level]
[175] *"It facilitates the dynamics between the project team."* [Delivery level]

l'expliquer aux parties prenantes, et même pour les professionnels c'est plus facile"[176] [Delivery level].

As *"un outil de prise de décision qui est plus parlant"*[177] [Delivery level], *"ça facilite la prise de décision parce que les gens ne sont pas capables de lire le plan 2D. Avoir du 3D et être en mesure de se promener dans une maquette avec réalité virtuelle est très gagnant et très mobilisant aussi"*[178] [Delivery level]. *"La visualisation 3D permet de prendre de meilleures décisions"*[179] [Delivery level], as *"permet d'avoir une prise de décision plus rapide"*[180] [Delivery level] and *"à long terme la visualisation 3D peut changer notre charge de travail"*[181] [Client side].

This is a virtuous circle that can improve the chances of project success. *"Ça prend beaucoup plus de temps qu'avant parce qu'on coordonne des choses qu'on n'a pas coordonné avant, par contre, puisqu'on le coordonne maintenant, on gagne du temps après, dans l'exécution ... c'est beaucoup plus de coordination, beaucoup plus de communication qu'on ne faisait pas nécessairement avant"*[182] [Delivery level]. *"Le BIM pousse à améliorer la construction, à être meilleur, à avoir moins de changements, de mieux construire, à coordonner d'avance, à mieux planifier ces travaux. Ce n'est pas juste la visualisation, c'est plus que ça. C'est la richesse de la base de données qu'est créée et qui perdure dans le temps"*[183] [Director level].

Table 3.14 summarizes the evidence extracted from the interviews.

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[176] *"Using 3D makes it easier to advance the project because it's easier to explain to stakeholders, and even for professionals it's easier."* [Delivery level]
[177] *"A tool for decision-making that is more talk."* [Delivery level]
[178] *"It makes decision-making easier because people are not able to read the 2D plan. Having 3D and being able to walk into a model with virtual reality is very winning and very mobilizing too."* [Delivery level]
[179] *"The 3D visualization allows for better decision."* [Delivery level]
[180] *"Enable faster decision-making."* [Delivery level]
[181] *"Long-term 3D visualization can change our workload."* [Client side]
[182] *"It takes a lot more time than before because we coordinate things that we have not coordinated before, however, since we coordinate it now, we save time after, in the execution ... it is a lot more coordination, a lot more communication that we did not necessarily do before."* [Delivery level]
[183] *"BIM is pushing to improve construction, to be better, to have fewer changes, to better build, to coordinate in advance, to better plan this work. It's not just visualization, it's more than that. It is the richness of the database that is created and that persists over time."* [Director level]

Table 3.14 Evidences for the overall BIM impact on stakeholder engagement[184]

FINAL DEBATE: Overall perception about the BIM impact on the stakeholder engagement.			
Categories	**ID**	**Evidences**	
Information	5	54'36"	*"La visualisation 3D c'est juste un aspect. Être capable de chercher l'information est la plus-value de l'intégration BIM en général."*
	9	43'41"	*"La facilité d'accès à l'information parce qu'elle est regroupée ensemble."*
	2	45'54"	*"Je crois aussi que la maquette, les processus BIM en général, améliorent un peu plus la pertinence de l'information, clarifient l'information, amènent une rigueur dans les informations".*
	3	46'14"	*"Having the opportunity to collect the information during the project and associate it with things that have end-up project delivery, efficiency is something easy to understand. Maintenance is knowing what they are getting before they get it, that's a big thing."*
	13	46'05"	*"Tu as une équipe de deux cents ou trois cents professionnels qui travaillent pendant trois ans à temps plein à développer un projet, ils connaissent leur projet, mais quand tu demandes à des gars de maintenance, des techniciens, d'apprendre toutes ces connaissances en une semaine, pour pouvoir l'opérer comme c'était imaginé c'est impossible. Peu importe le niveau d'intelligence, tu peux avoir les meilleurs au monde mais ils ne seront pas capables, c'est trop d'information, il faut y aller step by step, les impliquer très tôt, là il se construit un bagage de connaissances pendant le période du projet, et après ça, ce sera plus facile."*
Understanding	1	50'14"	*"Moi je pense que l'impact de l'utilisation du 3D est énorme ... c'est un outil merveilleux qui permet à tout le monde d'être au même niveau".*
	2	44'36"	*"Ça aide, c'est sûr. Ça aide pour bien définir notre questionnement, bien l'expliquer, être capable d'avoir une réception (compréhension) claire de la partie prenante".*
	5	52'46"	*"Ça enlève des interprétations."*
	3	45'33"	*"Being able to understand. Take someone that doesn't work with drawings every day and provide visualization outside the 2D drawing and you gonna get a huge increase in the understanding quickly".*
	9	45'03"	*"Même s'il ne navigue pas à l'intérieur de la maquette, ça aide beaucoup comme support de compréhension."*
Community	6	37'20"	*"Tout le monde est porteur du projet, tout le monde veut avoir une partie du mérite du projet."*
	1	13'50"	*"Naturellement, tout le monde souffrira un petit peu, mais globalement, ils savent que c'est pour le bien commun."*

[184] On this table is possible to observe extracts from the interviews demonstrating each interviewee contribution to the findings for this discussion. Also, it is indicated where the evidence can be found on the interview audios and the category to which evidence was categorized. These categories and their interconnections can be seen also on the Figure 3.7, page 110.

Table 3.14 Evidences for the overall BIM impact on stakeholder engagement (Continuation)

FINAL DEBATE: Overall perception about the BIM impact on the stakeholder engagement.			
Categories	**ID**	**Evidences**	
Community	11	33'40"	*"Aussi pour faire embarquer les gens dans un projet, et ça leur appartiendra, juste de dire : c'est mon idée."*
	11	34'07"	*"C'est une appropriation parce qu'ils vont utiliser les nouvelles infrastructures."*
	1	30'59"	*"Ce n'est pas mon projet, ce n'est pas ton projet, c'est leur projet."*
Efficiency	3	46'14"	*"Having the opportunity to collect the information during the project and associate it with things that have end-up project delivery, efficiency is something easy to understand."*
	4	58'21"	*"Plus d'efforts au départ pour finir gagnant pour avoir moins d'extraits."*
	5	53'59"	*"Meilleure cohésion entre les différents intervenants."*
	9	43'33"	*"Facilite la dynamique entre l'équipe du projet."*
	7	31'31"	*" Utiliser du 3D ça facilite l'avancement du projet car c'est plus facile de l'expliquer aux parties prenantes, et même pour les professionnels c'est plus facile."*
	10	24'32"	*"Ce sont des outils de prise de décision qui sont plus parlant que ce qu'on avait avant."*
	6	36'58"	*"Ça facilite la prise de décision parce que les gens ne sont pas capables de lire le plan 2D. Avoir du 3D et être en mesure de se promener dans une maquette avec réalité virtuelle est très gagnant et très mobilisant aussi."*
	5	54'26"	*"La visualisation 3D permet de prendre de mieux décision."*
	10	23'50"	*"Permettre d'avoir une prise de décision plus rapide."*
	9	45'43"	*"Á long terme, la visualisation 3D peut changer notre charge de travail."*
	4	56'11"	*"Ça prend beaucoup plus de temps qu'avant parce qu'on coordonne des choses qu'on n'a pas coordonnées avant. Par contre, comme on le coordonne maintenant, on gagne du temps après dans l'exécution ... c'est beaucoup plus de coordination, beaucoup plus de communication qu'on ne faisait pas nécessairement".*
	13	43'13"	*"Le BIM pousse à améliorer la construction, à être meilleur, à avoir moins de changement, à mieux construire, à coordonner d'avance, à mieux planifier ces travaux. Ce n'est pas juste la visualisation, c'est plus que ça. C'est la richesse de la base de données qu'est créée et qui perdure dans le temps"*
Engagement	1	39'46"	*"Il faut que chacun comprenne que c'est son projet, que la contribution de chacun est importante et essentielle pour la réalisation du projet"*
	2	45'08"	*"J'ai l'impression que ça augmente l'engagement de la partie prenante ... je crois que ça crée un engagement supplémentaire, l'engagement est très important pour être capable d'aller chercher les informations, aller chercher quand même une bonne participation des parties prenantes".*
	5	52'53"	*"Ça permet d'intégrer les parties prenantes dès le début du projet."*
	6	41'02"	T: 41:02 c'est un engagement dès le départ?
			I: "Oui, c'est une phase de planification."

3.4.2 How stakeholders would like to be involved on the project

It is very interesting to observe that the majority of interviewees stated the same answer to this question: they would like to be involved since the beginning of the project. Below are some examples:

- *"Je n'ai pas assisté à la réunion de démarrage et j'aimerais être là. Je pense que dans une bonne réunion de démarrage il faut dire aux gens qui contacter quand il y a quelque problème avant de paniquer."*[185] [Delivery level]
- *"Je pense qu'il faut intégrer les parties prenantes dans le processus de conception intégrée, dès le départ car tout le monde est là, donc dès la phase de conception car ça nous permet d'intégrer plus d'aspects de construction à la conception."*[186] [05 - Delivery level]
- *"Je n'étais pas impliqué à la base."*[187] [Director level]
- *"Être impliqué dès l'analyse de besoins et de contexte."* [188] [Client side]
- *"Dès le départ jusqu'à la fin."* [189] [Client side]

However, they also stated that *"ce serait l'fun que les gens qui travaillent, même les gens qui ne font pas partis du projet, que les gens le sachent, que les gens dans la communauté soient au courant de ce qui arrivera"*[190] [Client side], highlighting that *"ce qui est important c'est de s'assurer que le succès du projet passe par une bonne communication entre les parties prenantes, surtout dans un aéroport"*[191] [Client side].

Table 3.15 summarizes the evidence extracted from the interviews.

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[185] *"I did not attend the kick-off meeting and I would like to be here. I think in a good start meeting you have to tell people to whom to contact when there is some problem before you panic."* [Delivery level]
[186] *"I think we need to integrate stakeholders in the integrated design process from the start because everyone is there, so from the design stage because it allows us to integrate more design aspects into the design."* [Delivery level]
[187] *"I was not involved at the base."* [Director level]
[188] *"Be involved right from the analysis of requirements and context."* [Client side]
[189] *"From the beginning to the end."* [Client side]
[190] *"It would be fun for people who are working, even people who are not part of the project, for people to know, for people in the community to know what will happen."* [Client side]
[191] *"What is important is to ensure that the project's success depends on good communication between stakeholders, especially in an airport."* [Client side]

Table 3.15 Evidences for how the interviewees would like to be involved[192]

FINAL DEBATE: How you would like to be involved on the project if it will be redo?			
Categories	**ID**	**Evidences**	
Engagement	4	59'07"	*"Je n'ai pas assisté la réunion de démarrage et j'aurais aimé être là. Je pense que dans une bonne réunion de démarrage, il faut que les gens soient au courant qui contacter quand on a quelque chose, quand on a un problème avant de paniquer."*
	5	55'17"	*"Je pense que c'est d'être plus en avance, dès le départ, même de la phase de conception. Je pense que ça nous permettra d'intégrer des aspects plus de construction à la conception ... peut-être toutes les parties prenantes peuvent être impliquées dans le processus de conception intégrée. Dès le départ, tout le monde est là."*
	6	39'35"	*"Je n'étais pas impliqué à la base, j'aurais aimé jeter la base contractuelle avec le professionnel."*
	9	47'19"	*"On veut être impliqué dès l'analyse de besoins et de contexte."*
	12	18'52"	*"Dès le départ jusque à la fin."*
Community	8	34'13"	*"Serait l'fun que les gens qui travaillent, même les gens qui ne font pas partis du projet, que les gens le sachent, que les gens dans la communauté soient au courant de ce qui arrivera"*
	11	35'43"	*"Ce qui est important et de s'assurer que le succès du projet passe par une bonne communication entre les parties prenantes, surtout dans un aéroport."*

3.4.3 Final debate discussion

The interviewees were asked to answer two questions:

- Question 1: what your overall perception of 3D visualization impact over the stakeholder management on the project activities are?
- Question 2: If your last airport project experience would be redone, how would you like to be involved in?

