Alignment factors between client needs and design solutions during the project definition: Case study of a Canadian mega-hospital using Lean-led Design

by

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Facteurs d'alignement entre les besoins du client et la conception architecturale lors de la définition du projet

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RÉSUMÉ

La définition du projet fait référence aux trois premières phases du cycle de vie du projet, soit le montage, la programmation et la conception préliminaire, où les besoins du client sont identifiés et la conception architecturale est développée. En effet, définir et formaliser les besoins des clients est une tâche difficile, surtout dans les projets complexes tels que les hôpitaux, puisque le client est multiple. Dans ces projets, le client pourrait être à la fois le gestionnaire, le gouvernement et l'usager : le clinicien, le patient, le personnel, etc. Chaque client a ses propres besoins et intérêts qui peuvent parfois être en conflit avec les intérêts des autres clients.

L'approche traditionnelle utilisée lors de la définition du projet s'est avérée inappropriée. Dans ces pratiques traditionnelles, les usagers sont rarement consultés. En outre, l'accent est davantage mis sur les aspects techniques et moins sur les aspects fonctionnels. Ceci a un impact important, sur la qualité de l'aménagement, notamment l'environnement de travail ainsi que sur la santé et sécurité des cliniciens et patients. Des approches participatives telles que Lean-led Design — dans laquelle les usagers, y compris le patient, sont impliqués tout au long du processus de définition du projet — sont proposées afin de pallier ces défis. Cependant, la littérature nous informe peu sur l'impact que de telles approches ont sur l'alignement entre les besoins des clients avec la conception architecturale.

Cette recherche identifie d'abord les facteurs qui influencent l'alignement entre les besoins et la conception architecturale lors de la définition du projet, sur la base d'une revue systématique de la littérature. Elle propose ensuite un cadre conceptuel établi en fonction de ces facteurs qui servira à développer et évaluer une étude de cas longitudinale d'un méga-hôpital situé au Canada. Ce projet complexe hospitalier implémente la démarche du Lean-led Design afin d'assurer l'alignement des besoins et des exigences suite à la fusion de deux hôpitaux. La principale contribution de cette recherche est de fournir un cadre conceptuel qui pourrait aider les chercheurs et les gestionnaires à évaluer l'adéquation entre l'alignement des besoins et la conception architecturale lors de la définition du projet. La prémisse est qu'un meilleur alignement offre plus de valeur pour les usagers.

Mots-clés : Alignement, définition de projet, Lean, valeur, besoin, client

Alignment factors between client needs and design solutions during the project definition

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ABSTRACT

Project definition refers to the first stages of a project life cycle (i.e., planning, programming, and preliminary design) in which client needs are identified and a conceptual design solution is developed. Defining and formalizing client needs are complex tasks especially in complex projects such as hospitals since naturally multiple clients such as managers, the government, users, clinicians, patients, and staff members among others, are involved. Each client has their own needs and interests that could sometimes be conflicting with those of the others.

However, traditional methods of project definition management have been proved to be inadequate. In the traditional approach, users are rarely consulted, and the focus is more on technical issues and less on functional aspects, which impacts the future work environment and may consequently lead to increased hospital-acquired infections or patient mortality. Participative approaches such as Lean-led design, in which users including patients are involved in the process of project definition, are proposed to address this problem. However, little is discussed in the literature regarding the value of such approaches in terms of better alignment of projects with client needs.

This research first identified the factors that can impact the alignment between needs and design solutions during the project definition via a systematic literature review. Based on these factors, a framework was provided to assess and improve the alignment. The validity of the framework was then empirically evaluated and revised based on a longitudinal mega-hospital case study that had implemented the Lean-led design approach the objective of which was to ensure a harmony between needs and requirements as a result of integrating two hospitals. The main assumption here is that better alignment provides more value to end users and the main contribution of this research is a framework that can help researchers and managers to assess and evaluate alignment during the project definition stage.

Keywords: Alignment, project definition, Lean, value, need, client

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LIST OF ABREVIATIONS

LPDS	Lean Project Delivery System
TFV	Transformation-Flow-Value
QFD	Quality Function Deployment
HOQ	House of Quality Matrices
BIM	Building Information Modelling
TVD	Target Value Design
IT	Information Technology
LPS	Last Planner System
BIM	Building Information Modelling
PLM	Product Lifecycle Management
eRIM	electronic Requirements Information Management
SBD	Set Based Design
CBA	Choosing By Advantages
EBD	Evidence-Based Design
IPD	Integrated Project Delivery
IFD	Integrated Facility Design
CMAR	Construction Manager At Risk
CMGC	Construction Manager–General Contractor
VSM	Value Stream Mapping
NCH	*Nouveau Complexe Hospitalier*
HEJ	*Hôpital de l'Enfant-Jésus*

L'HDQ	*L'Hôtel-Dieu de Québec*
CHU	*Centre Hospitalier Universitaire*
CHUL	*Centre Hospitalier de l'Université Laval*
HSFA	*Hôpital Saint-François d'Assise*
HSS	*Hôpital du Saint-Sacrement*
SQI	*Société Québécoise des Infrastructures*
TFP	Technical and Functional Program

INTRODUCTION

One of the reasons for client dissatisfaction and value loss is the "ill" performed project definition (Pikas et al., 2018). Project definition refers to the first stages in the life cycle of a project that immediately precedes design. In these stages, client needs are identified and preliminary design solutions are developed to respond to them (Ballard, 2006; Forgues et al., 2018).

However, traditional project definition practices have been proved to be inadequate since they lead to alignment problems between client needs and design solutions (Forgues et al., 2018; Pham, 2015; Tzortzopoulos et al., 2009). Actually, in the traditional perspective where users are rarely consulted with during the design process, the focus is rather on technical issues (e.g., structural, mechanical), leaving out the functional needs (e.g., internal traffic and relationship between hospital services), (Serugga et al., 2020c). This often results in an inefficient building in terms of functionality and quality of the work environment (Fischer et al., 2017).

This is particularly true in healthcare projects where an "ill" performed project definition process leads to low quality of patient care, medical errors, healthcare service disruptions, etc. (Lake et al., 2019). A poor project definition may for example lead to unnecessary and relatively long walking distances for nurses, sometimes up to 3 miles in a single dayshift (Hicks et al., 2015) as well the possibility of causing nosocomial infections, injuries or patient death (Becker & Parsons, 2007; Hamilton, 2020; Lake et al., 2019).

Project definition of healthcare facilities tend to be a complex task (Soliman Junior et al., 2019) due to three main reasons. First because of being related to different types of clients associated with such an environment which potentially include users (i.e., doctors, nurses, and managers), financial supporters, or even the government. Each client stakeholder having their own point of view, needs, or interests which could possibly be in conflict with those of other stakeholders (Junior et al., 2018). The second reason is related to different building codes and regulations (e.g., fire and safety codes) that govern the definition of healthcare buildings (Baldauf et al.,

2020). The third reason has roots in the dynamic nature of client needs and demands over time as a result of the ageing population and the rapid advances in medical technologies among other things (Soliman-Junior et al., 2020). The healthcare industry is undergoing various transformations regarding its physical environment; and new constructions and renovations of the existing hospitals are currently thriving.

Having said that, design professionals should comprehensively define client needs to be able to align them with healthcare building designs (Almqvist, 2017; Caixeta et al., 2019; Tzortzopoulos et al., 2009). However, if design professionals do not properly understand user activities and users are usually not involved in the project definition process (Caixeta et al., 2013; van Amstel et al., 2015), it would be very hard, if possible at all, to propose a solution that is efficient enough.

To address this issue, user-inclusive approaches such as the Lean-led Design have been suggested (Caixeta et al., 2019; Grunden & Hagood, 2012). Unlike the traditional mindset, users in this approach play a significant role from the beginning of project definition since they are involved in the process of mapping, analyzing, and optimizing the care pathways (flows) that patients and clinicians would follow (Smith et al., 2020). Involving the users in the reflection is seen as essential for a successful project (Larsen et al., 2021). It is expected to help design professionals to better understand user needs and thus align them with the building design (Caixeta & Fabricio, 2021).

Lean-led Design has gained popularity in improving quality of care in the United Kingdom and the United States (Forgues et al., 2018; Hicks et al., 2015). However, empirical research about implementing this approach is so far limited (Schouten et al., 2020), and, to the best of our knowledge, none has explored the impacts of this inclusive approach on aligning client needs with design solutions during the project definition stage. Furthermore, not enough information is available in the literature regarding a suitable model that could facilitate proper definition management of complex projects, so there exists the need for knowledge development about dynamic processes and client inclusion in the process of project definition

(Schouten et al., 2020; von Danwitz, 2018). Empirical studies are needed to gain insight into how this approach is implemented in actual healthcare projects and what are its impacts on the process of project definition (Schouten et al., 2020).

For that reason, this research presents a mega-hospital case study based in Quebec (*nouveau complexe hospitalier*), where the Lean-led Design approach has been used in the process of project definition. The objective of which was to achieve an alignment between the client needs and the conceptual design, by involving the main clients including the users, in the process.

To better understand the impact of participative approaches such as Lean-led Design on alignment during project definition, we address the following research question:

What are the factors that impact alignment between client needs and conceptual design solutions during project definition of a hospital?

The main generic goal of answering this research question is to improve the alignment between client needs and the building design, during the project definition stages of complex projects and the assumption is that higher alignment provides more value to end users.

To answer research questions, the following objectives were established:

1) Identifying the main factors that enable or facilitate alignment between the needs and the schematic design in hospitals while using the Lean-led Design approach;
2) Identifying the main factors that inhibit or hinder alignment between the needs and the schematic design in hospitals while using Lean-led Design approach;
3) Developing a conceptual framework in order to better manage the alignment between client/user needs and design solutions during the project definition phase.

Thesis structure

The thesis is structured in five chapters. Chapter 1 explores the theoretical background of the project definition stage of complex projects, as the main theme of the current investigation, the existing challenges and limitations of the conventional practices, and the different initiatives proposed by the authors to deal with that. This chapter ends with a discussion for a specification of the research scope.

Chapter 2 concentrates on justifying the methodological choices of the study, such as the epistemological position, single case study, and data collection techniques as well as providing a description of the steps to achieve the three research objectives, from the identification of alignment factors to the development and evaluation of a conceptual framework.

Chapter 3 aims at presenting the first results of a qualitative systematic literature review, presenting a map of the main important factors impacting needs-solution alignment classified into different categories. For easier reading and understanding, this chapter maintains a systematic structure in which each category is divided into two subcategories: facilitating and hindering. The presentation of each subcategory begins with a table that summarizes the different factors identified, then continue with a presentation of each factor and thus ended with a summary. This chapter is concluded by presenting a conceptual framework developed based on the identified factors.

Chapter 4 aims to compare the conceptual framework developed in chapter 3 with the qualitative results of a single case study of "*nouveau complexe hospitalier*." More accurately, by following the same structure in chapter 3, the alignment factors identified in each stage of the project definition process and their evolution over time are presented. Subsequently, this chapter aims at falsifying or confirming the validity of the previously developed framework in chapter 3.

Chapter 5 presents a discussion about different factors identified in both literature and case study: the significance of some factors and the relationship between them, as well as their evolution during the project definition stages.

Lastly, a general conclusion summarizes the overall issue and the research findings. It also outlines the contribution of this work to the theory and practice of construction management as well as the limitations associated with it, followed by the opportunities for future work.

CHAPTER 1

PROJECT DEFINITION IN COMPLEX PROJECTS

Since at least 1995, project definition has been considered as the most important and critical phase of a project's lifecycle (Serugga et al., 2020b; Yussef et al., 2020). Many researchers agree with the fact that an effective project definition has a direct causal effect on value generation and alignment (Construction Industry Institute, 1995; Dicks et al., 2017; Esnaashary Esfahani et al., 2020; Larsen et al., 2020; Xia et al., 2016). According to Cho and Gibson (2001) effective project definition of large buildings could improve cost performance, schedule performance, and change orders by at least 5%, 10% , and 3% , respectively. A recent study by Safapour and Kermanshachi (2019) on causes of reworks in complex projects found that efficient project definition is the best way to minimize additional costs of project reworks. In healthcare projects, a growing body of research shows that project definition may directly impact user health and safety (Hamilton, 2020; Joseph et al., 2018; Joseph & Rashid, 2007; Smith, 2017).

In spite of the importance of project definition in delivering better services, current practices are still considered 'inadequate', especially for healthcare projects. This results in a lack of alignment between client needs and design solutions (Forgues et al., 2018; Larsen et al., 2020). In chapter 1, we examine the current literature to understand and clarify the context of project definition of healthcare projects, helping to specify the research scope and questions.