Figure 3.8 shows the answers' classification that embrace just the main idea for each answer.

[192] On this table is possible to observe extracts from the interviews demonstrating each interviewee contribution to the findings for this discussion. Also, it is indicated where the evidence can be found on the interview audios and the category to which evidence was categorized. These categories and their interconnections can be seen also on the Figure 3.7, page 110.

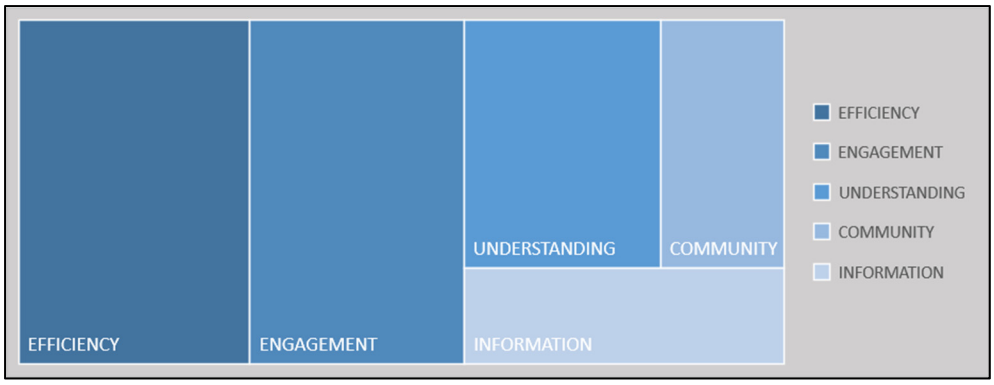

Figure 3.8 Categories emphasized on the final debate answers

When considering just the main idea for every answer, it is possible to observe the relevance of “Efficiency”, “Engagement”, “Understanding”, “Community” and “Information” concepts have to their overall perception of the 3D visualization impacts over the stakeholders’ management.

3.5 Validation

This section shows the results of the interviewees’ contributions to the findings, subsection 3.5.1 and the framework validation, subsection 3.5.2.

3.5.1 Sampling

The sampling constitution is described in section 2.3, page 49. Table 2.3, page 50, shows the balance amongst the interviewee's profile, which is aligned with the research intention of gathering the overall perception about stakeholders' impacts, instead of from any specific point of view. On this subsection, the participant's contribution is detailed as follows. Table 3.16 shows the contribution extracted from every interview.

Table 3.16 Evidences per interviewee

Interviewee	Interviewee group	Evidences provided
1	Director level	28
2	Delivery level	35
3	Director level	22
4	Delivery level	22

Table 3.16 Evidences per interviewee (Continuation)

Interviewee	Interviewee group	Evidences provided
5	Delivery level	30
6	Director level	35
7	Delivery level	20
8	Client side	16
9	Client side	27
10	Delivery level	25
11	Client side	30
12	Client side	14
13	Director level	36

On the table above, it is possible to observe that the number of contributions per interviewee. From a total of 340 contributions, 87 were from the clients' group, 121 from the Director level and 132 from the Delivery level. Considering the number of interviewees for each group, we have the average of 21, 30 and 26 contributions per member, respectively. This is consistent with the research intention to get a heterogeneous point of view, embracing all types of project participation.

This balance between the contributions and the interviewee characteristics shows that the question subjects are not related exclusively to one profile type but concerns to all of them. It represents that both stakeholder management and its 3D visualization effects are perceived as a relevant matter by the clients, direction and operational project levels. However, by analyzing the most cited categories from a profile type perspective, it is possible to observe some interesting similarities and differences amongst them. Table 3.17 summarizes the comparative between the categories most cited by each interviewee profile.

Table 3.17 Categories presented by each interviewee profile

Categories	Client side	Director level	Delivery level
UNDERSTANDING	*	*	*
EFFICIENCY	*	*	*
INFORMATION	*	*	*
ENGAGEMENT		*	*
EXPERIENCE	*		*
HIERARCHY AUTHORITY	*		*
RELATIONSHIP		*	
COMMUNITY	*		
TRUST		*	
CONFLICT			

Based on the Table 3.17 above, Understanding, Information and Efficiency are those concepts present on all categories, representing the core perceptions of the research question. Also, the category of Conflict is not present as the most relevant for any of the interviewees' profiles.

Despite this alignment, each profile shows its particularities when considering the categories present on its answers. For the client side, the concept of Community is present exclusively, as Relationships and Trust are to the Director level. On the other hand, the Delivery level is the most aligned one with both the two other levels, connecting the Client side and the Director level, even if not presenting those categories exclusively present for the Client and Director level, Community for the first, and Relationship and Trust for the second one. These relations can also be observed when compared with the total of occurrences, being Understanding, Efficiency and Information the most cited concepts when considering all profiles. Figure 3.9 shows the comparison amongst categories based on the total of occurrences.

Figure 3.9 Total occurrences for each category

When considering the total of answers, it is possible to observe that the results for the interviewee's profiles are aligned with the total number of contributions made by each category. This alignment is important to reflect the perspective of all profiles in order to build a heterogenous answer to the research question.

When comparing how relevant one category appears for each interviewee profile, some particularities can also be observed related to each interviewee profile. Figure 3.10 below shows a comparison amongst the most cited categories from each of the interviewee's profile.

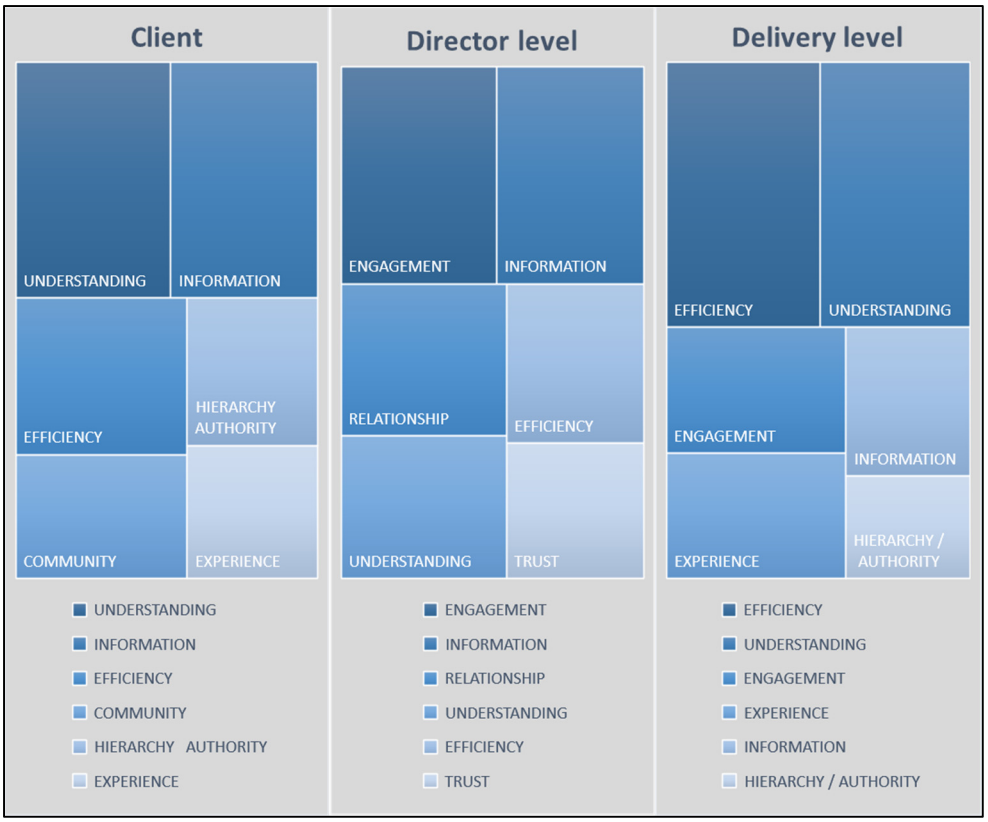

Figure 3.10 Most cited categories for each interviewee profile

The figure above demonstrates the proportionality of occurrences for each category by each interviewee profile. The categories are organized from a decreased list, starting with the most cited ones. Were included on this analysis just those categories with expressive numbers.

From a Client perspective, it is interesting to notice that those three concepts present in all profiles are also the first three most cited ones for this profile. The presence of Understanding as the most relevant one is very significative and relate to most fundamental aspect of 3D visualization. From a Director level perspective, the Engagement category is the most relevant and reveals the fundamental focus for this level of project participation, which is related to the management aspects of project activities, especially related to stakeholders. From a Delivery level perspective, it is interesting observe that the Efficiency concept is the most relevant, also leading to the focus of this project participation level, which is the operational aspects of project activities.

3.5.2 Framework

The validation of the framework and its findings was performed with two specialists with different backgrounds (see subsection 2.1.2, page 47). The Validation Protocol (see APPENDIX IV, page 147) was presented without any further explanation about the theoretical references used to structure the research design. Thus, their analysis was based just on their experiences. Each of their contributions is stated above, some of them accompanied by the author's observations.

The validator 01

- The overall perception about the framework is that it is *"solid and works. It is clear, fair, enough and easy to understand"*. This validator agrees with all points presented on the framework and its findings.
- It was suggested by this validator that Dimension 2 might include information management.

On this dimension, the focus was just on the quality of the information being used on the communication process. No other element of it was included on the two questions to this dimension: what the relevance of quality information to the communication process is, and how the impacts when added information in 3D format are. To include the information management to this dimension, as suggested by the validator, will bring a new element to the communication process that was not covered by the research.

- Despite the fact that the validator considered the categories as correct, the category of experience received more attention, especially by the very word used to nominate this category. He stated the term "knowledge" could fit better because *"when the stakeholders do not understand something it is not because of their previous experience, but because they don't have the knowledge and tools to decode technical documents"*. This validator argued that the term experience could mean the anecdotal experience instead of on the field experience, which brings some bias to the term. Instead of experience, this validator suggests the use of knowledge.

Although the validator's suggestion seems very appropriate to overall data analysis, the author will keep the term chosen for this category, which was framed based on the interviewees' answers. For the interviewees, the experience is related to the specific domain knowledge, but also, the knowledge gained through previous participation on projects that encompass such domains. For them, the formal and structured knowledge is not needed, but that knowledge gained by living the same experience before, or at least, the similar experience that gives you the tools to codify the language being used on that new project. However, an extra explanation was added to the subsection 2.4.1, page 51.

- Regarding the category experience, the validator added that *"the more experience (time in the company, for example, referring to the anecdotal experience) one has, the less willing one would be to understand, because an anecdotal experience is valued more than knowledge and on the field experience"*. This context leads to 3D visualization being able to break this bias, because explanation is not needed, the visualization talks by itself. In this sense, the validator agreed with the finding that by improving the project propositions understanding, the 3D visualization can reduce the impacts that the lack of experience can bring.
- Another aspect stated by the validator is the social aspect involving using 3D visualization: *"it breaks barriers to decode the information, because knowledge is not needed to understand a 3D"*, adding the notion of *what you see is what you get* the concept, where there is not space to go around the issue. The path is straight to the results. By stating that *"the 3D visualization levels everyone"*, the validator agreed with one of the research findings: the 3D is a common language that everyone can read.
- Relating to the findings on Dimension 2, the validator added another element linked to the lack of experience: the imprecise information process, always present in companies. In this case, the lack of experience from the project side not being able to tailor the information as needed, which might impact on the creation of trustful relationships. In his understanding, *"trust is a synonym of attention, where those that receive attention will become satisfied by being remembered and included in the process, generating trust because of this direct relationship that is created"* with the communication process. Also, he stated that *"understanding dominates experience and trust, and also creates engagement and trust, while*

experience or knowledge gives the tools needed for understanding" at the same time. In doing so, the validator agreed with the finding for this dimension.

- Relating to the findings on Dimension 3, the validator agreed that engaging stakeholders earlier in the process is fundamental, and that lack of experience on the domain is also a challenge. However, the earlier engagement, from his point of view, *"is not an issue but the project manager responsibility"*.

The author agrees with this observation that stakeholder engagement is one of the project manager responsibilities. However, the author also agrees with the interviewees' perception of the engagement as a challenge due to its difficulty.

- The validator pointed out that the background of the three dimensions schemes is project information. All processes are there to generate and manage project information.

The author agrees with the validator. However, project information is not the subject of this study.

The validator 2

- This validator agreed with the dimensions. However, he observed that, in his point of view, *"stakeholder management, communication process and decision-making process are so intimately linked that they are probably the most influential ones and impossible to separate one from another"*. He goes further arguing that for him *"communication process starts before stakeholder management in a more holistic view of projects in airports"*.

The author agrees with the validator perception that all three dimensions are closely linked. It is because of this understanding that the interviews were framed using the path that goes from the more superficial aspect, the broadest dimension of stakeholder management that includes every aspect related to this relationship between stakeholders and project, to the deeper one, the narrowest dimension of the decision-making process, which is focused just on the aspects related to the activity to make decisions during the project execution.

- This validator agrees with all the challenges to manage stakeholders stated by the interviewees – Dimension 1, Question 1. However, he complemented that list adding another challenge related to *"having very different objectives for the airport that stakeholders try to achieve. It is not conflict, but different business objectives"*. He also linked that situation to the weight each stakeholder carries on the decision-making process. He finalizes stating that *"tools like BIM could start helping the decision-making process because it can illustrate the pros and cons looking to the options, which facilitate the process"*.

Conflict, or business objectives misalignment as the validator stated, is present on the literature but not on the interviewees' answers. Also, the stakeholders' weight to the decision-making process is contemplated in the category of Hierarchy/Authority.

- Regarding the strategy to engage stakeholders, he agrees with the concepts stated by the interviewees, but he also argued that for him, *"is all about transparency and the simple basic human nature that claims for understanding"*. As part of a good stakeholder management strategy he stated that *"is important to understand the cultural context within which the project is operating, country-wise, city-wise, which include politics, but as well within the organization, looking for it in a holistic perspective to reach that trust and transparency, essential elements to build the community sense and to achieve the desire outcome"*.

His complementation is very interesting when considering various projects in within different contexts. Despite transparency being present on some answers, this cultural aspect is not mentioned by the interviewees. This could be a result as they are being immersed in their own culture and answering the questions focusing just on the case study.

- Related to the Dimension 2, question 1, he stated that *"is essential to have the right information in the right time"*, agreeing with the interviewees' answers. However, he questioned the use of the term quality, arguing that *"it can be defined in very different ways, shape and form, depending on who you talk to"*. Although the research refers to the 3D visualization, he would *"expend it for a much wider BIM, with 4D, 5D or 6D. Depending on who is defining the quality, some of these dimensions in BIM will be more relevant. Again, the*

right time and right information, for the right individual, because each of these stakeholders will be looking for different information".

The quality information definition was kept open to the interviewees to define it as the right one for them. The research focused on the effects of having the good quality information by the interviewee perception. In this case, a uniform concept of quality does not influence the research, just because exactly as mentioned by the validator, the quality definition has many different conceptualizations depending on who is talking.

- Considering the impacts that 3D visualization can have over the communication processes (Dimension 2, question 2), he agreed entirely with the engagement final impact. He also highlighted that the advantage of BIM is to consolidate all project information in a single model forming a common basis of understanding. He argued that *"in order to get the common basis to discussion and decision-making process, everyone needs to have the same information with the level of quality"*.
- Related to Dimension 3, he would not add another element to those stated by the interviewees for the question 1. Considering the impacts stated for question 2, he agreed with the interviewees' impacts, but he highlighted that the 3D visualization *"improves interpretation, but sometimes does not fully answer because the model by themselves cannot yet define the entire experience. It gets close, but it has still a part of the final product that will not be 100% delivered by the model"*.

CHAPTER 4

DISCUSSION

The research aim was to find out how the use of 3D visualization of project information may impact stakeholder management. The case study chosen was an airport engineering project that combines the multiple stakeholders' environment of airports to the construction and project management technical domains in a scenario where the management of all actors involved, internal and external stakeholders, assume an important role for gathering project success. The subsections that follow compare the results of the data analysis to the content of the literature review.

4.1 Dimension 1 – Stakeholder Management

The aim of this dimension was to identify the challenges to manage stakeholders on this multiple actors' environment present on airport projects, and what would be a good strategy to manage them. The results show that engaging stakeholders is the biggest challenge faced by airport stakeholders' management. This finding is consistent with the literature where scholars point out that just involving as many stakeholders as possible on the decision-making process is not enough (Wijnen et al., 2008). Even if they are involved, they do not engage because they have divergent interests (Zografos & Madas, 2006), becoming a very difficult task to satisfy all of them (Harrison et al., 2012).

This challenge gets its complexity enhanced due to the lack of experience in both, airport industry of the project team, and construction process of airport stakeholders. These two aspects were significantly present on the interviewees' answers, despite the lack of research on these subjects, as shown by the literature review. For the second aspect related to experience, technologies as BIM can fulfill this necessity of understanding alignment.

Another aspect not present on the literature and referred by almost all interviewees is the failure in getting the right participants involved, especially with the power to make decisions. Despite the idea that having the ones empowered to make decisions joined on the decision-making

process being common sense, the importance to this stakeholders' group is so evident that the lack of more profound studies of its impact to the project success is a gap that deserves more attention, especially because it can lead to the entire project failure. This issue may be related to one of the biggest construction industry (Fellows & Liu, 2012) and airport engineering project (Bosi, 2015b) problems, which is namely communication.

An interesting aspect not present on the findings, but largely present on the literature referring to projects in general as also specifically on airport projects, is related to conflicts as already mentioned on subsection 3.1.3, page 77. Scholars state that conflicts among airport stakeholders are based on the disagreement about the parameters to planning and designing airports (Wijnen et al., 2008), as to how would be a satisfactory performance of its operations (Kleinschmidt et al., 2010; Zografos & Madas, 2006). As mentioned by the Validator 2, page 129, as airport stakeholders have very distinct business objectives, they may never agree with some project objectives. Then, this misalignment will persist all over the project, becoming almost impossible not to have some sort of conflict among stakeholders, as the interviewees suggested.

Concerning the strategies to better manage airport stakeholders, the findings suggest that building efficient communication process based on trustworthy relationships may decrease the conflicts between stakeholders. However, there are some barriers to establish this effective communication among airport stakeholders, like the lack of integration of the airport process, but also technical and cultural aspects (Pastor & Benavides, 2011). This leads to the concept of community suggested by the interviewees as a strategy to truly get the buy-in of stakeholders.

Interestingly, trust had a role on the strategy, but, similarly as conflict, does not figure among the challenges. A relevant aspect of trust that impacts the relationships on airport context is the willing to be vulnerable, that is the primary obstacle (Smyth, 2012) to develop trustful relationships (Davis & Walker, 2007). As trust is linked to commitment (Costa, 2003), the concept of community used by the interviewees can be related to build trustful relationships.

This sense of belonging that the concept of community brings, in the perspective of the interviewees, is another gap in the literature related to the domains studied on this research.

4.2 Dimension 2 – Communication Process

The aim of this dimension was to identify the relevance of quality information to the communication process, and what the impacts to this process are when visualizing information on the 3D format. The finding that good quality information can impact on stakeholder engagement is aligned to the literature (Loosemore, 2012; Olander & Landin, 2008). Also aligned is the idea that good information impact the communication among stakeholders and project team, increasing the efficiency of its process (Landin, 2000; Olander & Landin, 2008).

The results go a little bit further, saying that an efficient communication process is based on the precise information needed by the stakeholders (Whyte et al., 2010), which combined with a better understanding of the subject being discussed, can promote trust to the process (Bew & Underwood, 2010). At the end, better understanding through a more efficient and trustworthy process can create engagement. The idea is simple: you have the information that you need, you understand it clearly, and then you trust on it. With these elements, the communication process gains the stakeholders' attention, which means, their engagement on the discussion. Furthermore, the findings suggest that this is a virtuous cycle. As sharing the precise information can create engagement, engaged actors contribute to the project by sharing ideas and knowledge, that improves the quality of information (Bourne & Walker, 2005).

When using the 3D visualization as a tool to inform stakeholders, the results endorse the literature by inferring that it improves the understanding and the efficiency of the communication process (Azouz et al., 2014; Crotty, 2013; Kunz & Fischer, 2012). The better understanding gain through the 3D visualization reduces the lack of experience by creating a common language that all actors can speak. Scholars say that reading technical documents is a challenge (Crotty, 2013; Kunz & Fischer, 2012), and in this point the research findings and the literature are aligned.

However, the concept of experience used by the interviewees is not just the capacity of reading drawings, graphics and sheets, as stated by the literature. It goes deeper, involving the capacity of stakeholders (internal and external to the project) to collaborate with their own knowledge (airport or construction domains) in order to achieve the project outcomes. In this sense, the visualization of the project solutions in 3D format level all actors to be able to collaborate, improving their engagement. Along with a better understanding promoted by the 3D visualization, and the access of the precise information needed by the stakeholders, comes the trust on the information, that also corroborate to their engagement.

4.3 Dimension 3 – Decision-making Process

The aim of this dimension was to identify the challenges to engage stakeholders to the decision-making process and the impacts to this process when using information in 3D format. The challenges stated by the interviewees for this dimension are very similar to those of the Dimension 1, adding to the lack of experience and hierarchy/authority, the findings show the importance of having the right information to make decisions as a challenge to get stakeholders engaged in the process. For the first two challenges, experience, and hierarchy/authority, both are not related to the concepts extracted from the literature review, as explained on subsection 4.1, page 133. However, the importance of having good information is aligned with the literature, as also is the trust that derives from this quality information (Schade et al., 2011).

It is worthy to notice that, as also mentioned on subsection 4.1, page 133, the conflicting interests are not present on the challenges to engage stakeholders on the decision-making process listed by the interviewees. However, researchers agree that the existence of different objectives amongst stakeholders brings difficulties to this process, as alignment between actors is not easily achieved (Schade et al., 2011).

As explained on subsection 4.2, page 135, the use of 3D visualization impacts the lack of experience by creating a common language that all actors can comprehend. It was already cited on the previous subsection that as the 3D visualization improves the communication process by enabling understanding and increasing the trust on the information flowing through the process. It also improves the decision-making process that uses that better communication.