The first section presents the different stages of project definition. In the second section, the challenges of identifying and managing client needs are discussed. In general, the third and fourth sections present the conventional practices of managing project definition and their limitations. In the third section, the nature of the problems that need to be addressed in the project definition stage is presented and the last section compares and contrasts the main perspectives regarding project definition with the conventional practices. The objective of this comparison is, of course, choosing the appropriate approach to answer our research question.

1.1 The “project definition” definitions and stages

Project definition has different aliases such as “design briefing”, “client briefing”, “front-end loading”, “front end planning”, “project definition and clarification”, “project scope definition” “initial task”, “pre-project planning”, and “fuzzy front end” (Almqvist, 2017; Collins et al., 2017; Elzomor et al., 2018; Pikas et al., 2018).

With a closer look at “project definition,” it is possible to identify two main perspectives, depending on the context of studies: 1) traditional construction project management and 2) Lean construction.

In the traditional construction project management, project definition represents the first phase of the construction project life cycle, where the aim is to define the idea/purpose, scope and goals, funding, feasibility, risk; and help to balance client needs and design solutions (Almqvist, 2017; Cano & Lidón, 2011; Crawford et al., 2006; Serugga et al., 2020b; Xia et al., 2016). According to Winch et al. (1998), project definition is the “*process of turning the client’s desire for a built product into a clear brief*”. Blyth and Worthington (2010, p. 20) define it as a “*process of understanding an organization’s needs and resources and matching these to its objectives and its mission*”. Construction Industry Board (1997, as cited in Emmitt et al., 2009, p. 13) define project definition as “*the process through which a client informs others of his or her needs, aspirations and desires for a subject*”.

In the context of Lean construction, project definition represents the first phase of the Lean Project Delivery System (LPDS), which consists of five interconnected phases: Project Definition, Lean Design, Lean Supply, Lean Assembly, and Lean use (Ballard, 2000). According to Ballard and Zabelle (2000); Whelton et al. (2003) project definition is the process that involves the understanding and formalization of client needs, translation of these needs into design criteria, and development of the design concept.

The project definition phase is usually broken down into several stages that vary, depending on the research perspective, so there is not a consensus in the literature, resulting in confusion, especially when trying to combine project development with content development (brief, conceptual design, preliminary drawings, specifications, etc.). For instance, Project Management Institute (PMI) holds that project definition includes the initiation process group with the development of the Project Charter, Project Statement of Work, and the Preliminary Project Scope Statement (Cano & Lidón, 2011). Whelton et al. (2003) suggest that project definition concerns the stages of project proposal preparation, project initiation, design, and appraisal. Kamara, Augenbroe, et al. (2002) argue that this early phase is related to four stages, namely inception (appoint design team), feasibility (clarify client needs), concept design, and scheme design.

Thus, if project definition is a matter of capturing and defining client needs, developing the project requirements, and providing a solution; two questions must be firstly tackled: 1) what is the nature of the needs? And 2) who is the client?

1.2 The nature of the client and the need in complex projects

Different terminologies are used synonymously with the word "needs" even if they have subtle differences in meaning (Whelton, 2004). These terminologies can include "values", "purposes", "wants", "goods", "tastes", "preferences", "utility", "objectives", "goals", "aspirations", and "drives" (March, 1983).

A "need" could be defined as "*a measurable discrepancy between the current and desired status for an entity*" Altschuld and Witkin (2000, p. 45). It could be related to quality, safety, functionality, aesthetics, economy, or time (Chinyio et al., 1998). According to Bennett (1985) "need" is subjective and may be concealed because it may have social, cultural, political, or religious dimensions. This point is supported by Thyssen et al. (2010) who believe that a need is something that is perceived differently by each stakeholder and changes over time.

Needs are in the mind of the client which very often make the project definition process complex since not all clients can describe their needs to other parties (Tzortzopoulos et al., 2006). This complexity increases in the case of healthcare projects, where the term "client" represents not only the owner but also a wide range of individuals with the needs also evolving in time (Baldauf et al., 2020; Serugga et al., 2020a). In healthcare projects, the client is the project manager, but there is also the legislator, the funder, the surrounding society, and the user as well. The term "user" consists of a wide range of individuals including doctors, nurses, administrators, patients and their families, maintenance technicians, cleaning staff, and in the case of educational institutions, medical students (Sengonzi et al., 2009).

To better manage this complexity, Bertelsen and Emmitt (2005) classify needs based on client groups, namely owners, users, and society. Each client group has a specific need that changes based on their priority, role, or responsibility. For instance, owner focus is on investment, while user focus is on the utility, and the society mainly focuses on the aesthetics. For example, within groups of users, hospital administrators seek to reduce operating costs, nursing staff desire a quick access to all necessary equipment to provide care, doctors focus on patient safety. Besides that, among medical specialists, what a medical specialist perceives as a safety benefit may differ from another medical specialist.

Another existing classification of needs is that of Altschuld and Witkin (2000, as cited in Whelton, 2004) which is based on the three levels that generally exist in organizations. Level 1 addresses the needs of primary customers of the organization (the patients in our case), Level 2 addresses the needs of the organization's staff that provide services to level 1 (e.g., medical professionals and service providers) and Level 3 addresses the needs of the part of the organization that support both levels 1 and 2 (e.g., medical building facility). However, according to Whelton (2004), too often there is a loss of focus on level 1 and 2 during the project definition process, which results in poor outcomes.

Furthermore, the complexity of need management in healthcare projects is not only due to the existence of various client stakeholders but is also related to the dynamic nature of needs

(Parrish et al., 2008). Needs tend to change over time between the project definition and the operation phases (Whelton et al., 2005). Technology-based medical treatments are rapidly growing, which means that hospital workspaces should adapt accordingly (Lemieux, 2003). For instance, automation of drug distribution systems via robots represents a technological change that has emerged in health facilities and this constant evolution of technologies in hospitals requires not only adjustments in clinical practices, but also reconfigurations of workspace layout. Given that completion of large-scale projects can sometimes take more than a decade, some degree of flexibility is required to adapt the process based on the dynamic needs for novel medical equipment, when plans are already approved.

Uncertainty of needs also depends on the demographic changes regarding patients. The population in North America is aging which implies an increased burden on the healthcare system (Pryke et al., 2017). Evidence suggests that percentage of senior population will double in the coming years in Quebec (Quebec Government, 2012). In addition, according to the predictions of the World Health Organization (WHO), 80% of older people could potentially deal with cancer within the next 20 years (WHO, 2020). The increase in population along with certain diseases means that specific sectors in the healthcare system need to expand their working areas, requiring redevelopment and thus a high level of workspace flexibility.

Therefore, needs do change over time, thereby increasing the difficulty of predicting them and defining requirements of dynamic projects with large timescales and high level of uncertainty. However, conventional practices do not take into consideration the dynamic aspect of projects. In these practices, construction professionals assume that requirements are the basis of a project and once set and frozen, the project begins (Forgues et al., 2008).

1.3 From client needs to requirements

In the conventional process of project definition, the first stage, namely capturing the needs, is usually done in a hurry. They are often established without the participation of key client stakeholders. Needs are mainly conceptualized by design professionals in a single event, based

on interviews, examination of client documents, visits to similar facilities, and meetings with client representatives (Kamara, Anumba, et al., 2002; Ryd, 2004). Work sessions are used to confirm the identified needs and information, which can be in the form of correspondence (e-mail), sketches, drawings, etc. Based on the collected information, briefing experts translate client needs into requirements and prepare a brief document (Ryd, 2004) which is the official start of the project definition process.

In fact, requirements are defined as "*a set of statements of objectives and functions on what the design must achieve or do*."(Pikas et al., 2018, p. 1303). While in this research study needs are regarded as unprocessed sentences expressed in the natural language of clients, requirements are the result of the translation and interpretation of those needs into building vocabulary (Kamara, Augenbroe, et al., 2002). This means that requirements originate from client needs. However, architects are ill-equipped to understand and manage complex client requirements. Prioritizing client requirements is a challenging process since their needs are sometimes conflicting and every client obviously tries to prioritize their own requirements (Serugga et al., 2020c).

Furthermore, in writing the brief during the project definition stage, both project and client requirements are considered. As illustrated by Kamara, Anumba, et al. (2002), requirements could be related to the site (e.g., ground conditions), environment (climatic factors), regulation (building, safety, etc.), and construction (technical aspects). Hence, by determining the requirements, the brief is written and the architectural solution is developed by designers (Pikas et al., 2018; Whelton, 2004).

However, the brief often uses technical jargon, leaving the functional issues aside (Forgues, 2006b). The "voice of the client" is often lost in the process of defining technical or regulatory requirements. There is a tendency for briefing experts to leap to design solutions due to commercial pressures and start developing conceptual designs without full examination of clients needs and requirements (Chung et al., 2009; Chung et al., 2017; Kelly & Duerk, 2002).

As an example, according to Chung et al. (2017), a project brief for a multimillion-dollar project was confined to only three pages.

Little evidence supports the conventional practice in achieving a match between the future product/solution and client needs (Pegoraro & Paula, 2017; Pikas et al., 2018). It is concluded that the conventional approach towards project definition is considered "inadequate" and has many limitations, especially in complex projects (Barrett & Barrett, 2006; Barrett & Stanley, 1999; Forgues et al., 2018; Kamara, Anumba, et al., 2002; Shen et al., 2004). We wish to remind that in this research, we mean by complex projects, large-scale projects that involve many stakeholders (managers, clients, etc.) with different needs and priorities, as explained by Whelton (2004). These projects are also characterized by uncertainty because on one side, the needs are dynamics and on the other side, the clients to whom the needs are identified change over the years: during project development (see Figure 1.1).

1.4 Limitations of conventional project definition practices

Based on the undertaken literature review, we identified five main problems associated with conventional project definition practices that impede the alignment between needs and solutions (Table 1.1): 1) focusing on the transformation view, 2) simplifying the dynamic project environment, 3) lack of client (user) involvement, 4) insufficient time for project definition, and 5) inadequate management of information. The identified problems will be discussed below in more details.

Table 1.1 Problems of the conventional project definition practices

Problems	Authors	
Focusing on the transformation view	(Tzortzopoulos et al., 2020).	(Forgues et al., 2018)
	(Koskela et al., 2002)	(Pikas et al., 2020)
Simplifying the dynamic project environment	(Perminova-Harikoski & Hellstrom, 2015)	(Shenhar et al., 2001)
	(Whelton, 2004)	(Bentahar & Ika, 2019)
		(Kärnä & Junnonen, 2017)
Lack of client (user) involvement	(Pikas et al., 2020)	(Howie, 1996)
	(Blyth & Worthington, 2010)	(Latham, 1994)
	(Kamara, Augenbroe, et al., 2002)	(Lee & Egbu, 2005)
	(Kelly et al., 2005)	(Barrett & Stanley, 1999)
	(Caixeta et al., 2013)	(Whelton, 2004)
	(Winch et al., 1998)	(Neal, 1995)
	(De Bakker et al., 2010).	
Insufficient time for project definition	(Lee & Egbu, 2005)	(Latham,1994)
	(Kamara, Augenbroe, et al., 2002)	
Inadequate management of information	(Jallow et al., 2017)	(Winch, 2010)
	(Blyth & Worthington, 2010)	(Jallow et al., 2008)
	(Tzortzopoulos et al., 2008)	(Whelton, 2004)

Focusing on the transformation view

According to authors such as Koskela et al. (2002); Pikas et al. (2020), the root cause of the problems in conventional project definition management is the fact that it does not base itself on the axes of the production theory which are transformation (what), flow (how), and value (why), namely TFV. In the transformation view the process is seen as a transformation of inputs (total transformation) to outputs (elementary tasks) in a temporal manner in order to carry out the tasks as efficiently as possible. The flow component conceptualizes production as a dynamic process comprised of inspection stages and aims at reducing waste (e.g., delay and wait time). Value generation in production aims at aligning the designed product with client needs (Koskela et al., 2002; Tzortzopoulos et al., 2020). These three complementary views co-exist and must equally contribute to project definition.

However, Forgues et al. (2018) point out that flow and value are not sufficiently addressed in traditional practices. Tzortzopoulos et al. (2020) add that design managers tend to focus on tasks, resources, and contracts which overshadows client requirements. Tzortzopoulos et al. (2008) confirm this conclusion and point out that in healthcare projects, the focus is mainly on the transformation view since hospital processes are organized around functional areas that tend to be perceived as isolated. Consequently, the building sector suffers from poor or incomplete project definition, resulting in significant changes in final stages of the project lifecycle, extra costs, and schedule overruns (Forgues et al., 2008).

Simplifying the dynamic project environment

Several authors (e.g., Perminova-Harikoski and Hellstrom (2015), Whelton (2004), and Kärnä and Junnonen (2017)) highlighted that very often, traditional project definition practices are linear and too general and have been criticized for their oversimplification by treating all projects as the same by assuming that "*a project is a project is a project*" Shenhar and Dvir (1996, p. 33). However, "*One size does not fit all*"; projects differ in size, complexity, technology, and risks (Norozpour, 2015).