This finding is aligned to the literature because trust has an important role that affects stakeholder engagement (Bourne, 2005) and the increased stakeholders' engagement improves the decision-making process efficiency (Mathur et al., 2008).

4.4 The 3D visualisation impacts on stakeholder management

Based on the interviews analysis result, the overall perception about the 3D visualization impacts on stakeholder management consists in three main elements: it provides good quality information, it promotes better understanding, and it increases the efficiency of project processes, which is in accordance with the literature. The findings go further about the role that the understanding level has, bringing the idea that it can create engagement and the sense of community that is also reinforced by a better level of engagement. These two concepts, engagement and community, will impact the efficiency of project process themselves. Figure 3.7, page 111, shows the connections between these concepts.

However, there are two absent concepts from the interviewee's speeches that deserves attention: conflict and collaboration; and a concept present on dimensions 1 and 2 but absent on the overall impact perception: relationships. These three concepts are intimately connected, and, intriguingly, they were not cited by any interviewee. Figure 4.1 below shows the findings extracted from the interviewees, complemented from important concepts extracted from the literature.

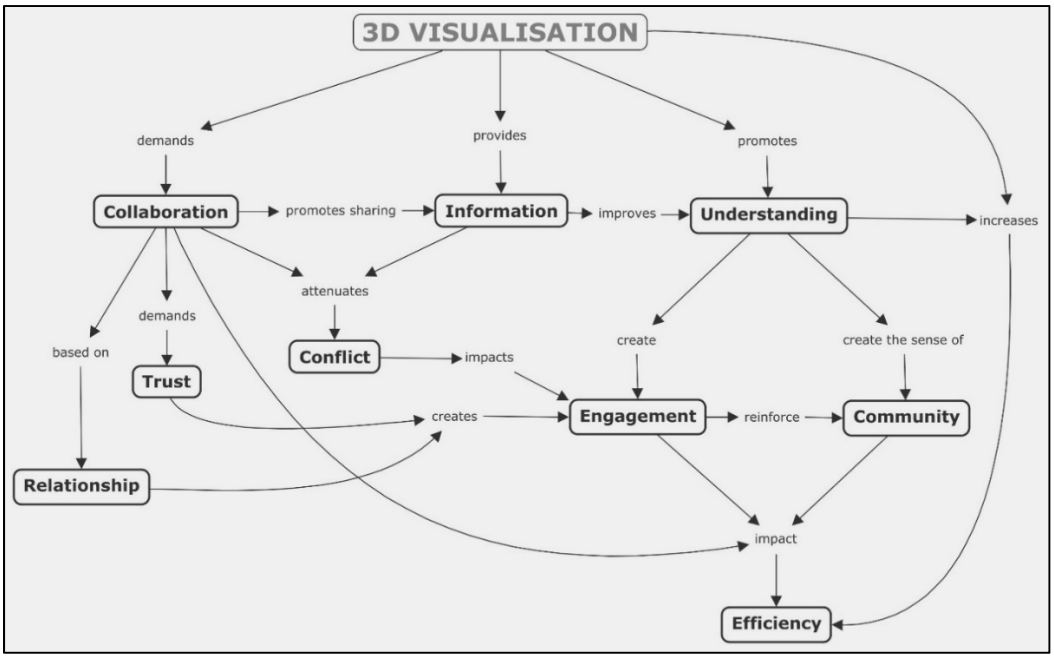

Figure 4.1 3D visualization impact on stakeholder management

Collaboration and information in 3D format are mutually dependent. The first enable the second through sharing (Dietrich et al., 2010; Eastman et al., 2011); and the second promotes the first by allowing alignment among participants (Crotty, 2013). Collaboration demands trust and common objectives (D'Amour et al., 2005; Schöttle et al., 2014), that could be understood as part of the community concept. Collaboration is also based on relationships (Kvan, 2000; Schöttle et al., 2014) and might limit conflicts (Dietrich et al., 2010; Egan & Williams, 1998).

The 3D visualization positively impacts the efficiency of stakeholder management, especially by providing good quality information and improving understanding. However, providing information in 3D format demands collaboration, which allows a sharing environment, which improves the understanding and, consequently, the efficiency of all processes using that information. Collaboration also attenuates the conflicts, which has a direct impact on stakeholders' engagement. Furthermore, because collaboration depends on the relationships among actors to be achieved, and it creates a trustworthy environment, collaboration might also impact significantly the stakeholders' engagement, which improves the efficiency of stakeholder management.

The conceptual map represented on Figure 4.1 was built to explain the connections between categories, answering the research question about the impact that the 3D visualization can have to the stakeholder management and to the project success itself. This conceptual map might be considered by the project manager as a tool to build an action plan to better manage stakeholders. Each concept on the map could be considered a focal point that the project manager could use to establish the strategies to improve the approach to each stakeholder group and to measure if the actions to manage them are been affective.

For instance, if the project manager wants to intensify the external stakeholders' strategies, he/she could provide actions to reinforce the sense of ownership of the project, getting them knowing how it would look like, using tools as virtual reality. Furthermore, if the project manager wants to verify if a specific group of stakeholders are being properly heard, he/she could look at signs of conflict between requirements that could bring conflicting situations among different groups and acting accordingly before any damage to their engagement to project happens.

By using the conceptual map as a guide to build strategies to manage stakeholders and control their efficiency, the project manager and his/her team could improve the stakeholder management, helping to achieve the project success.

CONCLUSION

Airports deal with countless elements that impact on their efficiency, starting with its multiple stakeholders' environment with not so rarely, divergent objectives. This industry is complex and dynamic, demanding the same rigor from any intervention to its infrastructure. Then, construction projects facing this challenge with a strategy that includes stakeholder management could raise the chances of project success by implementing communication processes that help those stakeholders on the decision-making process.

An engineering project inserted in this complex scenario is fruitful to observe the influence of BIM technologies on the effectiveness of the stakeholders' management. Our assumption was that, by refining the information quality used, the communication process will gradually improve, producing a positive effect the decision-making process. Thus, the research question was how the use of 3D visualization, the aspect of BIM technologies being focused on, can impact the efficiency of stakeholders' management. The study objectives were: to verify the impact of good quality information on stakeholder management, how it affects the decision-making process and the stakeholder engagement.

A single case study - the terminal area enlargement of the Québec City International Airport - was chosen to answer the research question. The data was gathered mainly by interviews made with the stakeholders, internal and external to the project. The data was codified using concepts extracted from the literature review and the interviews. Those most cited ones were used on the data analysis and the results were a combination of the interviews and the literature review content. The findings were demonstrated through the conceptual maps in which the concepts on the map were the categories used to codify the data, and the links between them were the connections among categories.

Running projects in a complex environment where multiple stakeholders might have divergent opinions about the project outcomes is a challenging task. The research findings suggest that the use of 3D visualization can break the barriers of understanding, creating a common language that all stakeholders can speak, impacting on their engagement to the project activities.

Considering the data analysis results, combined with concepts based on the literature review, this research can contribute progressing the understanding of the 3D visualization impact on stakeholder management. The findings answer the research question – how the 3D visualization impact stakeholder management – with the following aspects:

- it demands a more collaborative project environment for sharing information, which helps to develop trustworthy relationships that lower the conflicts between stakeholders and increase their engagement to the project activities;
- it provides information in a readable format that aligns understanding and lower the conflicts amongst stakeholders, internal and external;
- with fewer conflicts and an improved understanding, it creates engagement, reinforcing the sense of community within airport stakeholders that increase the efficiency of the stakeholder management process.

Other contributions from this research are:

- the new concepts extracted form the interviews and not encountered on the literature review, namely hierarchy/authority, community and experience;
- the framework used to structure this research that could be tested on other cases to verify how strong it is answering the research question;
- the choice of using the conceptual map technique to visually demonstrate the abstract concepts present on this research;
- the management implications when working in a collaborative work environment, including how to organize a collective effort to take the best advantage of new technologies like BIM, as the needed organizational and personal behavior changes.

Rival Explanations and Limitations

Considering the specific case study of this research, some rival explanations for the findings, especially concerning the stakeholders' engagement to the projects, could be the small number of actors involved that could have allowed the team to engage stakeholders in more productive ways. Besides, the project environment generated by this specific airport size and business model could have influenced the level of engagement, impacting more on the stakeholders'

management than the exposure to the 3D visualization, subject of this study. These two characteristics, combined with the fact that this was the first project with BIM in airports in Canada, could have propitiated a positive environment to the project, which may have influenced the overall success of the stakeholder management results.

The limitations to this study are based on the single case being studied and the lack of the researcher participation during the project execution for direct observations. Despite the interviewee's profile had covered all types of the project participants, given to the findings some heterogeneity, the findings are based on the speech of twelve key actors and may not represent the truth for the majority of stakeholders. Also, despite the methodology applied to the data gathering and analysis, both processes were carried out by one researcher. Then, to exclude such bias on the findings, the research should be applied to different airports and with a larger sample to confirm the results.

Recommendations for further research

The literature review for this study focused just on researches made specifically to the related domains, airport industry, construction industry and project management. From this context where identified some gaps on the literature that could be further explored:

- The influence of the lack of previous experience of the project team in airport context and the lack of previous experience of airport stakeholders on construction processes to the achievement of project objectives;
- The level of the hierarchy of those involved in the project activities, especially the authority to make decisions and its impact on the project activities;
- The sense of belonging to the project as part of its team through the concept of community and its impact on the community engagement to the project objectives and activities.

On the other hand, the analysis of the data gathered by the interviews considered just the more representative ideas. However, some perceptions, despite coming from fewer interviewees, are interesting insights to future researches concerning the changes on the organizational culture and professional behavior:

- **The resistance to new technologies:** being BIM a new technology, it could not be totally comprehended by the majority of technical professionals, as it is also true for the airport community. As mentioned by one interviewee, *"pour le moment il y a des gens qui ne sont pas super habitués à la technologie donc ils sont très réfractaires à cette idée de technologie"*[193] [Delivery level]. It will take some time to vulgarize this way-running engineering projects to truly see its benefits. *"On n'est pas là à 100 % encore, je dirais que la société, du moins le secteur (ou le domaine) aéroportuaire, ne maitrise pas encore ça à 100%"*[194] [Delivery level], which means that the way people interact with this kind of technology might interfere on the positive impacts that it implementation can offer.
- **Organizational changes:** running a construction project with BIM technologies brings numerous benefits. However, as stated by an interviewee, *"le BIM ne règle pas tout, parce que c'est une boite noire que tu dois nourrir pour avoir l'information pertinente. Si les gens ne sont pas conscients qu'il faut mettre la maquette à jour, selon moi on va arriver au même constat que lorsqu'on utilisait du papier. Pour moi, le BIM ce n'est pas la clé pour tout"*[195] [Director level]. Concomitant with BIM technologies implementation should come organizational changes that propitiate fully utilization of its benefits.
- **Personal behavior changes:** another aspect is related more to the effects of the utilization of BIM and the organizational culture. With BIM stakeholders are much more involved in the decision-making process, but sometimes, *"les gens n'aiment pas être imputables de leur décision, parce que souvent, la facilité n'est pas de répondre ou de ne pas se positionner"*[196] [Director level]. Thus, new technologies like BIM, or even more integrated delivery methods, require a different behavior of its players and might impact the overall project success.