Whelton (2004) believes that the management style should be adapted to the project complexity and environment (Figure 1.1). A linear and directive style of management, namely top-down, may be appropriate for organizations with low levels of complexity, but a more adaptive style of management is necessary in projects with high complexity (when different entities are involved); with a lot of uncertainty and a dynamic nature, such as healthcare projects. In such projects, different interactions are required in order to understand each other's needs and make decisions. Furthermore, users have little or no experience with design and construction processes, so the process becomes even more challenging (Tzortzopoulos et al., 2006). However, as much as hospital projects are complex and thus cannot be managed via a linear management style, the conventional practices are still linear.

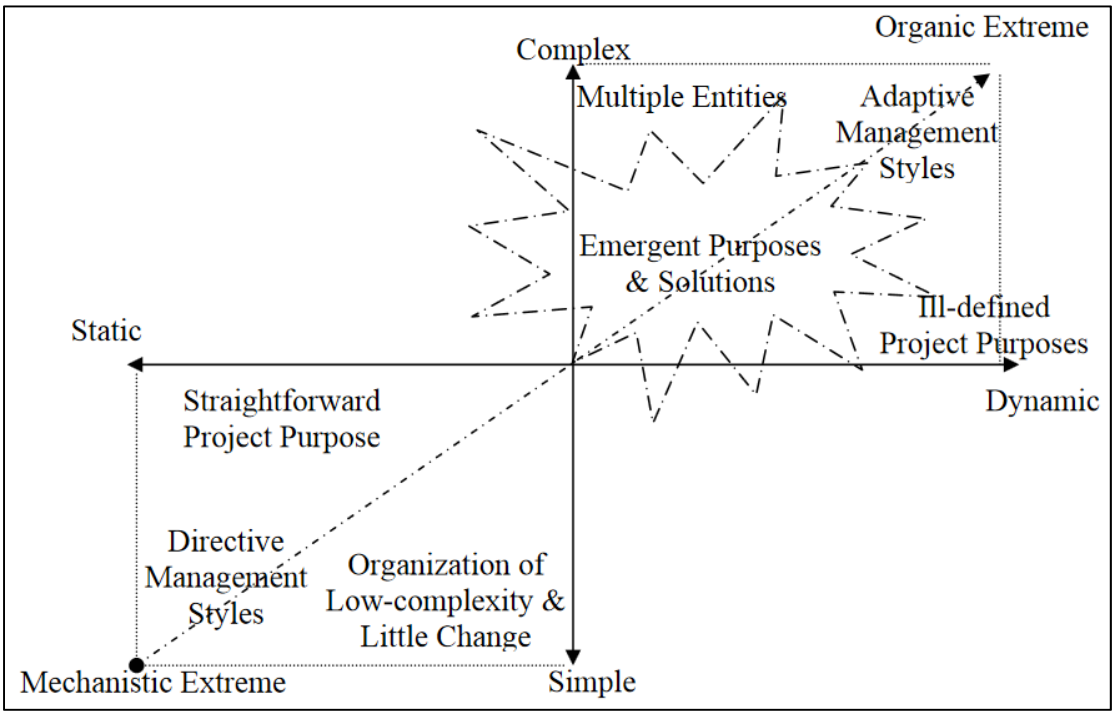


Figure 1.1 Project management styles and complexity
Taken from Whelton (2004, p. 49)

Lack of client (user) involvement

According to Barrett's investigations, many project definition inefficiencies can be attributed to the lack of client involvement (Barrett & Stanley, 1999; Kamara & Anumba, 2001) which gives the project suppliers (i.e., architects and engineers) the predominant perspective in the process.

In fact, Latham (1994) argue that architects usually base their designs on technical issues, with aesthetics and posterity in mind and not very much preoccupied with the client perspective. This is also emphasized by Whelton (2004), arguing that architects make assumptions based on their perceptions of user needs, which tend to be influenced by their own professional and personal background. In this sense, Kamara, Augenbroe, et al. (2002) add that not all architects are good brief writers, so there is a tendency for them to focus on design rather than establishing clear client requirements. The same authors argue that very often the client does not have

control over the definition process and the architect plays the central role likely holding the belief that "*Expert knows best*".

According to Blyth & Worthington (2010), what usually seems to happen is that the only client involved in the process is the "*paying client*" and "user" clients are usually not systematically involved by the team. The lack of involvement leads to the development of two user-need gaps that neither architects nor their clients are usually aware of, one being between designers and users and another between users and the paying client (Figure 1.2).

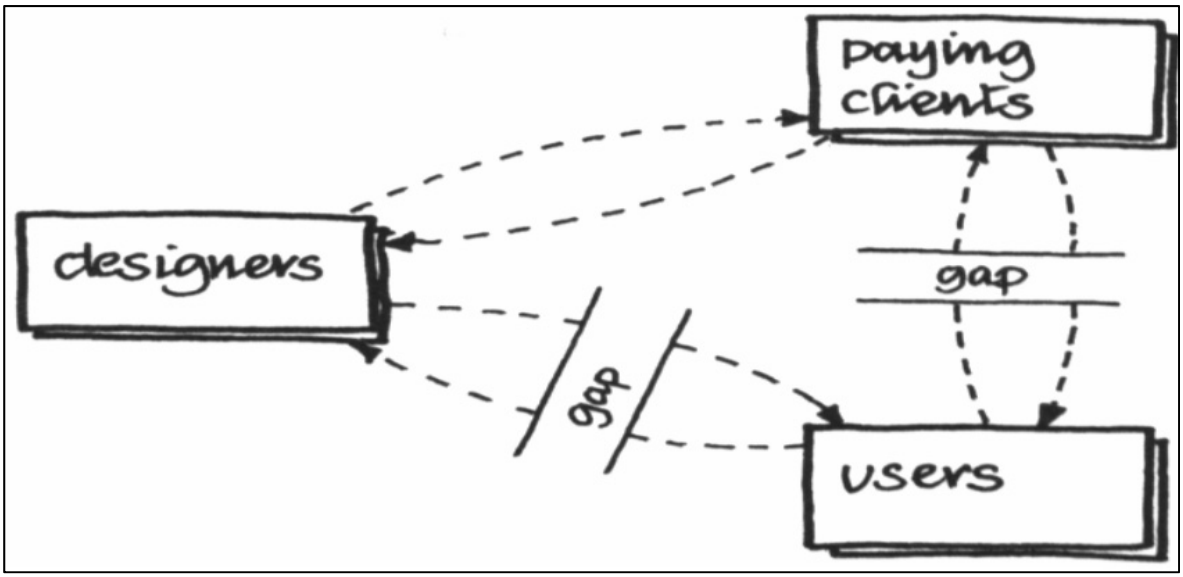


Figure 1.2 Zeisel's user-need gap model
Taken from Zeisel (1984 cited in Blyth & Worthington, 2010, p. 26)

According to Winch et al. (1998), the lack of client involvement creates five gaps that hinder the achievement of client value during the project life cycle, the first three of which can be traced to the project definition phase:

- Gap 1: between client expectations (needs) and management team perceptions of client expectations (needs);
- Gap 2: between management team perception of client expectations (needs) and management team translation of those perceptions into service quality specifications;
- Gap 3: between service quality specifications and actual service delivery;

- Gap 4: between actual service delivery and external communication to the client about the service;
- Gap 5: between actual service delivery and the client' s perception of the service.

These three first gaps in conventional practices cause a lack of continuity and alignment between client expectations and the delivered service (De Bakker et al., 2010). This also means causing design mistakes, incomplete designs, misunderstanding of user expectations, and as a consequence noticeable rework (Caixeta et al., 2013; Dikmen et al., 2005; Howie, 1996; Kelly et al., 2005; Pikas et al., 2018).

Blyth and Worthington (2010) outline that this phenomenon is often due to the contractual delivery methods adopted in a conventional project definition that usually ignore users and focus on reducing cost and meet delivery deadlines. The same authors point out (p.5) the irony that "*frequently, professional designers do not solve all problems that are theirs to resolve and the users are left to carry on as best they can*". However, if user needs are not fully understood in a construction project, multiple design alterations during the project is very probable (Spiten et al., 2016).

Insufficient time for project definition

Different authors such as Lee and Egbu (2005) and Latham (1994) believe that one of the problems of the traditional approach is the insufficient time spent on defining and understanding client needs. According to them, for achieving the purpose of the project, sufficient time is not spent at the beginning of the project definition stage to identify the potential issues and what exactly clients have in their mind. Bell (1994, as cited in Spiten et al., 2016) adds that oftentimes there seems to be a rush in project definition processes, resulting in a failure of recognizing user expectations. This point is supported by Blyth and Worthington (2010) who emphasize that design professionals very often underestimate the amount of time it takes to complete the project definition stage. This may happen due to a sense of urgency to come up with an immediate design solution.

Inadequate management of information

According to Kamara, Augenbroe, et al. (2002), another problem of the traditional approach is the inadequate management of information. As explained previously (section 1.3), several methodologies for data collection are used during project definition, such as interviews, workshops, examination of client documents, visits to similar facilities, among others (Whelton, 2004). However, even though the collected information is recorded in formal documents (e-mail, sketches, etc.,), they are not collectively stored as part of the final project definition output, namely the brief document and documents are kept in different locations (Jallow et al., 2017). Furthermore, in some cases proper documentation is non-existent and the information is collected based on verbal communications with clients causing the loss of a large amount of client information. Although the brief document represents the main reference for design professionals, it is still a static document (Jallow et al., 2008). With this approach, the capacity for traceability of changes in needs is poor, which represents one of the key factors in delays and budget overruns in construction projects (Kamara, Augenbroe, et al., 2002).

Little has changed in project definition processes in the last 30 years (Pikas et al., 2018) with a tendency to be treated as a '*black art*' realized by construction professionals for clients, guaranteeing the perfect solution (Blyth & Worthington, 2010). Compared with later stages of the project life cycle, project definition is characterized by complexity: uncertainties and fuzziness. In both practice and academia, project definition is less addressed and remains understudied and unstructured (Almqvist, 2017; Serugga et al., 2020b). But the question still remains: Why is project definition characterized by complexity: fuzziness and uncertainty?

1.5 Fuzziness and uncertainty in project definition

The difficulty to realize an effective project definition process is due to the complex nature of the problems at hand, such as defining the purpose of a building facility and client needs. In this process, decision-making is challenging and rational methods are difficult to apply (Barrett & Stanley, 1999; Pikas et al., 2018).

In fact, Rowe (1987) proposes that there are generally two categories of problems, well defined and ill-defined (or ill structured). Well-defined problems refer to those for which the ends (set of project goals) are apparent, and solutions require the provision of appropriate means (set of process actions and decision rules). On the other hand, in ill-defined problems both the ends and the solutions are unknown (Whelton & Ballard, 2002). Rittel and Webber (1973) propose another categorization of design problems known as "wicked" for problems that are highly ill-defined and too complex to be solved by rational methods in a linear fashion. They can be described as the following: "*no definitive formulation of a problem; no stopping rule; solutions are not true or false, but bad and good; no exhaustive list of admissible operations; for every problem there are many explanations depending on the designer's experience and knowledge; every wicked problem is a symptom of another; no definitive test; every problem is unique; and no room for failure*" (Pikas et al., 2018, p. 1304).

Having said that, problems in the project definition stage are classified as "wicked" because at the outset of the design process project goals are still unknown (Pikas et al., 2018). It is thus a matter of defining the needs along with providing a solution. In fact, it is generally believed that design is a progression from problems to solutions on a macro level, however, on a micro level, problems do not occur in isolation from potential solutions (Pikas et al., 2018). Halstrøm and Galle (2015, p. 3.3) emphasize that "*design problems and solutions stand in a chicken-and-egg relation of mutual dependency, and therefore in practice tends to evolve in parallel*". This means that problems and solutions should co-evolve simultaneously (Archer, 1979; Cross, 2001). However, the question is whether designers systematically progress from problems or jump to solutions before full elaboration of the problem (Pikas et al., 2018).

According to Ballard et al. (2009), the complexity of managing and controlling the early stages of a project is related to three main factors: 1) uncertainty needs, 2) duration of implementation, and 3) work complexity. Design solutions emerge through a complex process with time constraints. The sequence of work cannot be fully predicted initially since unforeseen design activities might be unveiled gradually (Lia et al., 2014). Cavarec (2012) also highlight the paradox of making the right decisions at the right time during a project due to the complex and

uncertain context (Figure 1.3). They believe that during the project definition process, the manager and the team should make important decisions even if they know little about the context and the consequences of them. Besides that, during the last phases of the project lifecycle, when managers and team members better understand the context and the consequences, decision can no longer be taken. This means that "*when they can, they don't know; and when they know, it is too late*"(Cavarec, 2012, p. 4).