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[193] *"For the moment there are people who are not super used to technology and are very reluctant to this idea of technology."* [Delivery level]
[194] *"We are not 100% there, I will say that the airport community does not master it yet to 100%."* [Delivery level]
[195] *"BIM does not solve everything, because it's a black box that you have to fulfill to have the relevant information. If people are not aware of keeping the model actualized, we will come to the same conclusion by the time when we used paper. For me, BIM is not the key to all."* [Director level]
[196] *"People do not like to be imputable to their decision, because often the easiest way does not respond or do not position yourself."* [Director level]

APPENDIX I

SEMI-STRUCTURED INTERVIEW PROTOCOL (English first version)

INTRODUCTION

- Interviewer presentation
- Research presentation
- Permission to record the interview
- Interview structure presentation

RESPONDENT'S IDENTIFICATION

Title:

Name:

Last name:

Current position:

Working experience in the airport industry:

LAST EXPERIENCE RELATED TO AIRPORT PROJECTS

- What was the most recent engineering airport project you participated in? What was your role and your level of involvement?
- Considering this last experience on airports, what was the most challenging aspect about this project? And the most rewarding aspect about it?

DIMENSION #1: STAKEHOLDER MANAGEMENT

The activities that have their place on airports involve not only passengers and air companies. To be operational, an airport demands a variety of services to process passengers and luggage, providing security and comfort, which require diverse professionals as those directly related to the airport administration, air companies, governmental and regulatory institutions, as commercial services, like restaurants, stores and other convenience services, which, joined to other occasional airport infrastructure users, from what can be called the airport community, the airport stakeholders.

1. Considering this multiple stakeholder environment, running engineering projects can be pretty challenging. Could you tell how the airport community is managed and what are the challenges to engage them on the project objectives?

DIMENSION #2: COMMUNICATION PROCESS

To gain and maintain the airport community engagement to the project objectives, an efficient communication with them and the project team is fundamental, especially considering the complexity of the airport environment and its multiple actors. For example, when reporting the pace of execution of project activities or presenting a design solution for some construction issue, everyone involved should get the same understanding about the information being communicated to be able to align ideas and solutions.

2. Considering this aspect, what is the relevance of the quality of the communication amongst the airport community and the project team about the execution of the project activities?

DIMENSION #3: DECISION-MAKING PROCESS

Airports need to get an efficient and effective decision-making process. For example, if it is necessary to interrupt the operation of some sector of the departure area to get a job done, the decision including how to maintain this area operational with the required level of comfort, how to isolate it to permit access to the work team maintaining the security conditions. Then, the project team presents to operational, commercial and security teams the possible scenarios to involve them in the decision about what would be the best strategy and they are invited to contribute and required to give their approval.

3. Considering this scenario and your current experience on involving the airport community or being involved by the project team on decisions like that, what are the challenges presented?

FINAL DEBATE

4. Considering your experience, what is your overall perception about the impacts that the use of 3D visualization can cause to stakeholders' management at airport industry?

APPENDIX II

SEMI-STRUCTURED INTERVIEW PROTOCOL (English final version)

INTRODUCTION

- Interviewer presentation
- Research presentation
- Permission to record the interview
- Interview structure presentation

RESPONDENT'S IDENTIFICATION

Title:
Name:
Last name:
Current position:
Working experience in the airport industry:

LAST EXPERIENCE RELATED TO AIRPORT PROJECTS

- What was the most recent engineering airport project you participated in? What was your role and your level of involvement?
- Considering this last experience on airports, what was the most challenging aspect about this project? And the most rewarding aspect about it?

DIMENSION #1: STAKEHOLDER MANAGEMENT

The activities that have their place on airports involve not only passengers and air companies. To be operational, an airport demands a variety of services to process passengers and luggage, providing security and comfort, which require diverse professionals as those directly related to the airport administration, air companies, governmental and regulatory institutions, as commercial services, like restaurants, stores and other convenience services, which, joined to other occasional airport infrastructure users, from what can be called the airport community, the airport stakeholders.

1. **Considering this multiple stakeholder environment, running engineering projects can be pretty challenging. Could you tell how the airport community is managed and what are the challenges to engage them on the project objectives?**

DIMENSION #2: COMMUNICATION PROCESS

To gain and maintain the airport community engagement to the project objectives, an efficient communication with them and the project team is fundamental, especially considering the

complexity of the airport environment and its multiple actors. For example, when reporting the pace of execution of project activities or presenting a design solution for some construction issue, everyone involved should get the same understanding about the information being communicated to be able to align ideas and solutions.

2. Considering this aspect, what is the relevance of the quality of the communication amongst the airport community and the project team about the execution of the project activities?

DIMENSION #3: DECISION-MAKING PROCESS

Airports need to get an efficient and effective decision-making process. For example, if it is necessary to interrupt the operation of some sector of the departure area to get a job done, the decision including how to maintain this area operational with the required level of comfort, how to isolate it to permit access to the work team maintaining the security conditions. Then, the project team presents to operational, commercial and security teams the possible scenarios to involve them in the decision about what would be the best strategy and they are invited to contribute and required to give their approval.

3. Considering this scenario and your current experience on involving the airport community or being involved by the project team on decisions like that, what are the challenges presented?

FINAL DEBATE

4. Considering your experience, what is your overall perception about the impacts that the use of 3D visualization can cause to stakeholders' management at airport industry?
5. If the project was to be redone, how would you like to be involved?

APPENDIX III

SEMI-STRUCTURED INTERVIEW PROTOCOL (French final version)

INTRODUCTION

- Présentation de l'intervieweur
- Présentation de la recherche
- Permission d'enregistrer l'interview
- Présentation de la structure d'entrevue

IDENTIFICATION DU RÉPONDANT

Titre:
Nom:
Position actuelle:
Expérience de travail dans l'industrie aéroportuaire:

DERNIÈRE EXPÉRIENCE LIÉE AUX PROJETS AÉROPORTUAIRES

- Quel a été le plus récent projet d'aéroport d'ingénierie auquel vous avez participé? Quel était votre rôle et quel était votre niveau d'implication dans ce projet?
- Compte tenu de cette dernière expérience sur les aéroports, quel était l'aspect le plus difficile de ce projet? Et l'aspect le plus gratifiant à ce sujet?

DIMENSION # 1: GESTION DES PARTIES PRENANTES

Les activités qui se déroulant dans les aéroports n'impliquent pas seulement les passagers et les compagnies aériennes. Pour assurer le confort et la sécurité des usagers et la gestion des bagages, l'aéroport fait appel à divers intervenants, notamment l'administration aéroportuaire, les compagnies aériennes, les institutions gouvernementales et règlementaires, les restaurants, les magasins et autres services qui forment la communauté aéroportuaire, etc. Les questions suivantes portent sur les relations entre l'équipe de projet et la communauté aéroportuaire.

1. Compte tenu de cet environnement où il y a de multiples acteurs, les projets d'ingénierie en cours peuvent être assez difficiles. Pourriez-vous nous dire comment la communauté aéroportuaire est gérée et quels sont les défis pour les impliquer dans les objectifs du projet?

DIMENSION 2: PROCESSUS DE COMMUNICATION

Pour obtenir et maintenir l'engagement de la communauté aéroportuaire envers les objectifs du projet, une communication efficace avec eux et l'équipe de projet est fondamentale, surtout si l'on considère la complexité de l'environnement aéroportuaire et de ses multiples acteurs. Par

exemple, lorsque vous signalez le rythme d'exécution des activités du projet ou que vous présentez une solution de conception pour un problème de construction, tous les participants doivent avoir la même compréhension de l'information communiquée pour pouvoir aligner les idées et les solutions.

2. Considérant cet aspect, quelle est la pertinence de la qualité de la communication (entre la communauté aéroportuaire et l'équipe de projet) sur l'exécution des activités du projet?

DIMENSION 3: PROCESSUS DE PRISE DE DÉCISION

Les aéroports ont besoin d'un processus décisionnel efficace et efficient. Par exemple, s'il est nécessaire d'interrompre l'exploitation d'un secteur de la zone de départ pour effectuer un travail, la décision comprend comment maintenir cette zone opérationnelle avec le niveau de confort requis et comment l'isoler pour permettre l'accès à l'équipe de travail et maintenir des conditions de sécurité. Ensuite, l'équipe de projet présente aux équipes opérationnelles, commerciales et de sécurité les scénarios possibles, pour les impliquer dans le processus de décision.

3. Compte tenu de ce scénario et de votre expérience actuelle d'implication de la communauté aéroportuaire ou d'implication de l'équipe de projet dans des décisions de ce type, quels sont les défis présentés?

FINAL DEBATE

4. Compte tenu de votre expérience, quelle est votre perception générale des impacts que l'utilisation de la visualisation 3D peut avoir sur la gestion des parties prenantes dans l'industrie aéroportuaire?

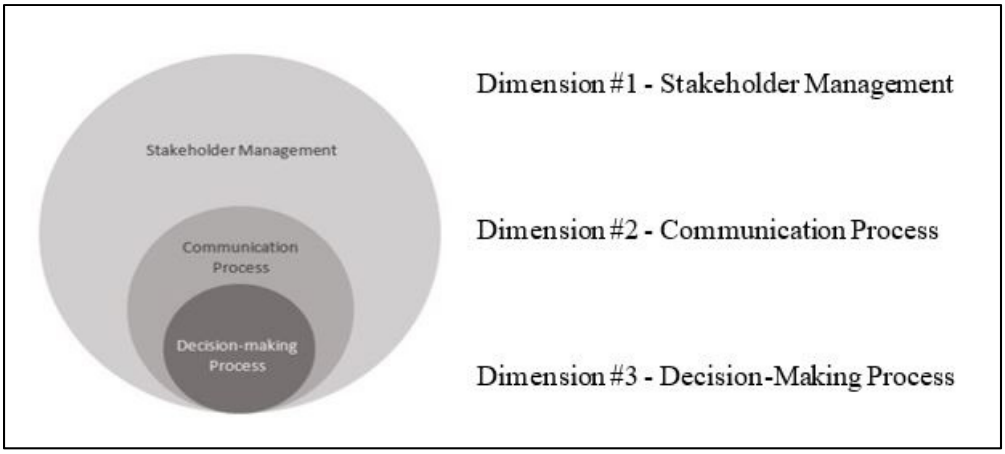
5. Si le projet était à refaire, comment aimeriez-vous être impliqué?

APPENDIX IV

VALIDATION PROTOCOL

1. THE DIMENSIONS

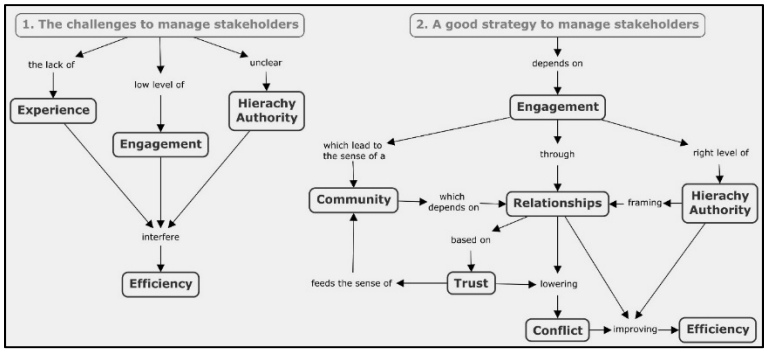
To verify the impact on stakeholder management when informing through 3D visualization, the interviews were framed using the dimensions described below:



1.1. The research focus was to verify whether the 3D visualization exposition can impact on stakeholder management. Considering this focus, do you agree that the decision-making process will demonstrate that impact?