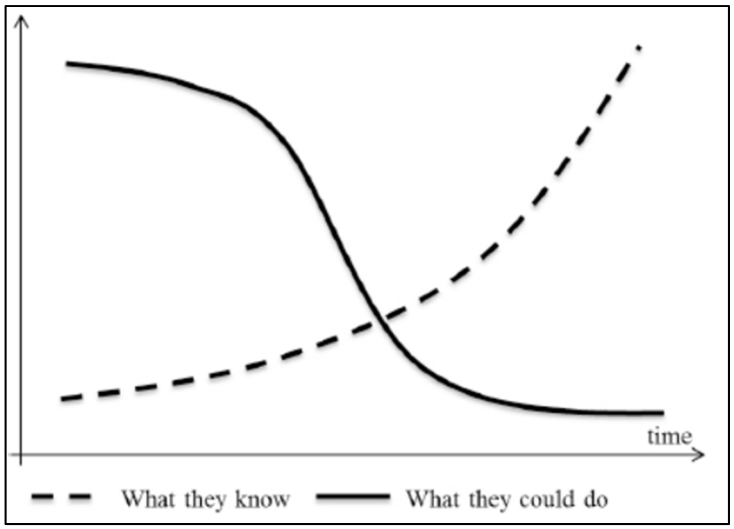


Figure 1.3 The paradox of the project manager
Taken from Cavarec (2012, p. 4)

Furthermore, Emmitt and Ruikar (2013) argue that project definition is about managing people and information. Whelton (2004) and Pikas et al. (2018) believe that defining a project is complex due to different aspects associated with it, that should be addressed which are: 1) product, 2) process, and 3) organization. On the one side, project definition is aimed at addressing client expectations on time according to the budget (Tzortzopoulos et al., 2020). On the other side, project definition management aims to bring construction stakeholders together, defined as "*individuals or groups who may affect or be affected by the project processes, contents, or outcomes*" (Eskerod et al., 2015, p. 6) to achieve a common purpose. This point is supported by Blyth and Worthington (2010) who view project definition as a matter of balancing two different interests: those of the users (e.g., doctors, nurses, etc.) on the demand side, and those of the delivery team on the supply side (e.g., architects, engineers,

regulatory agencies). Thus, the role of the project manager should be conciliatory, continuously listening to all stakeholders and teasing out client demands (Blyth & Worthington, 2010).

To sum up, project definition is a difficult challenge in project management, especially in the case of healthcare projects where the environment is uncertain and complex. Evidence suggests that this process cannot be solved by rational methods in a linear manner. So, different alternatives to traditional practices have been proposed to deal with it.

1.6 Review of solutions to improve the project definition process

We aimed to review and identify different research initiatives on client value generation and improvement of client need and requirement management. Table 1.2 presents the relevant ones which are classified based on their purpose such as improving decision-making (introducing the "voice of the client"), improving requirement and information management, increasing flexibility, and improving workflow during the preliminary design process, improving conversation between the stakeholders, client-driven management, and/or user-driven management. These initiatives will be discussed below in more details.

Table 1.2 Different initiatives to improve the project definition practices

Propositions	Authors
Improving decision-making: Introducing "voice of the client"	
Quality Function Deployment	[1][2][3][4][5]
Target Value Design	[15][16][17][18]
Set Based Design	[19][20][21][22][23]
Choosing By Advantage	[24]
Evidence-Based Design	[25][26][27][28]
Improving requirement and information management	
Building Information Modelling	[6] [7] [13] [9] [10] [8][29]
Product Lifecycle management	[30]
electronic Requirements Information Management	[14]
Increasing flexibility and improve workflow during the preliminary design process	
Scrum framework	[31][33]
Improving the conversation between stakeholders	
Lean-project delivery system	[34]
Client-driven management	
Knowledge management framework	[15]
Client-driven requirement management framework	[11] [12]
User-driven management	
Lean-led Design	[35][36][37]

[1] (Kamara, Anumba, et al., 2002), [2] (Natee et al., 2016), [3] (Dikmen et al., 2005), [4] (Wood et al., 2016), [5] (Parsanezhad et al., 2016), [6] (Soliman-Junior et al., 2020), [7] (Jallow et al., 2014), [8] (Fortineau et al., 2019), [9] (Baldauf et al., 2020), [10] (Eastman et al., 2009), [11] (Forgues, 2006a), [12] (Forgues, 2006b), [13] Fu et al. (2007), [14] (Jallow et al., 2017), [15](Whelton, 2004), [16] Do et al. (2015) [17] Gomes Miron et al. (2015) [18] Meijon Morêda Neto et al. (2019), [19] (Parrish et al., 2008), [20] (Singer et al., 2009), [21] (Ghosh & Seering, 2014), [22] (Hannapel & Vlahopoulos, 2014), [23] (Malak Jr & Paredis, 2007), [24] (Kpamma et al., 2017). [25] (Hamilton & Watkins, 2008), [26] (Ding, 2016), [27] Forgues et al. (2018), [28] Peavey and Vander Wyst (2017), [29] Fu et al. (2007), [30] (Aram & Eastman, 2013), [31] (Streule et al., 2016), [32]Hamzeh et al. (2009), [33] Lia et al. (2014), [34] Ballard (2000, 2008), [35] Schouten et al. (2020), [36] Smith et al. (2020) [37] Grunden and Hagood (2012).

Improving decision-making: Introducing "voice of the client"

Some researchers (such as Kamara, Anumba, et al. (2002)) propose to introduce the "voice of the client" during project definition to improve supplier's decision-making. They propose systematic steps for capturing and processing the information regarding client requirements. This proposition aims to facilitate verification of proper consideration of client requirements, namely the "voice of the client", in the design solution.

To support this approach, different techniques and methods derived from product development such as Quality Function Deployment (QFD), are suggested. Kamara, Augenbroe, et al. (2002) investigated the employment of QFD as a tool for client requirement processing. Mallon and Mulligan (1993) validated the applicability of QFD in the design of a hypothetical renovation project. Dikmen et al. (2005) propose the use of QFD in housing projects, as a strategic tool to support accurate decisions by introducing the voice of the client, which usually tends to be disregarded in the design process. Taking advantage of this perspective to support green hospital designs by identifying the end-user factors that impact the design, has also been proposed by While, Woods et al. (2017).

As explained by Dikmen et al. (2005), the principal QFD technique is the House of Quality Matrices (HOQ). The HOQ is a combination of different sub-matrices with the goal of increasing client satisfaction by maximizing accordance between products and client requirements (see. Figure 1.4).

However, the size of these matrices can be very large thus requiring complex analyses especially in the case of megaprojects. According to Wolniak (2018), QFD is not suitable for all applications and is usually recommended for projects with limited numbers of clients and low level of uncertainty. It is considered useful for client requirement management but not appropriate for complex projects with conflicting requirements (Caixeta & Fabricio, 2021). Other methods and techniques, such as Target Value Design (TVD), and Set Based Design (SBD), and Choosing By Advantage (CBA) which are also adapted from the product

development theory, have been proposed to facilitate decision-making by construction. Professionals in complex projects as well as clients value generations.

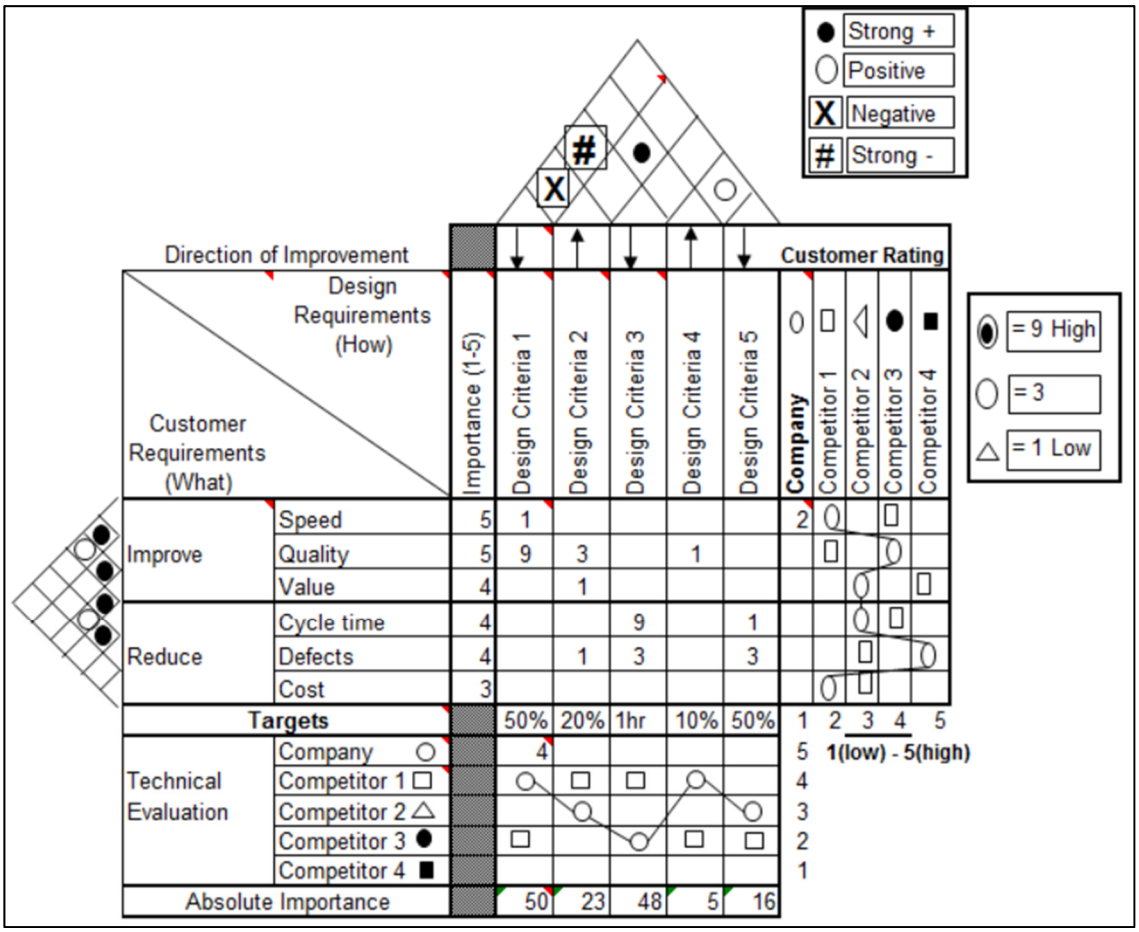


Figure 1.4 An example of HOQ matrix
Taken from: https://www.qimacros.com/quality-tools/qfd/
(Consulted in July 2021)

Different authors such as Do et al. (2015); Gomes Miron et al. (2015); Meijon Morêda Neto et al. (2019) suggest the use of Target Value Design (TVD) to make sure that client needs are met. This method is an adaptation of Target Costing (Do et al., 2015) and it is proposed to be used during the process of project definition, including in healthcare projects to maximize client value. However, the focus is mostly on cost management and generating "*value for money*". Other "values" and requirements of projects are usually not clearly documented in majority of studies (Gomes Miron et al., 2015).

Another proposition is the Set Based Design. It is recruited in construction projects including hospitals, during the preliminary design stage where the focus is on product design (Parrish et al., 2008). This collaborative technique involves all key suppliers (e.g., architects, engineers) and clients to be able to consider and evaluate all possible design alternatives and thus align the requirements with design solutions. In this approach, every alternative is evaluated and none of these alternatives should be eliminated without a logical reason to do so (Ghosh & Seering, 2014; Singer et al., 2009). The main objective of SBD is to use groups of values for design variables, so the professionals communicate about the design in terms of sets instead of single solutions. This process helps avoid early finalization of decisions and allows for high flexibility in dealing with dynamic requirements (Hannapel & Vlahopoulos, 2014). However, its limitations are also discussed by authors such as (Malak Jr & Paredis, 2007). For instance, SBD is not a comprehensive decision-making approach since the focus is only on the elimination of designs from a particular set, and not on completing a decision. To deal with that, some authors propose the use of Choosing By Advantage (CBA) system to improve decisions and manage wicked problems in participatory designs. Unlike the conventional approach, CBA aims to classify each design option and then assign a degree of importance (ex. desirable [want] or mandatory [must]) to support correct decisions, increase transparency, and share understanding (Kpamma et al., 2017).

Evidence-Based Design (EBD) has also been proposed as an approach to help professional designers in their decision-making based on evidence and solid research findings, also in healthcare projects (Hamilton & Watkins, 2008). Unlike previous propositions, EBD considers patients and clinicians at the centre of reflection and aims to design the best physical environment for their well-being (Ding, 2016). According to different authors such as Ding (2016); Forgues et al. (2018); Peavey and Vander Wyst (2017), improving the environment should positively impact the patient's healing process and staff efficacy.