2. THE CATEGORIES

DIMENSION #1 – Stakeholder Management: on this dimension, the interviewees where asked what were the challenges to manage stakeholders and what a good strategy would be.



From the interviewees' perspectives, the main challenges to manage stakeholders through the project activities (Question 01) include the project team lack of experience in the airport industry, and the lack of experience of construction industry and project management by those airport stakeholders involved on the project. Also, the wrong level of hierarchy/authority to

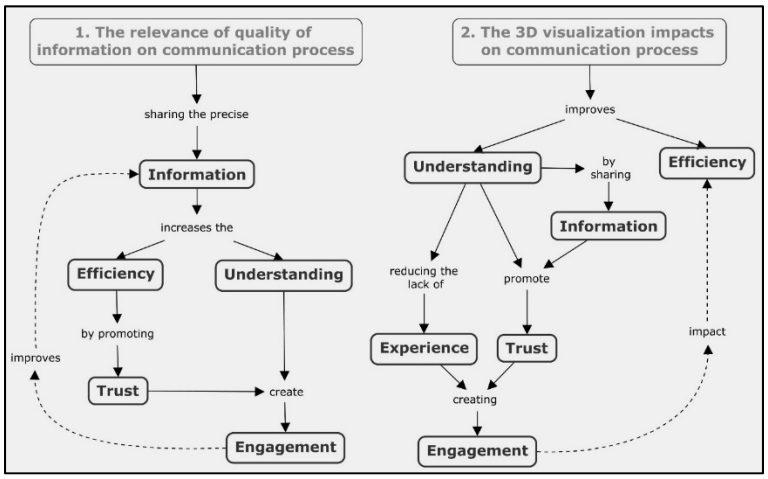
make decisions of those involved on the decision-making process, and the airport stakeholders' lower level of engagement, especially on the early stages of the project.

2.1. Do you agree with the interviewees' perspective of the challenges managing stakeholders?

The strategy to manage stakeholders (Question 02), from the interviewees' perspectives, depends on the engagement of those with the right level of hierarchy/authority to make decisions, which will create a sense of community based on trustworthy relationships, decreasing the conflicts amongst them.

2.2. Do you agree with the interviewees' strategy to manage stakeholders?

DIMENSION #2 – Communication process: on this dimension, the interviewees where asked to state the relevance of the information quality being communicated to the relationships amongst the stakeholders and the project team, and what would be the impacts when providing that information on 3D format.



The interviewees stated that the relevance of the information quality (Question 1) is on sharing a precise information to the stakeholders, considering the one that will receive it, its content, format and time. This sharing will increase the efficiency of the communication process as the information understanding, establishing trustworthy relationships among all involved, that lead to increased levels of engagement.

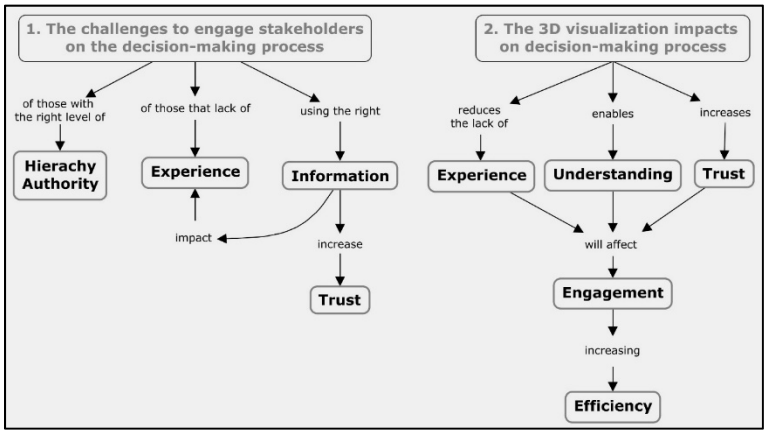
2.3. Do you agree with the interviewees' perspective of the relevance of the information quality?

When asked what would be the impacts on this process by providing the 3D visualization of the information being communicated (Question 2), the interviewees argued that it will improve the efficiency of the communication process by promoting a better understanding. This better comprehension will reduce the lack of experience on construction process and it will allow to increase the quality of the information by promoting trustful documents. With alignment of

understanding and increased trust, their level of engagement will improve, which impact the efficiency of project process.

2.4. Do you agree with the interviewees' 3D visualization impacts on the communication process?

DIMENSION #3 – Decision-making process: on this dimension, the interviewees where asked what the challenges to engage stakeholders on the decision-making process were and what would be the impacts when using the 3D visualization on the process.



The interviewees stated that the challenges to engage stakeholders on the decision-making process (Question 1) were the level of hierarchy/authority of those involved on the process, their lack of experience on the domains (mainly construction) and the use of the right information, which impact the level of experience, as also can increase trustful relationships among all involved and to the documents being generated.

2.5. Do you agree with the challenges stated by the interviewees?

From the interviewees' perspective for the 3D visualization impact on decision-making process (Question 2) include the reduction of the lack of experience on the domains (airport and construction), it enables a better understanding of the subject being discussed, and it increases the level of trust on the information being given. Those three concepts will affect the stakeholders' engagement, which can increase the efficiency of the decision-making process.

2.6. Do you agree with the interviewee's perception of 3D visualization impact on the decision-making process?

APPENDIX V

CATEGORIES THEORETICAL REFERENCES

Categories	Theoretical references		Literature related to
Engagement	(El-Gohary et al., 2006)	"A positive involvement with stakeholders can be a decisive factor that can 'make or break' a project." (p.604)	Construction Industry
	(Shindler & Cheek, 1999)	"Open and inclusive public processes enjoy increased support" (p.03). "Early and continuous involvement improves public understanding of the issues and managers understanding of participant perspectives." (p.05)	Construction Industry
	(Widén et al., 2014)	"Structured process of engagement with stakeholders should form an integral part of the innovation process and that doing so will raise the prospects of successful innovation diffusion." (p.06)	Construction Industry
	(Olander & Landin, 2008)	A proactive strategy to stakeholders' management is more likely to gain their support to the project.	Construction Industry
	(Chinyio & Akintoye, 2008)	Engage stakeholders demands a combination of approaches and skills, since stakeholders influence project in different ways.	Construction Industry
	(Thomson et al., 2003)	There is a need for a common value language amongst construction project participants to engage stakeholders. "This language must be usable by people with different knowledge, expectations and objectives so they can articulate their values." (p.14)	Construction Industry
	(Schade et al., 2011)	"From a client's perspective the AEC sector needs to be involved earlier in the building process. On the other hand, the AEC sector also needs to involve the client more in the design process to ensure the business and project goals as expressed by the client are met by the proposed design." (p.375)	Construction Industry
	(Wijnen et al., 2008)	"Inconsistencies in data, assumptions, models, and results, the current approach does not facilitate easy and comprehensive collaboration among stakeholders, resulting in excluding some of them altogether, or involving them too late." (p.17)	Airport Industry

Categories	Theoretical references		Literature related to
Efficiency	(Costa, 2003)	Relate trust to team performance, positively reflecting on the team outcomes and attitudes to the organization.	Project Management
	(Jehn & Bendersky, 2003)	"In order to have high performance and creativity, without too much loss of satisfaction or consensus-building ability, a group needs to have low levels of relationship conflict throughout its lifecycle, moderate levels of process conflict at the beginning, and moderate levels of task conflict starting in the middle of group's project or life-cycle." (p.228)	Project Management
	(Alper et al., 2000)	"The team performance will be affected by the way project teams deal with conflicts. 'In a team setting, knowing that the group members tend to manage conflict cooperatively can strengthen conflict efficacy and team productivity." (p.637)	Project Management
	(Chiocchio et al., 2012)	"Together, communication, coordination, cooperation, synchronicity, are key to processes that influence team performance." (p.08)	Project Management
	(Kozlowski & Bell, 2003)	Team effectiveness is influenced by three factors: coordination (manage interdependencies), cooperation (opposite of conflict) and communication (enable the other two factors).	Project Management
	(Gully et al., 2002)	Team-efficacy and potency are related positively to performance. Interdependence moderate the relationship between team-efficiency and performance but not between potency and performance.	Project Management
	(Chiocchio et al., 2011)	"Collaboration boosts the positive effect of trust and dampens the negative effect of task conflict, offering the opportunity to substantially improve performance." (p.87)	Construction Industry
	(Pabedinskaitė & Akstinaitė, 2014)	"In the course of the development of airports, the improvement of their performance and service quality is a highly topical and challenging issue, which is widely considered from various angles and using different methods." (p.408)	Airport Industry
	(Jehn & Bendersky, 2003)	"In order to have high performance and creativity, without too much loss of satisfaction or consensus-building ability, a group needs to have low levels of relationship conflict throughout its lifecycle, moderate levels of process conflict at the beginning, and moderate levels of task conflict starting in the middle of group's project or life-cycle." (p.228)	Project Management

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	(Pabedinskaitė & Akstinaitė, 2014)	"In the course of the development of airports, the improvement of their performance and service quality is a highly topical and challenging issue, which is widely considered from various angles and using different methods." (p.408)	Airport Industry
Understanding	(Kunz & Fischer, 2012)	"Only visual models have the power to support description to and evaluation by a broad class of stakeholders." (p.37)	Construction Industry
	(Toledo, González, Villegas, & Mourgues, 2014)	"Using the 3D/4D model improve the understanding of both the project progress control information and the information shown to help visualize and manage the project constraints." (p.976)	Construction Industry

Categories	Theoretical references		Literature related to
Understanding	(Wijnen et al., 2008)	"Information should be shared in such a way that an organization and its stakeholders gain an understanding of each other's perspectives and objectives. Only when there is a mutual understanding is it possible to look for solutions that are satisfactory to all parties involved." (p.18)	Airport Industry
	(Koch, 2004)	"Through the 3D visualization technology, an airport stakeholder can experience the visualization as though they were inside it, giving many more cues as to the desirability of a particular layout." (p.28)	Airport Industry
	(Emmitt, 2010)	"It is the lack of common areas of understanding and a failure to develop a shared understanding that lead o ineffective communication" (p.30). "Clients unfamiliar with construction may be incapable of reading drawings and so virtual and physical models may be needed to communicate design intent and represent the proposed form of the building." (p.40)	Construction Industry
Information	(Whyte et al., 2010)	"For clients, the value of data is derived from the operational expenditure and capital expenditure decisions. The big challenges at hand-over include the data accuracy and completeness." (p.28)	Construction Industry
	(Pryke, 2004)	The author conceptualizes construction project as a "network of information exchange relationships." (p.795)	Construction Industry
	(Wijnen et al., 2008)	Airport strategic planning involve "many resources, both inside and outside the organization: a lot of *data* are involved, requiring a significant number of *people*, possible using *tools*, to turn the data into *information* relevant for decision-making." (p.14)	Airport Industry
	(Jordani, 2010)	"For the design/construction team, participation from one to several years is focused on a building project. For the owner, the focus is on the lifecycle of the facility. What was a project with fixed duration for the design/construction team is a long-term asset on the owner's book. Digital information about a facility, its assets and systems, is essential to ongoing maintenance. Designs/construction teams have an opportunity to extend the value of their services by responding to this need with information needed for FM." (p.16)	Construction Industry