Even though such initiatives have a positive impact on the project definition process by introducing the "voice of the client" or "voice of the patient", they are supply chain solutions because the management process is under the control of the design team with an occasional or indirect client (user) involvement. Furthermore, the focus is more on managing client

requirements and improving design decisions and less on how to capture and understand the functional and operational needs. In addition, the application of these methods in empirical research is limited.

Improving requirements and the information management

Recent studies have proposed the use of Building Information Modelling (BIM) not only to improve the communication between stakeholders but also to support a systematic requirement management during project definition of healthcare projects. Unlike the traditional practices where the information is crystallized manually within a very narrow timeframe, many studies have proposed the use of computers to connect the requirements with the product model. Soliman-Junior et al. (2020) proposed a semantic-based framework for automated rule checking of design solutions instead of manual compliance checking. Rules should enable an unambiguous formalization of implicit knowledge and thus reduce errors. Jallow et al. (2014) have proposed a framework that considers different functions, such as storage, distribution, and dependency checking. The same authors outline the importance of BIM in enabling collaboration between stakeholders. Baldauf et al. (2020) devised a process model through a sequence of interrelated activities in the context of client requirement management with the support of BIM-based tools for social housing project. However, according to Jallow et al. (2017) current research in BIM is still limited. Little information exists on how client requirement is captured and managed during the whole project life cycle.

Other propositions aimed to facilitate the integration of the people, processes, and the system by automating the processes and providing a single source of information for all stakeholders. Jallow et al. (2017) have discussed the benefits of using the Product Lifecycle Management (PLM) system which is heavily used in the manufacturing context to help manage client requirements in construction. Holding the same perspective, authors such as (Aram & Eastman, 2013; Bouguessa et al., 2013) proposed the use of PLM to improve current BIM applications claiming that project management in construction is still activity-based rather than information-centric. Jallow et al. (2017) confirms this conclusion and adds that the proposed models and frameworks (e.g., Kiviniemi and Fischer (2005), Ozkaya and Akin (2007)) to

manage the requirements is limited considering the considerable need for a lifecycle requirement management support in construction projects. So, they emphasize the necessity of implementing information-centric frameworks in order to fill the gap and present electronic Requirements Information Management (eRIM) as a solution. This is an information-centric framework that focuses on managing and controlling the content of documents regarding client information. Unlike the conventional static "brief", this framework facilitates access of all parties to the information about client requirements during the whole lifecycle. According to Jallow et al. (2017), eRIM takes a philosophical approach to integrate people, processes, and systems in a more efficient way, which is in line with the BIM philosophy. Future research on how eRIM can be integrated within a BIM environment as a client requirement management system is recommended.

However, the focus of these initiatives is on aligning client requirements with design solutions, however, little attention is given to capturing client needs.

Increasing flexibility and improving workflow during the preliminary design process

Studies such as (Streule et al., 2016), investigated the implementation of agile methods from the IT sector into preliminary design and design management in construction and propose the use of Scrum framework to deal with unpredictable environments and constant changes. Instead of trying to predict unforeseeable risks, the idea is to develop the ability to both create and respond to changes and approach them as profitable opportunities. This framework also aims to improve the collaboration and the communication between project stakeholders. Even though Scrum should facilitate bottom-up processes and work environment transparency, consequences of implementing this method in complex projects are still not clear.

Conversation between stakeholders

Furthermore, authors such as Aapaoja et al. (2013); Thiry (2002), have highlighted the importance of the stakeholder involvement in reducing the ambiguity during the process of project definition. Emmitt and Christoffersen (2009) stress the importance of discussing each client's needs and expectations to increase value generation. According to Green (1996),

project definition should be seen as a mutual learning process that is reached through a series of conversations between clients and professionals. Limited studies, however, exist on how the processes can be managed in these contexts (Kpamma et al., 2017).

In the context of Lean Project Delivery (see section 1.1). Ballard (2000, 2008) emphasizes the importance of collaboration and conversation during the project definition process to establish alignment between project purpose, design criteria, and conceptual designs (Figure 1.5). In this context, purposes refer to stakeholders' needs and value, while criteria refer to the translation of those purposes using technical words and they are used to test the validity of design concepts generated.

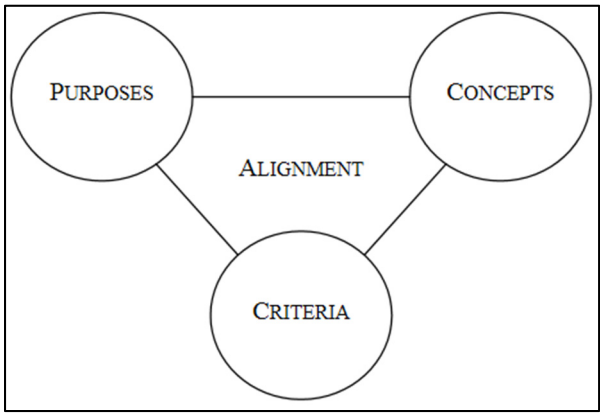


Figure 1.5 Project Definition Delivery Model
Taken from Whelton (2004, p. 19)

According to Ballard (2000, 2008), through conversation, the supplier's job (architects and engineers) is not only to provide what the client wants, but also to understand why they want it in order to help them make better decisions and understand the consequences of those choices by using methods such as TVD, SBD, CBA. But according to the author's experience, this does not appear to be a common practice. In fact, suppliers often hold the premise that clients know what they want, thus, suppliers do not challenge their self-understanding (Ballard, 2008). Even though the project definition delivery system covers the whole process of project definition and aims to align client needs with designs, in the process of management the predominant perspective is of the suppliers and not of the client (user). It is noteworthy that empirical studies are a few in this context.

Client-driven management

Whelton (2004) criticizes systematic methods of managing client requirements and suggests a collaborative and adaptive approach for project definition based on the project definition delivery model knows as "knowledge management framework". This author claims that the alignment between needs and design concept is achieved through negotiation and dialogue between the professional and the client group. Unlike the proposition of Ballard (2008), in the proposition of Whelton (2004), the project manager (the client representative) plays a significant role in managing collective dialogues (Figure. 1.6). Here, client representatives act as a translator and facilitator for eliciting client stakeholders needs; also helping to frame the interests of one group in terms of the other group's perspective. However, this becomes challenging in complex projects, where different stakeholders are involved with conflicting needs and objectives thus representatives require lots of efforts and training to manage a rigorous and collaborative process in an uncertain and complex environment.

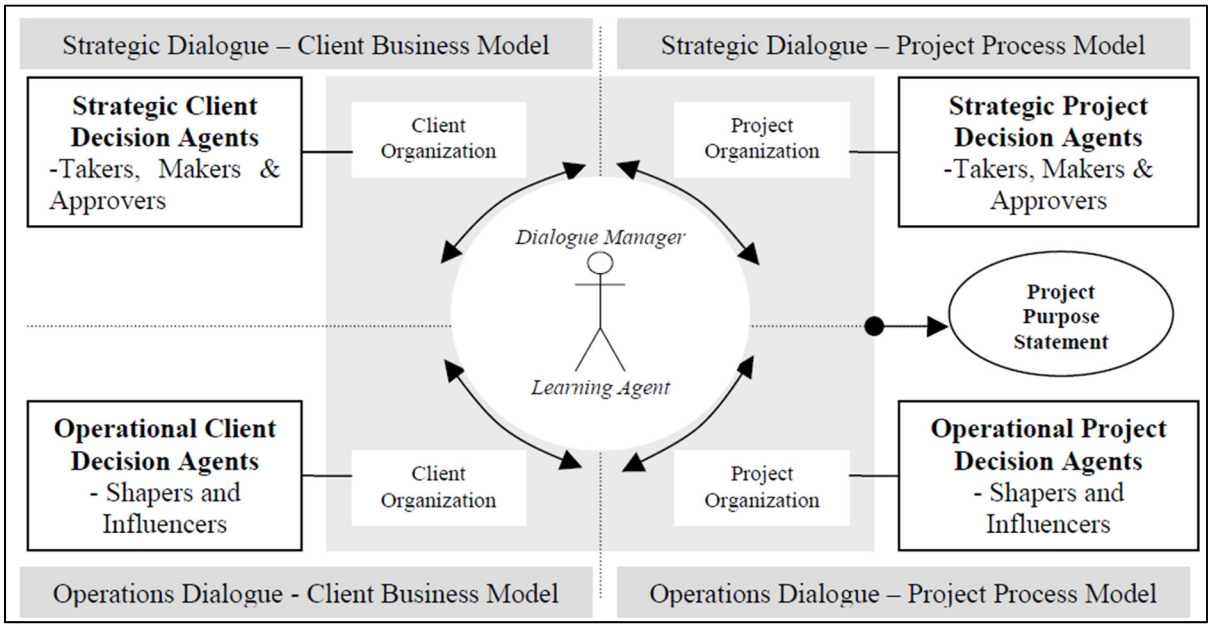


Figure 1.6 Project Definition Translator & Facilitator Role
Taken from Whelton et al. (2001, p. 206)

Following the same line of thinking of Whelton (2004), project management institute, PMI (2003), argues for a client-driven project definition process for efficient value generation. Forgues (2006a, 2006b) shares the same view adding that the traditional practices are usually

dominated by: 1) the project manager who is the client representative and 2) the architect who represents the professional design team. The provided thus provided a collaborative framework, inspired by information technology (IT) organizations, which involved a large group of stakeholders both in client and supplier sides. This framework uses requirement metrics in order to help client stakeholders to monitor the alignment with strategic expected outcomes at project level and client stakeholders are actively involved in the process. They are responsible for validating supplier-related components of the solution. Even though this framework aims to boost the capability of clients to elicit requirements and to systematically manage them, its implementation is limited to a specific group of owner-occupier clients (Forgues, 2006b). Furthermore, similar to TVD, the focus in this context is only on generating "*value for money*".

User-driven management

In a similar vein, different authors proposed methods that aim to empower the user during the project definition process in order to better align their needs with the proposed designs.

In fact, the term user involvement is commonly used in design management literature, also referred to as user participation. The term "participation" implies "user" involvement but without indicating which user nor the degree of participation (Yalniz, 2020). Researchers use the same terms to describe different degrees and levels of participation (Caixeta et al., 2019). To clarify the concept, Caixeta et al. (2019) performed a systematic review on the definitions and levels of user involvement in the building design process, which was concluded by the identification of three levels of user involvement (Figure 1.7).

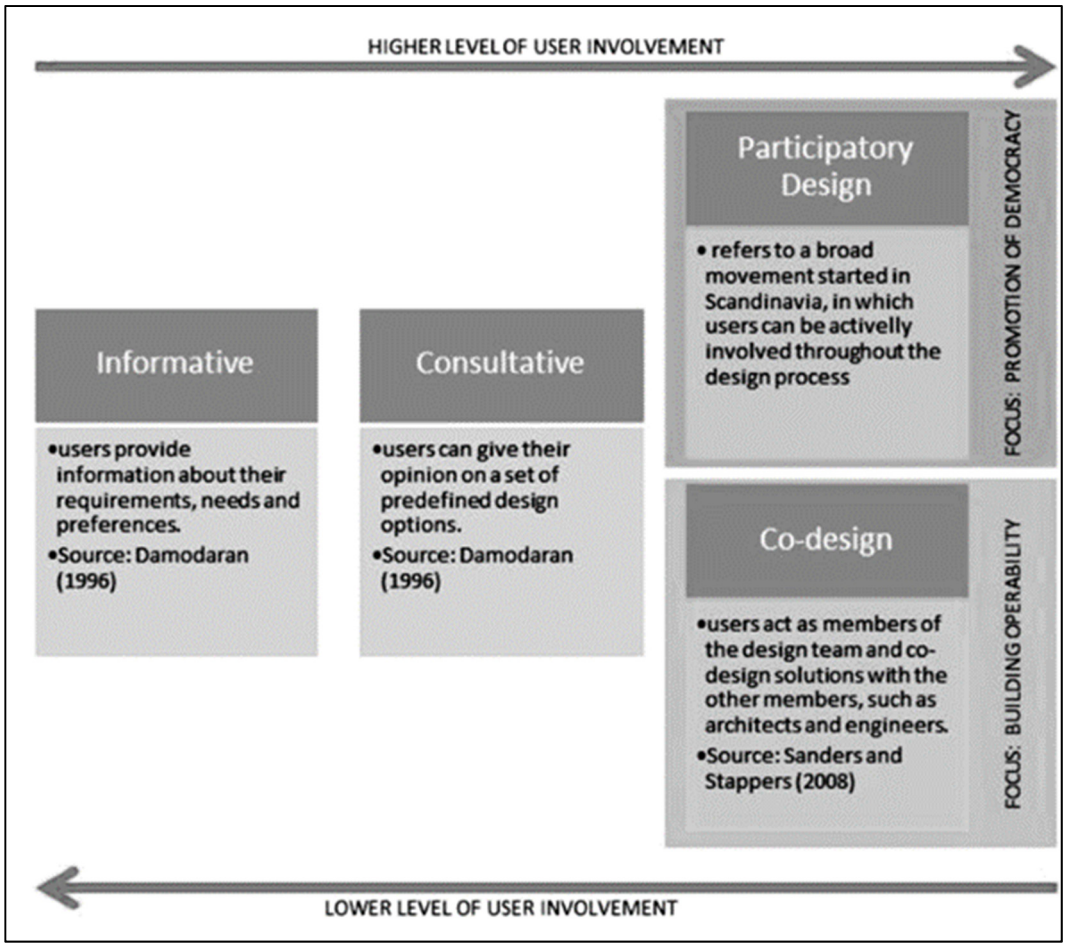


Figure 1.7 Levels of user involvement proposed for building design process
Taken from Caixeta, Tzortzopoulos, et Fabricio (2019, p. 19)

The classification of levels was based on the reason and typology of interaction between users and professional designers. The first level of involvement is called “informative”. At this level, users provide information about their needs and desires and receive information about the solution design from the professional design team. The second and intermediate level is called “consultative”. At this level, users can give their opinion based on a set of predefined design options. The third and the highest level of involvement is called “participatory design” and “co-design”, while some authors consider participatory design and co-design as synonymous (Stangel & Szóstek, 2015), Caixeta et al. (2019) argue that the two strategies are different and could be implemented in a complimentary way: one during the design stage and the other during the early stages. According to these authors, participatory design, started in Scandinavia, concerns involving the users in the design stage process in a continuous way to

promote a democratic design process, while co-design is a form where users act as members of the design team during the project definition phase. In the healthcare sector, the objective is to improve the usability and operability of the building to be designed. This means that participatory design is basically used during the design stage and co-design during the early design stages.

Having said that, “co-design” represents a more appropriate strategy for the project definition phase. To support the implementation of this strategy, many authors proposed the Lean-led design also called as: Lean healthcare design (e.g., Reijula et al., 2014), Lean 3P design (e.g., Hicks et al., 2013), Lean design of hospitals (e.g., Hicks et al., 2015), Lean exploration loops into healthcare facilities (e.g., Mazur et al., 2017), Lean-led architectural Design (e.g., Ding, 2016), and Lean-led hospital design (e.g., Grunden & Hagood, 2012).

This structured approach, specific to hospitals, is proposed to be applied during the whole process of project definition, starting from identifying client needs to the stage of proposing conceptual design solutions (Grunden & Hagood, 2012). Unlike the traditional way, where the user is a passive recipient of a product, in Lean-led design users take a more proactive stand during the whole process. The objective is to improve the healthcare flow by rethinking the way hospital projects work (Schouten et al., 2020). Hicks et al. (2015) emphasizes the importance of analyzing and optimizing hospital flows (patients, staff, visitors, supplies, equipment, medication and information) before estimating the required area of each department and proposing a design solution.

Authors such as (Grunden & Hagood, 2012; Schouten et al., 2020; Smith et al., 2020) claim that applying the lean-led design approach should align real user needs with design solutions. However, publications on this approach are limited and to the best of our knowledge, none of them have explored how Lean-led design facilitates alignment.

It is important to highlight that, in this research, publications about Lean healthcare (e.g., Hallam & Contreras, 2018; Antony et al., 2019; Costa et al.,2017) and Lean Design (Freire &

Alarcón, 2002; Herrera et al., 2020; Chbaly et al., 2019) were not included because the focus of these initiatives is different than our research one. In fact, even though Lean healthcare approach is proposed to be implemented in healthcare projects, the objective is to improve the processes during the operation phase of the project life cycle (Hallam & Contreras, 2018) and not the project definition. Besides that, the focus of Lean Design is to improve the design process during the design stage (Fosse & Ballard, 2016), which means the stage after the project definition. That's why, we decided to exclude both approaches.

To sum up, a variety of initiatives have been proposed to generate value and achieve alignment between the client needs and designs, but in different manners. However, in this research, we will be focusing on the alignment when using the Lean-led design approach due to several reasons discussed in the next section.

1.7 Discussion for a specification of the research scope

If the limitations of conventional practices are considered (see section 1.4), it is possible to confirm that the propositions actually intended to deal with many of the limitations (e.g., lack of client involvement, poor communication among the parties, inadequate management of information, etc.). Even though the propositions aim to involve clients (users) in the process of project definition, the level of involvement is still intermediate (consultative, see Figure 1.7) in the majority of propositions. Furthermore, among all the propositions only those adopting Lean construction principles, Lean-led design, Lean project delivery system, and knowledge management framework aimed to deal with all the three gaps highlighted by Winch et al. (1998) (see Chapter 1, section. 1.4). The focus of the other propositions is on the second and/or the third gap, between the perception of client needs and their translation into requirements, during the programming stage; and between the requirements and the conceptual design, during the preliminary design stage. The first gap, between client needs and the perception of client needs, always tend to be neglected during the planning stage.

Therefore, to address the above limitations and specify the research scope to study the alignment during project definition in the case of a hospital project, we have classified and compared different initiatives previously explained, based on five criteria (see Table 1.3).

Table 1.3 A comparison between the different methods and frameworks proposed to improve the project definition stages

METHODS/ FRAMEWORKS	C.1	C.2	C.3			C.4	C.5
	Focus?	Involvement level	Alignment ?			Complex project?	Origin?
			i	ii	iii		
Quality Function Deployment	P	2		x	x	No	Product development.
Target Value Design	C	2			x	Yes	Product development
Lean Project Delivery system	P	2	x	x	x	Yes	Construction
Knowledge management framework		3.2	x	x	x	No	Construction
Client-driven requirement framework	C	3.2		x		No	Information technology
Scrum framework	P	2			x	Yes	Information technology
Set Based Design	P	2			x	Yes	Product development
Choosing By Advantage	P	2			x	Yes	Product development
Building Information Modelling	I	3.1		x	x	Yes	Construction
Product Lifecycle Management	I	3.1		x	x	Yes	Manufacturing
eRIM	I	2		x	x	Yes	Construction
Evidence Based Design	E	2			x	Yes	Hospital
Lean-led Design	**E,F**	**3.2**	**x**	**x**	**x**	**Yes**	**Hospital**

The first criterion (C.1) is about the focus of the proposition: *What do the author's aim to improve: costs (C), information (I), building functionality (F), environment of buildings (e.g., noise, lighting, etc.) (E), or design process (P)*? It was important for us to take into account this criterion, because the specific focus of our research was to improve building functionality (user needs).

The second criterion (C.2) signifies the level of user involvement: *What is the level of user involvement: Informative (1), Consultative (2), Participatory (3.1) or co-design (3.2)?* It was important for us to take this criterion into account because the level of user involvement impacts alignment achievement.

The third criterion (C.3) is about the type of alignment to be achieved and the project definition stage. *The solution aims to achieve an alignment between: client needs and the perception of the client needs, planning stage (i), perception of the clients 'needs and their translation into requirements, programming stage (ii), requirements and conceptual design, preliminary design stage (iii)?* It was important for us to take into account this criterion because our research focus is on the whole process of the project definition: from the clients 'needs until the conceptual design.

The fourth criterion (C.4) deals with adapting the propositions to complex projects. *Could the approach be implemented in complex projects?* It was important for us to take into account this criterion because our research focus is on complex projects, especially hospitals.

The fifth criterion (C.5) is on the origin of the solution. *What is the origin of the solution?* It was important for us to take into account this criterion in order to see if the proposed solution is specific to construction projects or adapted from other industries.

Altogether, based on these comparisons we have chosen the Lean-led Design approach to study alignment during project definition, due to the following four reasons:

1) Lean-led Design focuses on improving functional issues that are usually less commonly addressed. According to the literature, the majority of the proposed solutions to improve the project definition process, focus on costs or information (e.g., client-driven requirement framework, BIM) , and neglect the functional aspects;
2) High level of user involvement. In the Lean-led Design approach, users take a more proactive role, unlike other solutions proposed to improve the project definition process

(e.g., evidence-based design, Quality Function Deployment) where the predominant perspective is that of the suppliers or the clients who provide the funds;

3) Unlike approaches adapted from other industries (e.g., information technology, manufacturing), Lean-led design was first developed to be implemented during the project definition of healthcare projects, which is exactly the topic of current research;
4) Lean-led Design is the only approach for healthcare projects that empowers users during the whole process of project definition, unlike the majority of solutions that focus on only one stage (e.g., BIM focuses on the programming or preliminary stages, Set Based Design focuses on the preliminary design stage). In other words, Lean-led Design is the only inclusive approach that aims to align client needs with design solutions, adapted to hospital complexity as well.

Therefore, starting from the premise that Lean-led Design is a relevant approach and since it is a participative and inclusive approach aiming to align client needs with design solutions, it stands in sharp contrast to the existing conventional approaches. Considering that, the following questions have been of interest to us, as presented in the introduction:

What are the factors that impact the alignment between client needs and conceptual design solutions during project definition of a hospital?

More specifically:
What are the factors that facilitate that alignment?
And
What are the factors that impede that alignment?

As a matter of fact, few studies in the context of the construction industry have focused on achieving alignment during the whole process of project definition, especially in complex projects and implementation of Lean-led design cases, since they are a few. This consequently limits the opportunity to study the details regarding its implementation and potential contribution to alignment between client needs and design solutions.

For that reason, based on two interconnected steps (the first one being a literature review- see Chapter 3, and the second one being a case study- see Chapter 4), this research study aims to investigate the above-mentioned questions. The following section presents the followed methodology to that end.

CHAPTER 2

METHODOLOGY

In this chapter, we aim to depict and justify our methodological choices adopted in order to answer our main research question. To do so, we divided this chapter in different sections. We firstly start by presenting and justifying the epistemological position chosen to answer our research question previously announced. Secondly, we introduce the research strategy adopted which is mainly qualitative. Thirdly, we present the research steps with the data collection treatment and analysis strategy of documentation, and interviews. Finally, we conclude this chapter with the validity, and reliability of the study. All the information presented in this chapter should allow the reader to fully understand the research methodology from the first steps until the conclusions.

However, before starting to present the different sections, we felt it important in order to understand the research process, to first present the four basic elements of a research paradigm: 1) ontology, 2) epistemology, 3) methodology, and 4) methods (Scotland, 2012). Table 2.1 summarizes the meaning of each element.

Table 2.1 The different element of a research paradigm

N	Element	Definition and questions to be asked
1	Ontology	Is the study of being *What constitutes reality?* (Crotty, 1998, p. 3)
2	Epistemology	Represents the theory of knowledge that defines what kind of knowledge is possible and legitimate: *What is the nature of the relationship between the would-be knower and what can be known?* (Guba & Lincoln, 1994, p. 108)
3	Methodology or Strategy	Refers to the strategy, plan of action, process or design lying behind the choice and use of particular: *How can the inquirer go about finding out whatever they believe can be known?* (Guba & Lincoln, 1994, p. 108)
4	Methods	Techniques used to gather and analyze data related to the research question: *What are the specific techniques and procedures used to collect and analyze data ?* (Crotty, 1998, p. 3)

We understand paradigm as a set of practices and beliefs composed of four elements, classified in different levels but also intimately linked to each other: choices made in higher levels (ontology and epistemology) determines choices in lower levels (methods) the lower levels. In the following section, we will present in detail our choices, starting with the ontological and epistemological ones.

2.1 Ontological and epistemological position

Different scientific paradigms are established by researchers with shared beliefs about the nature of reality and knowledge construction (Crotty, 1998). The most frequently adopted paradigms, as presented by Welford et al. (2011), are positivism, post-positivism, interpretivism, constructionism. Every paradigm is based upon its own ontological and epistemological assumptions, and there is no single paradigm superior to the others (Weaver & Olson, 2006). In this research we adopt a post-positivism paradigm. In order to justify our choice, we developed a comparative table based on Crotty's (1998) framework (Table 2.2).

Table 2.2 Existing differences between four paradigms
Adapted from Crotty (1998)

Research question	**Paradigm**	**Ontology**	**Epistemology**
What is the truth? What can we establish with certainty?	Positivism	"real" ordered and regular world	Objective /dualist
What causes or influences outcomes?	Post-positivism	Reality can never be fully known	Objective
How have people in this setting constructed reality?	Constructionism	The human world	Subjective
What is the culture of this group of people?	Interpretivism	People and culture	Subjective

As shown in table 2.2, post-positivism seeks to understand causes or influences outcomes, which is completely aligned with our research objectives and question. In fact, if we go back

to our research question: What are the factors that impact alignment between client needs and conceptual design solutions during project definition of a hospital? We can see that our intent is to understand what causes or influences the alignment between client needs and design solution. Our focus is thus on understanding facts not people and culture, which justify the reason for adopting a post-positivism paradigm not another.