Categories	Theoretical references		Literature related to
Information	(Wijnen et al., 2008)	"A major fundamental cause of the problems in involve airport stakeholders into the strategic planning is the 'dispersion of data, tools, information, and knowledge within the organization of the airport operator and those of its stakeholders." (p.17)	Airport Industry
	(Kleinschmidt et al., 2010)	"Having a detailed understanding of the physical structure of a building plays a fundamental role in initial building design and subsequent re-design, as well as managing the building throughout its life cycle. This information extends beyond a 3-dimensional representation of the building supporting information related to light and energy analysis, and properties of building materials." (p.61)	Airport Industry
	(Crotty, 2013)	"There are two challenges to deal with the storm of information generated by the construction industry: 'the quality of the information being generated and used on the project, and the means by which this information is communicated and shared amongst the project team." (p.01)	Construction Industry
	(Loosemore, 2012)	"Information provision is an issue not just of access and quantity, but of content." (p.201)	Construction Industry
	(Emmitt, 2010)	"Information needs to be correct and available when needed by the user." (p.89)	Construction Industry
Trust	(Tyler, 2003)	"Motive-based trust encourage people to commit themselves to their work and organization." (p.564)	Project Management
	(Costa, 2003)	Trust is a manifestation of behaviour towards others and a multi-component construct, being trustworthiness and co-operative behaviours the strongest of those components.	Project Management
	(Davis & Walker, 2007)	"Early development of trust engendered harmony within the stakeholder group." (p.386)	Project Management
	(Simons & Peterson, 2000)	"… trust moderates the connection between task conflict and relationship conflict' (p.16), being 'the intragroup trust the key to preventing task conflict from escalating into relationship conflict." (p.17)	Project Management
	(Smyth, 2012)	"Trust can be developed, and manager can develop trust proactively." (p.115)	Project Management

Categories	Theoretical references		Literature related to
Trust	(Emmitt, 2010)	"It is through interaction and communication that we are able to establish the trustworthiness of our fellow project participants" (p.45). "As individuals start interacting they begin to gather experiences and form opinions that may reinforce or challenge the anticipated stereotypical behaviour and hence the level of trust. The longer the relationship continues the greater the opportunity for trust to develop." (p.51)	Construction Industry
	(Smyth & Pryke, 2009)	"One thing that trust is not all about is open communication. If there is complete transparency of communication, then there is no need for trust. Collaborative relationships need trust, and complete transparency is simply unaffordable. Therefore, trust is needed in the face of uncertainty, hence a lack of information and information asymmetry. To develop collaborative relationships requires the development of trust." (p.129)	Construction Industry
Conflict	(Alper et al., 2000)	"Conflict management is a central task for members of teams." (p.627) Cooperative and competitive approaches to conflict have different outcomes to the conflict efficacity.	Project Management
	(Simons & Peterson, 2000)	"Task conflict is usually associated with effective decisions, and relationship conflict is associated with poor decisions" (p.01). However, "teams that report task conflict also tend to report relationship conflict" (p.03). Then, "efforts to stimulate potentially beneficial task conflict run a substantial risk of triggering detrimental relational conflict" (p.03).	Project Management
	(Jehn & Bendersky, 2003)	Conflict is both detrimental and beneficial. "While task conflicts may improve groups' productivity and creativity under some circumstances, it can also damage group members' satisfaction and their ability to reach consensus decisions." (p.225)	Project Management
	(Wijnen et al., 2008)	"One of the problems to engage airport stakeholders on the strategic planning process is the constant presence of conflicts amongst them." (p.17)	Airport Industry
	(Kleinschmidt et al., 2010)	"Each stakeholder has a different perspective on airport operations, and places different criteria on which successful airport operation is measured. Often these criteria are in conflict, and so in order to resolve challenges and to derive solutions benefiting all stakeholders, a truly multi-disciplinary approach is required." (p.58)	Airport Industry

Categories	Theoretical references		Literature related to
Conflict	(Emmitt, 2010)	"The perception of conflict can result from differences of opinion, simple misunderstandings, mistakes and/or fundamental differences in requirements. Thus, conflict exists where there is an incompatibility of interests." (p.132)	Construction Industry
Relationships	(Smyth & Edkins, 2007)	Value is added to the project through the people and its relationships, increasing the satisfaction of client end users and other stakeholders.	Project Management
	(Simons & Peterson, 2000)	"… relationship conflict is detrimental to decision quality and to affective commitment to the group." (p.03)	Project Management
	(Walker et al., 2007)	The stakeholder engagement strategy is related to the relationship amongst project team and stakeholders. This relationship is governed by trust, power and commitment.	Construction Industry
	(Arditi & Gunaydin, 1998)	"The quality of any construction phase is dependent of the relationships strength among participants based on mutual trust and less dependence on legal assistance." (p.202)	Construction Industry
	(Pryke & Smyth, 2006)	"The quality of relationships is a key element in the success of a project. Relationships can be managed and will in turn affect project performance." (p.25)	Project Management
	(Smyth & Pryke, 2009)	"Relationships therefore become a key focus, not only for effective application of the bodies of knowledge, the management of projects and project management tools and techniques, but also for managing the contextual conditions because knowledge and technique provide insufficient clarity and guidance for controlling these factors." (p.10)	Construction Industry

BIBLIOGRAPHY

Airports Commission, U. K. (2013). *Airports Commission: interim report*. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/271231/airports-commission-interim-report.pdf

Alper, S., Tjosvold, D., & Law, K. S. (2000). Conflict managment, efficacy, and performance in organizational teams. *Personnel Psychology, 53*(3), 625-642. doi:10.1111/j.1744-6570.2000.tb00216.x

Arditi, D., & Gunaydin, H. M. (1998). Factors that affect process quality in the life cycle of building projects. *Journal of Construction Engineering and Management, 124*(3), 194-203.

Atkin, B., & Skitmore, M. (2008). Editorial: stakeholder management in construction. *Construction Management and Economics, 26*(6), 549-552. doi:10.1080/01446190802142405

Azouz, Z., Katsanis, C. J., Forgues, D., Aksenova, G., Poirier, E., & Doré, S. (2014, July). *The BIM utopia: centralizing collaboration and communication through technologies.* Paper presented at the EPOC 2014 Beyond Boundaries, Colorado, USA.

Bar-Yam, Y. (2003). Unifying principles in complex systems. *Converging Technology (NBIC) for Improving Human Performance, MC Roco and WS Bainbridge, Dds., Kluwer*.

Bew, M., & Underwood, J. (2010). Delivering BIM to the UK Market. In *Handbook of research on building information modeling and construction informatics: Concepts and technologies* (pp. 30-64): IGI Global.

Bosi, F. (2015a). Airport Lean Design. In F. Bossi, P. Ferrulli, & E. Fossi (Eds.), *Looking to methods and tools for the Research in Design and Architectural Technology* (pp. 137-148). Florence, Italy: Florence University Press.

Bosi, F. (2015b). *Airport Lean Integration.* (Dottorato di Ricerca in Architettura), Università degli Studi di Firenze, Firenze.

Bourne, L. (2005). *Project relationship management and the Stakeholder Circle™.* (Doctoral thesis), Royal Melbourne Institute of Technology University, Melbourne, Australia.

Bourne, L., & Walker, D. H. T. (2005). Visualising and mapping stakeholder influence. *Management Decision, 43*(5), 649-660. doi:10.1108/00251740510597680

Carroll, A., & Buchholtz, A. (2014). *Business and society: Ethics, sustainability, and stakeholder management*: Nelson Education.

Chinyio, E. A., & Akintoye, A. (2008). Practical approaches for engaging stakeholders: findings from the UK. *Construction Management and Economics, 26*(6), 591-599. doi:10.1080/01446190802078310

Chiocchio, F., Forgues, D., Paradis, D., & Iordanova, I. (2011). Teamwork in integrated design projects: Understanding the effects of trust, conflict, and collaboration on performance. *Project Management Journal, 42*(6), 78-91. doi:10.1002/pmj.20268

Chiocchio, F., Grenier, S., A. O'Neill, T., Savaria, K., & Douglas Willms, J. (2012). The effects of collaboration on performance: A multilevel validation in project teams. *International Journal of Project Organisation and Management, 4*, 1-37. doi:10.1504/IJPOM.2012.045362

Costa, A. C. (2003). Work team trust and effectiveness. *Personnel Review, 32*(5), 605-622. doi:10.1108/00483480310488360

Cova, B., & Salle, R. (2012). Communications and stakeholders. In *The management of complex projects: A relationship approach* (pp. 131-146): John Wiley & Sons.

Crotty, R. (2013). *The impact of building information modelling: transforming construction*: Routledge.

D'Amour, D., Ferrada-Videla, M., San Martin Rodriguez, L., & Beaulieu, M.-D. (2005). The conceptual basis for interprofessional collaboration: core concepts and theoretical frameworks. *Journal of interprofessional care, 19*(sup1), 116-131.

Davis, P. R., & Walker, D. H. T. (2007). Trust, commitment and mutual goals in Autralian construction industry project alliances. In *Procurement Systems* (pp. 378 - 399): Routledge.

Dietrich, P., Eskerod, P., Dalcher, D., & Sandhawalia, B. (2010). The Dynamics of Collaboration in Multipartner Projects. *Project Management Journal, 41*(4), 59-78. doi:10.1002/pmj.20194

Druskat, V., & Druskat, P. (2012). Applying emotional intelligence in project working. In *The management of complex projects: A relationship approach* (pp. 78 - 96): John Wiley & Sons.

East, E. W. (2009). Performance specifications for building information exchange. *Journal of Building Information Modeling*, 18-20.

Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011). *BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors*: John Wiley & Sons.

Egan, S. J., & Williams, D. (1998). *Rethinking Construction - The report of the Construction Task Force.* Paper presented at the Proceedings of the Institution of Civil Engineers-Municipal Engineer.

El-Gohary, N. M., Osman, H., & El-Diraby, T. E. (2006). Stakeholder management for public private partnerships. *International Journal of Project Management, 24*(7), 595-604. doi:10.1016/j.ijproman.2006.07.009

Emmitt, S. (2010). *Managing interdisciplinary projects: a primer for architecture, engineering and construction*: Routledge.

Fellows, R., & Liu, A. M. M. (2012). Managing organizational interfaces in engineering construction projects: addressing fragmentation and boundary issues across multiple interfaces. *Construction Management and Economics, 30*(8), 653-671. doi:10.1080/01446193.2012.668199

Fernandes, E., & Pacheco, R. R. (2010). A quality approach to airport management. *Quality & Quantity, 44*(3), 551-564.

Freeman, R., & McVea, J. (2001). *A Stakeholder Approach to Strategic Management* (Darden Business School Working Paper No 01 - 02). Retrieved from http://doi.org/10.2139/ssrn.263511

Goleman, D. (1998). *Working with emotional intelligence*. New York, NY: Bantam Books.

Grabher, G. (2002). Cool Projects, Boring Institutions: Temporary Collaboration in Social Context. *Regional Studies, 36*(3), 205-214. doi:10.1080/00343400220122025

Gully, S. M., Incalcaterra, K. A., Joshi, A., & Beaubien, J. M. (2002). A meta-analysis of team-efficacy, potency, and performance: interdependence and level of analysis as moderators of observed relationships. *Journal of applied psychology, 87*(5), 819.

Hakfoort, J., Poot, T., & Rietveld, P. (2001). The regional economic impact of an airport: The case of Amsterdam Schiphol Airport. *Regional Studies, 35*(7), 595-604.

Harrison, A., Popovic, V., Kraal, B. J., & Kleinschmidt, T. (2012). *Challenges in passenger terminal design: A conceptual model of passenger experience.* Paper presented at the Proceedings of the design research society (DRS) 2012 conference.