In fact, post-positivism was developed after positivism (Guba & Lincoln, 1994). Ontologically, the post-positivist paradigm assumes that reality can never fully comprehend the whole truth, it can only approximate it and understand it probabilistically, unlike in the positivist (Young & Ryan, 2020). The epistemology of post-positivism is objective but it assumes that the results obtained from the research are considered as probably "true" (and not perfectly "true"), (Cherkaoui & Haouata, 2017; Guba & Lincoln, 1994). The absolute truth is nowhere to be found and can never be fully verified. All observations made are always extent personally biased, fallible and have errors (Nawrin & Mongkolsirikiet, 2012).

Furthermore, post-positivism recognizes that all theory is revisable, there is no absolute source of knowledge and the research findings warrant that knowledge is not universally generalizable to all cases and situations (Guba & Lincoln, 1994; Nawrin & Mongkolsirikiet, 2012). It assumes that in order to produce the most accurate knowledge, it would probably be easier to falsify the incorrect assumptions created rather than verifying them, unlike in positivism (Guba & Lincoln, 1994; Popper, 1963).

The characteristics of post-positivism are broad including bringing together theory and practice, allowing acknowledgment and encouragement for the researchers' motivations and commitment to the topic (Ryan, 2006). Post-positivist approach balances both positivist and interpretivist approaches (Panhwar et al., 2017). It is flexible and allows the researcher to use multiple methods and strategies to answer the research questions including qualitative one, unlike in the positivist paradigm (Kankam, 2019).

2.2 Research strategy

Our overall research strategy is a qualitative case study. Unlike the quantitative approach that evaluates the study with numbers, the qualitative research evaluates it with words and meanings (Marshall & Rossman, 2011). According to Yin (2009), a case study method allows researcher to retain the holistic and meaningful characteristics of real events, such as organizational ana managerial processes. It aims to uncover deeper processes, and understand how those processes unfold over time (Bluhm et al., 2011; Barney Glaser & Anselm Strauss, 1967). Yin (2009) explains that the use of a case study strategy could be justified when the research question starts with “how”, “why” or also “what”. However, the only exception is that question starting with “what” should not take form of a “how many” or “how much”, which is not our case. In fact, our intent is not to understand how many factors impact the alignment but to understand which factors impact the alignment and how these factors evolve in time, which is a justifiable rational for using such research strategy.

Two types of case studies were identified. The first type is a multiple case study, when the understanding the phenomenon is done by repeating the phenomenon in several contexts. The second type is a single case study, where the research is conducted in a unique context (Baxter & Jack, 2008). In this project we used single case study strategy due to two main reasons.

The first one, a single case study does not mean a single experiment (Yin, 2009) . It can be an organization with multiple cases or also a single process with multiple temporal phases Gehman et al. (2018). The second reason is, that a single case study help to develop a deeper understanding of a subject, and thus help to produce extra and better theories than a multiple case study (Dyer & Wilkins, 1991). It represent a significant contribution to theory building (Yin, 2009). The third reason of choosing a single case study, is the detailed qualitative accounts that facilitates not only the exploration and the description of the data in real-life environment, but also the explanation of the real-life situations’ complexities, which could not be captured through experimental or survey research (Yin, 1984).

Furthermore, according to Yin (2009) the selection of the case study should be based on different criteria. Stake (1995) argues that the selection could be based on its uniqueness. Eisenhardt (1989) advocates the idea of choosing “extreme” case study, so that the theoretical implications emerge more easily. Easton (2010, p. 8) agrees with that and added that a “*single case study must be able to stand on its own. The justification that is frequently used is the depth and comprehensiveness of case data. A case study will normally be very much more structurally complex and contains far more data at the level of the unit of analysis*.”

Therefore, based on these recommendations, we choose a mega-hospital, situated in Quebec *namely nouveau complexe hospitalier* (NCH), as our research case study. The main reason for that is because the project can be considered as "extreme" or “unique” with regard to the particular context that characterizes it and in which strong opposing logics coexist. It represents in fact one of the first-ever single projects that implemented Lean-led Design approach in Canada during the project definition. It is also one of the biggest hospitals in Canada project (208 185 m^2), that aims to consolidate the clinical activities of two existing hospitals: *Hôpital de l'Enfant-Jésus* (HEJ) and those of *L’Hôtel-Dieu de Québec* (L’HDQ) on the HEJ site by involving a wide range of stakeholders. Another rational for choosing this case study, is because it is a longitudinal case. It helps us to study the same case at different points in time, more specifically, it helps us to analyze over time the project definition process and practices, which are our units of analysis. The last reason is about the project proximity and accessibility: Quebec City.

After presenting the research strategy, we present below the research steps along with different methods used to collect data in order to answer our research questions.

2.3 Research Steps

Inspired by the case study method proposed by Yin (2003), this thesis followed three important steps (figure 2.1): 1) developing an alignment framework based on a literature review, 2) falsifying or confirming the validity of the framework based on a case study, 3) revising the

framework based on the comparison between the literature and the case study. In this section, we will present in detail the objective of each step; and the data collection, treatment and analysis strategy used to achieve this objective.

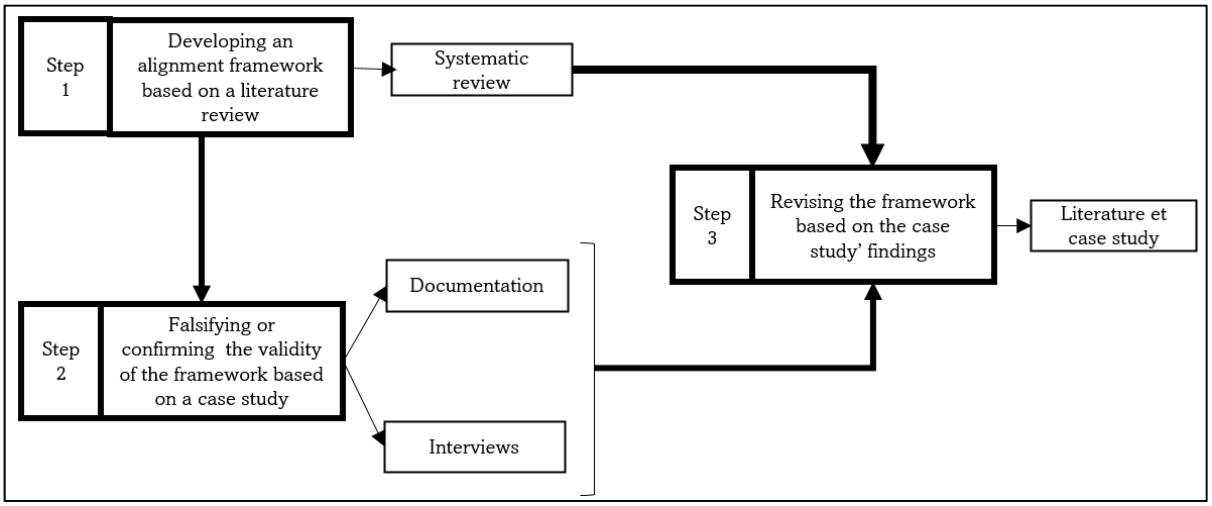


Figure 2.1 Research framework

2.3.1 Step 1: Developing a framework based on a literature review

In the step 1 we try to question (what are the factors that impact alignment between client needs and conceptual design solutions during project definition of a hospital?) based on a systematic qualitative literature review. This literature review plays an important role in our research not only to identify the alignment factors but also to develop a conceptual framework. This framework should provide us a solid ground to the case study analysis. In fact, one of the important points of differences between case study and ethnography (Guba & Lincoln, 1994) or grounded theory (Corbin & Strauss, 1990) is a theory development. Researchers adopting a case study strategy starts with the construction of a preliminary theory. It is in fact an essential part, whether the ensuring case study purpose is to develop or test a theory (Gehman et al., 2018; Yin, 2009).

systematic literature review

In order to gather existing factors that impact the alignment proposed in literature, we used a methodology inspired by a systematic literature review. According to different authors, such as (Denyer & Tranfield, 2009; Khan et al., 2003), a systematic literature review represents a good strategy in order to answer a specific question. It followed a structured process to minimize the impact of the researcher on the results of the search and to ensure that these results are both reliable and meaningful to end users (Munn et al., 2018).

Thus, in order to select and identify papers to review based on Scopus and Google scholar databases, we have used different key words, such as: ((“alignment factor” OR “enable*” OR “hinder*”) AND (“Project definition”) AND (“construction industry” OR “hospital” OR “Lean-led Design” OR “Lean”)).

After that we used four criteria:

1- All the searched words should appear in the abstract, the introduction or keywords of the studies found; because we wanted to avoid selecting papers where the keyword is just cited in their reference section, making sure that the content of the paper selected is directly related to our subject;
2- The selection included all publications during the last 20 years;
3- As our research strategy is qualitative, all papers using only survey data or statistical reporting of results are excluded. Qualitative data from a mixed methods study was included;
4- All papers written in languages other than English, French or Spanish are excluded, because of our lack expertise in these languages.

After verification we have identified only 9 papers that do not explicitly discuss the alignment factors per se. That’s why, we decided to broaden our scope of literature review to include papers in other areas, such as information and technology (IT) or construction project management, where alignment issue has been widely studied (for more details see chapter 3 section 3.2).

Based on that, we modified the keywords used. This is an example of what we used: ((“alignment factor” OR “enable*”OR “hinder*”) AND (“Project definition”) AND (“construction industry” OR “hospital” OR “Lean-led Design” OR “Lean” OR “construction project management”)) OR ((“alignment factor’” OR “enable*” OR “hinder*”) AND (“IT-business” OR “business organization” OR “ IT organization”)).

We found 112 papers that were filtered based on the same criteria used previously. After verification, we excluded 16 articles concerning quantitative works and 8 published in languages other than we above-mentioned. Thus, the number of publications decreased to 88, which correspond to the final number of papers retained for this study. As shown in the table 2.3, 23 papers selected are related to IT area, 30 papers are related to construction project management, 26 papers are related to the Lean context in which only 9 concern hospital projects.

Table 2.3 Selected paper details

Literature Sources	**Studies**				**Total studies**
	IT - business	**Construction**			
		Construction project management	**Lean**		
			Other projects	**Hospital projects**	
Studies Found	40	37	26	9	112
Studies Selected	23	30	26	9	88

Based on the 88 papers selected; we have mapped a total of 175 alignment factors (see ANNEX I). Figure 2.2 shows an extract of this mapping. In this figure we classified the factors not only based on the area studied and authors, but also into facilitating (green colour), hindering (red colour). After that, we classified these factors into seven categories, which helped us to develop a conceptual framework (see chapter 3).