Harty, J., & Laing, R. (2010). Removing barriers to BIM adoption: Clients and code checking to drive changes. In *Handbook of research on building information modeling and construction informatics: Concepts and technologies* (pp. 546-560): IGI Global.

Healey, P. (1996). Consensus-building across Difficult Divisions: New approaches to collaborative strategy making. *Planning Practice & Research, 11*(2), 207-216. doi:10.1080/02697459650036350

Innes, J. E., & Booher, D. E. (2004). Reframing public participation: strategies for the 21st century. *Planning Theory & Practice, 5*(4), 419-436. doi:10.1080/1464935042000293170

Jehn, K. A., & Bendersky, C. (2003). Intragroup conflict in organizations: a contingency perspective on the conflict-outcome relationship. *Research in Organizational Behavior, 25*, 187-242. doi:10.1016/S0191-3085(03)25005-X

Jordani, D. A. (2010). BIM and FM: The portal to lifecycle facility management. *Journal of Building Information Modeling, 13*, 16.

Kerzner, H., & Saladis, F. P. (2011). *Value-driven project management* (Vol. 1): John Wiley & Sons.

Kleinschmidt, T., Goonetilleke, A., Fookes, C. B., & Yarlagadda, P. K. (2010). *A multi-disciplinary approach for the design and management of airport terminals.* Paper presented at the Proceedings of the Third International and Twenty Fourth All India Manufacturing Technology, Design and Research Conference 2010-Global Trends and Challenges in Design and Manufacturing.

Koch, D. B. (2004). 3D visualization to support airport security operations. *Aerospace and Electronic Systems Magazine, IEEE, 19*(6), 23-28. doi:10.1109/MAES.2004.1308826

Kozlowski, S. W., & Bell, B. S. (2003). Work groups and teams in organizations. In W. C. Borman, D. R. Ilgen, & R. J. Klimoski (Eds.), *Handbook of psychology* (Vol. 12, pp. 333-375). New York: Wiley-Blackwell.

Kumaraswamy, M., & Rahman, M. (2012). Applying teamworking models to projects. In *The management of complex projects: A relationship approach* (pp. 78 - 96): John Wiley & Sons.

Kunz, J., & Fischer, M. (2012). Virtual design and construction: themes, case studies and implementation suggestions. *Center for Integrated Facility Engineering (CIFE), Stanford University, Stanford, California, United States*.

Kvan, T. (2000). Collaborative design: what is it? *Automation in Construction, 9*(4), 409-415. doi:10.1016/S0926-5805(99)00025-4

Landin, A. (2000). *Impact of quality management in the Swedish construction process.* (Doctoral Thesis), Lund Institute of Technology, Lund, Sweden.

Latham, M. (1994). *Constructing the Team*. London, UK: HMSO.

Lepine, J. A., Piccolo, R. F., Jackson, C. L., Mathieu, J. E., & Saul, J. R. (2008). A meta-analysis of teamwork processes: tests of a muiltidimensional model and relationships with team effectiveness criteria. *Personnel Psychology, 61*(2), 273-307. doi:10.1111/j.1744-6570.2008.00114.x

Loosemore, M. (2012). Managing project risks. In *The management of complex projects: A relationship approach* (pp. 187-204): John Wiley & Sons.

Mathur, V. N., Price, A. D. F., & Austin, S. (2008). Conceptualizing stakeholder engagement in the context of sustainability and its assessment. *Construction Management and Economics, 26*(6), 601-609. doi:10.1080/01446190802061233

McCracken, G. (1988). *The long interview* (Vol. 13). Newbury park, California: Sage Publications.

Newcombe, R. (2003). From client to project stakeholders: a stakeholder mapping approach. *Construction Management and Economics, 21*(8), 841-848. doi:10.1080/0144619032000072137

Nicolini, D., Holti, R., & Smalley, M. (2001). Integrating project activities: the theory and practice of managing the supply chain through clusters. *Construction Management and Economics, 19*(1), 37-47. doi:10.1080/014461901452067

Olander, S. (2007). Stakeholder impact analysis in construction project management. *Construction Management and Economics, 25*(3), 277-287. doi:10.1080/01446190600879125

Olander, S., & Landin, A. (2005). Evaluation of stakeholder influence in the implementation of construction projects. *International Journal of Project Management, 23*(4), 321-328. doi:10.1016/j.ijproman.2005.02.002

Olander, S., & Landin, A. (2008). A comparative study of factors affecting the external stakeholder management process. *Construction Management and Economics, 26*(6), 553-561. doi:10.1080/01446190701821810

Orndoff, C. J. (2005). Promising new tool for stakeholder interaction. *Journal of architectural engineering, 11*(4), 139-146.

Oum, T. H., Yu, C., & Fu, X. (2003). A comparative analysis of productivity performance of the world's major airports: summary report of the ATRS global airport benchmarking research report—2002. *Journal of Air Transport Management, 9*(5), 285-297. doi:10.1016/S0969-6997(03)00037-1

Pabedinskaitė, A., & Akstinaitė, V. (2014). Evaluation of the airport service quality. *Procedia-Social and Behavioral Sciences, 110*, 398-409.

Park, Y. (1999). A methodology for establishing operational standards of airport passenger terminals. *Journal of Air Transport Management, 5*(2), 73-80. doi:10.1016/S0969-6997(98)00040-4

Pastor, J. B. R., & Benavides, E. M. (2011, March). *Axiomatic design of an airport passenger terminal.* Paper presented at the The Sixth International Conference on Axiomatic Design (ICAD2011), Daejeon, South Korea, p. 95-102.

Pikas, E., Koskela, L., Dave, B., & Liias, R. (2015). *Case study on design management: Inefficiencies and possible remedies*. Paper presented at the Proceedings of the 23rd Annual Conference of the International Group for Lean Construction, Perth, Australia.

Pitfield, D. (1981). The economics of airport impact. *Transportation Planning and Technology, 7*(1), 21-31.

Poirier, E., Forgues, D., & Staub-French, S. (2016). Collaboration through innovation: implications for expertise in the AEC sector. *Construction Management and Economics, 34*(11), 769-789. doi:10.1080/01446193.2016.1206660

Popovic, V., Kraal, B., & Kirk, P. J. (2010). *Towards airport passenger experience models.* Paper presented at the Proceedings of 7th international conference on design & emotion, Chicago, Illinois.

Project Management Institute (PMI). (2017). *A guide to the project management body of knowledge (PMBOK® guide)* (6th ed.). Newtown Square, PA: Project Management Institute.

Pryke, S. D. (2004). Analysing construction project coalitions: exploring the application of social network analysis. *Construction Management and Economics, 22*(8), 787-797. doi:10.1080/0144619042000206533

Pryke, S. D., & Smyth, H. (2006). Scoping a relationship approach to the management of complex projects in theory and practice. In *The Management of Complex Projects: a relatioship approach* (pp. 21-45): John Wiley & Sons.

Rounce, G. (1998). Quality, waste and cost considerations in architectural building design management. *International Journal of Project Management, 16*(2), 123-127. doi:10.1016/S0263-7863(97)00042-2

Rowlinson, S., & Cheung, Y. K. F. (2008). Stakeholder management through empowerment: modelling project success. *Construction Management and Economics, 26*(6), 611-623. doi:10.1080/01446190802071182

Schade, J., Olofsson, T., & Schreyer, M. (2011). Decision-making in a model-based design process. *Construction Management and Economics, 29*(4), 371-382. doi:10.1080/01446193.2011.552510

Schöttle, A., Haghsheno, S., & Gehbauer, F. (2014). *Defining cooperation and collaboration in the context of lean construction.* Paper presented at the Proc. 22nd Ann. Conf. of the Int'l Group for Lean Construction.

Senecah, S. L. (2004). The trinity of voice: The role of practical theory in planning and evaluating the effectiveness of environmental participatory processes. In S. P. Depoe, J. W. Delicath, & M.-F. A. Elsenbeer (Eds.), *Communication and public participation in environmental decision making* (pp. 13-33). New York: State University of New York Press

Shindler, B., & Cheek, K. A. (1999). Integrating citizens in adaptive management: a propositional analysis. *Conservation Ecology, 3*(1).

Simons, T. L., & Peterson, R. S. (2000). Task conflict and relationship conflict in top management teams: The pivotal role of intragroup trust. *Journal of applied psychology, 85*(1), 102.

Smyth, H. (2008). The credibility gap in stakeholder management: ethics and evidence of relationship management. *Construction Management and Economics, 26*(6), 633-643. doi:10.1080/01446190801905414

Smyth, H. (2012). Measuring, developing and managing trust in relationships. In *The management of complex projects: A relationship approach* (pp. 97 -120): John Wiley & Sons.

Smyth, H., & Edkins, A. (2007). Relationship management in the management of PFI/PPP projects in the UK. *International Journal of Project Management, 25*(3), 232-240.

Smyth, H., & Pryke, S. (2009). *Collaborative relationships in construction: developing frameworks and networks*: John Wiley & Sons.

Strauss, A., & Corbin, J. M. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*: Sage Publications, Inc.

Thomson, D. S., Austin, S. A., Devine-Wright, H., & Mills, G. R. (2003). Managing value and quality in design. *Building Research & Information, 31*(5), 334-345.

Toledo, M., González, V., Villegas, A., & Mourgues, C. (2014). *Using 4D Models for Tracking Project Progress and Visualizing the Owners Constraints in Fast-Track Retail Renovation Projects.* Paper presented at the Proceedings of the 22th Conference of the International Group for Lean Construction (IGLC22).

Tyler, T. R. (2003). Trust within organisations. *Personnel Review, 32*(5), 556-568. doi:10.1108/00483480310488333

Walker, D., Bourne, L., & Rowlinson, S. (2007). Stakeholders and the supply chain. In *Procurement Systems* (pp. 94-124): Routledge.

Ward, S., & Chapman, C. (2008). Stakeholders and uncertainty management in projects. *Construction Management and Economics, 26*(6), 563-577. doi:10.1080/01446190801998708

Whyte, J., Lindkvist, C., & Ibrahim, N. H. (2010). *Value to clients through data hand-over: A pilot study, Summary Report to Institution of Civil Engineers (ICE) Information Systems (IS) Panel, version 1.1*. Retrieved from https://www.reading.ac.uk/web/files/designinnovation/20101208_Report_to_ICE_V1.1_formatted_for_web.pdf

Widén, K., Olander, S., & Atkin, B. (2014). Links between Successful Innovation Diffusion and Stakeholder Engagement. *Journal of Management in Engineering, 30*(5), 04014018. doi:10.1061/(ASCE)ME.1943-5479.0000214

Wijnen, R. A., Walker, W. E., & Kwakkel, J. H. (2008). Decision support for airport strategic planning. *Transportation Planning and Technology, 31*(1), 11-34.

Wu, P. P.-Y., & Mengersen, K. (2013). A review of models and model usage scenarios for an airport complex system. *Transportation Research Part A: Policy and Practice, 47*, 124-140.

Xue, X., Shen, Q., & Ren, Z. (2010). Critical Review of Collaborative Working in Construction Projects: Business Environment and Human Behaviors. *Journal of Management in Engineering, 26*(4), 196-208. doi:10.1061/(ASCE)ME.1943-5479.0000025

Yin, R. K. (2003). Case study research design and methods third edition. *Applied social research methods series, 5*.

Zografos, K. G., & Madas, M. A. (2006). Development and demonstration of an integrated decision support system for airport performance analysis. *Transportation Research Part C, 14*(1), 1-17. doi:10.1016/j.trc.2006.04.001