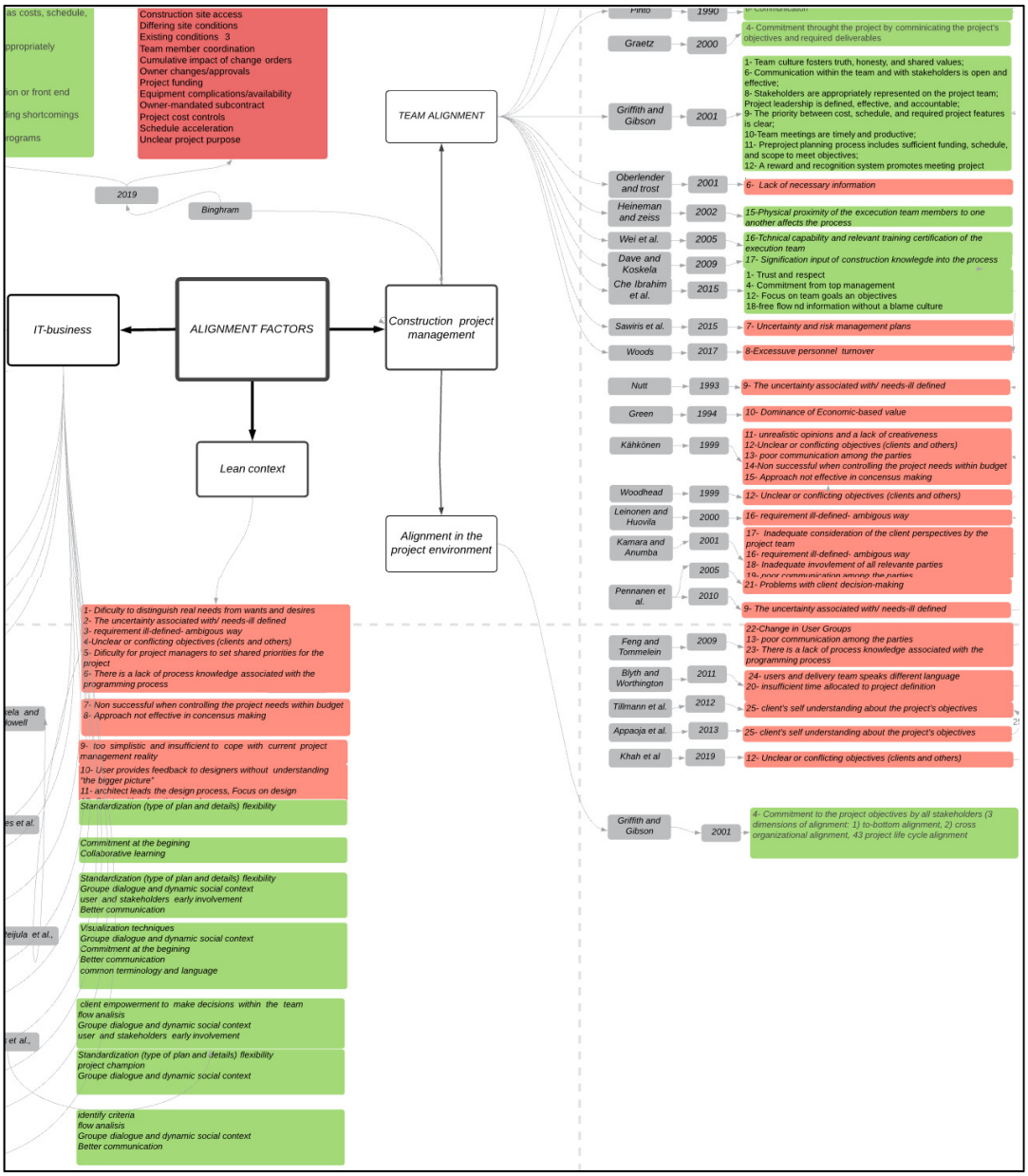


Figure 2.2 An example of alignment factors mapping

2.3.2 Step 2: Falsifying or confirming the validity of the framework based on a case study

After identifying the alignment factors based on the literature and developing a conceptual framework, in step 2, we aim, based on our case study, to identify the alignment factors and to

falsify or confirm the validity of the conceptual framework. The results of this step 2 are presented in chapter 4. To do so, we used two data collection strategy: documentation, interviews. The combination of these data should provide an important way of ensuring reliability and validity of the research (Denzin, 1978; Yin, 1984).

2.3.2.1 Documentation

According to Myers (2009), documentation review is important in any data collection strategy. This methodology usually provides a better comprehensive information about the phenomenon. It is useful for tracing decisions over time and for identifying relevant events and facts historically rooted.

In this study, the documentation was an important source of data that we used to develop a comprehensive understanding of the different participative methods and tools used during the project definition of the megaproject NCH. It helped us also to identify the facilitating alignment factors addressed during each stage.

Our principal source of documentation was the SharePoint. It represents a virtual document storage platform shared between the different stakeholders of the project studied. However, we found 10380 documents divided into seven big folders to choose from to build up an understanding of what happened during the project definition and to use in the analysis. We had access to all written project materials such as meeting reports, PowerPoint presentations of all Lean activities, PowerPoint presentations that were held to share results with stakeholders, building plans, etc. These documents were produced by different firms and participants and often not classified in a logical order with the objective to communicate information about the project, coordinate the collective work, or produce a tangible output for the project realization (e.g., an architectural plan). Therefore, due to time constraints, we developed criteria selection to frame the corpus and to choose only the important documents for our research. These criteria were based on the research question and literature review (introduction and chapter 1) and were divided into inclusion and exclusion ones. For instance,

an inclusion criterion is a document produced during the project definition, and an exclusion criterion is the press communication. Table 2.4 shows an example of the document selection method.

Table 2.4 Document selection criteria-example

Inclusion criterion	Exclusion criterion
First and last version of the document (date and time)	Duplicate
Brief document	Press communication
Clinical plan	Name and contact information
List of Lean activities implemented	Notice of Meeting
Meetings reports	Calendar
Organization chart new hospital complex	Email exchange
Site plan	Timeline
Plans and preliminary specifications	Demolition certificate

Therefore, based on the criteria selection we were able to reduce the documents from 10380 to 245. After that, we mapped these 245 collected documents using a Mind map in order to easily visualize them using a colour for each big folder that includes several documents. Also, to locate them in the SharePoint, we assigned a code for each document selected based on its purpose and the stage when it was produced (planning, programming, schematic design). Figure 2.3 shows an example of the mapping obtained (see ANNEX II).

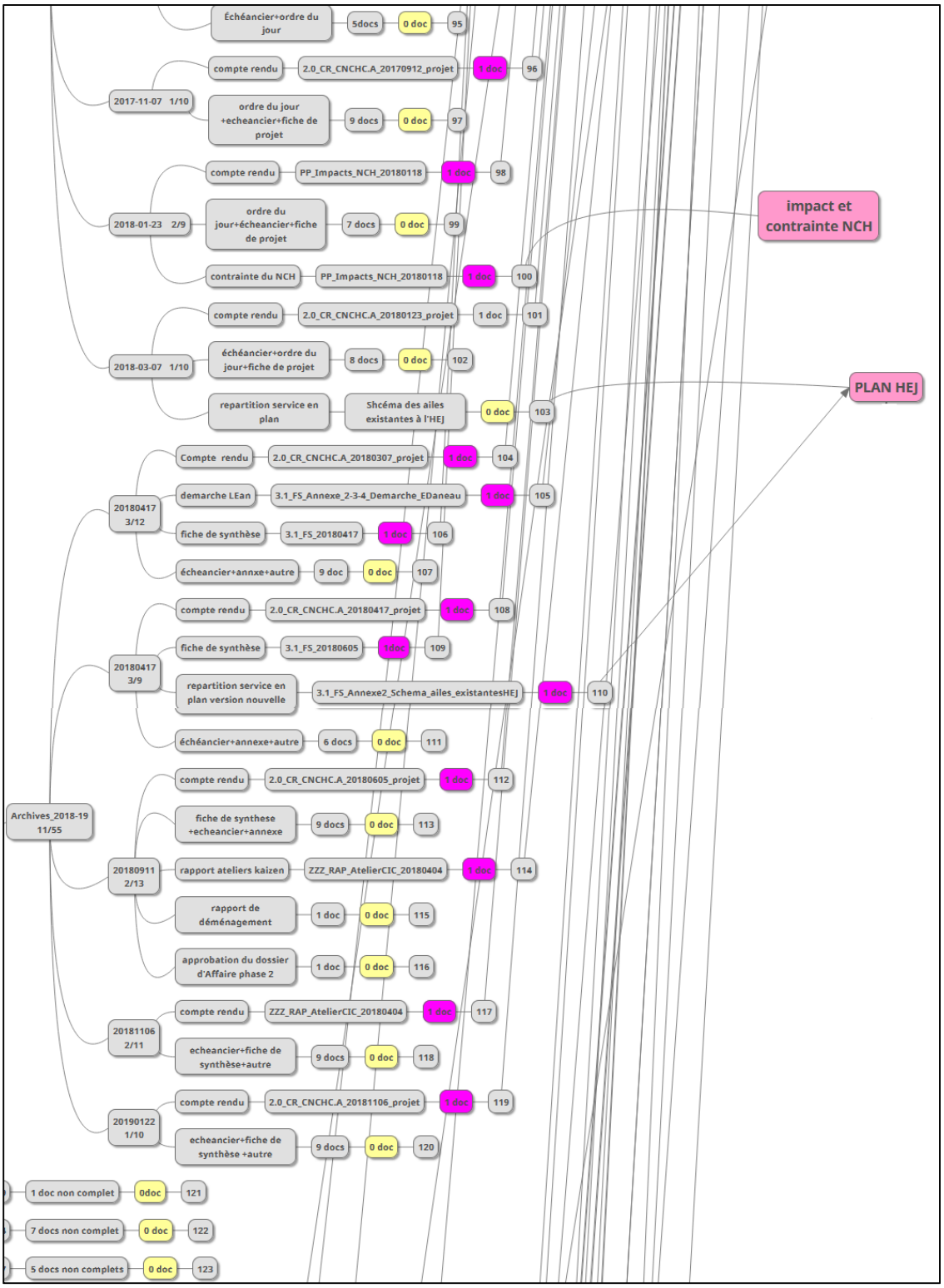


Figure 2.3 An example of documentation mapping

We after that, classified the document into two typologies:1) written record 2) graphical representation (figure 2.4). For the written record, we have identified four subcategories: documents related to planning stage (e.g., clinical plan), documents related to the programming stage (e.g., functional and technical program), general and synthesis reports (e.g., workshop synthesis sheets), and administrative documents (e.g., case record). For the graphical representation we have identified three subcategories: architectural plans (e.g., design concepts), schemes (ex. organization chart), presentation (ex. presentation used during a Lean activity).

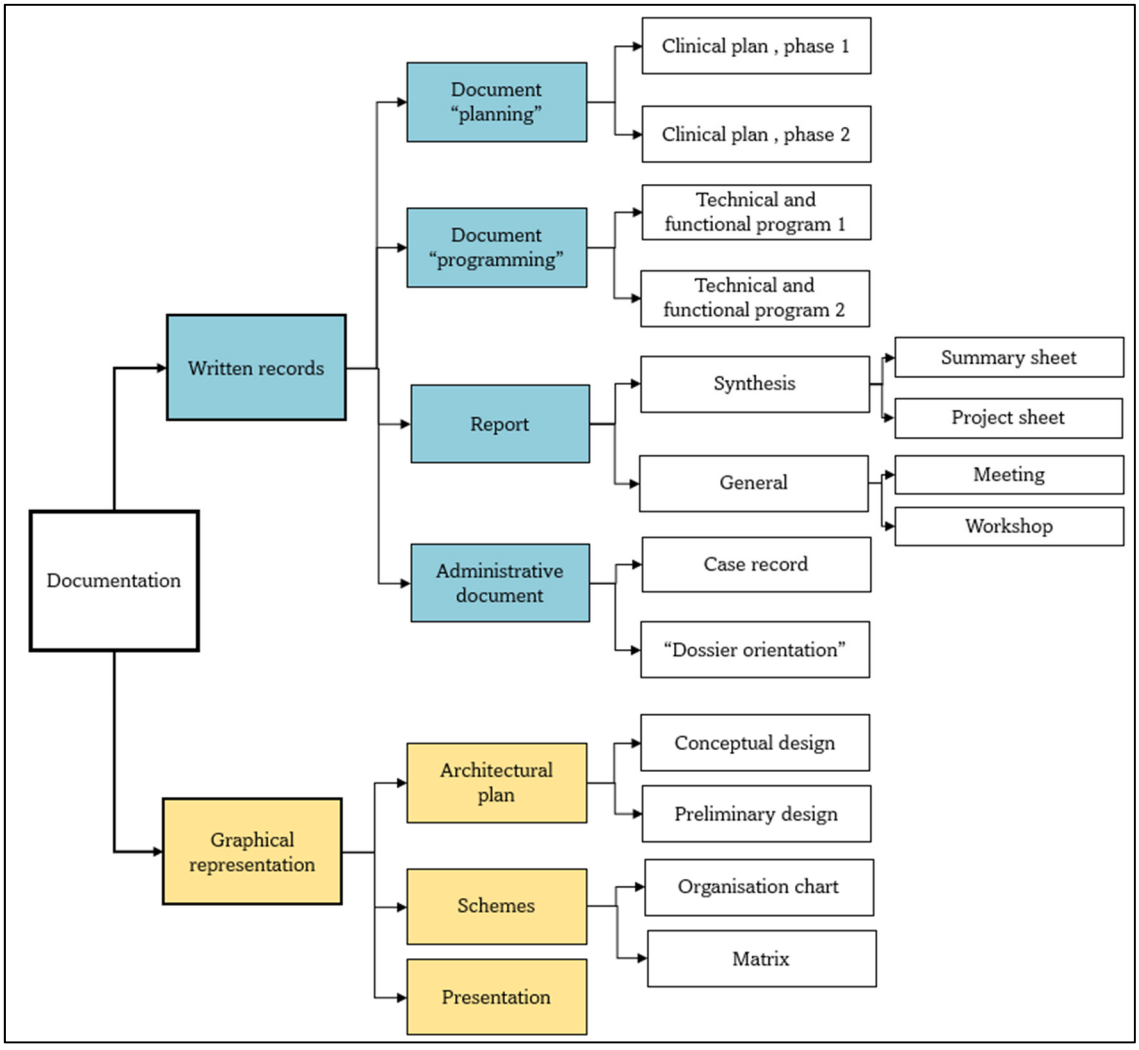


Figure 2.4 Typologies of documents

We classified the documentation not only based on their typology but also following the chronological order (see ANNEX III). Thereafter, we identified the input and output of each project definition stage (which represents our subunits). For instance, the clinical plan represents the main output of the planning stage and thus the input of the programming one. The objective was to map the entire process and the different steps of the project definition of the project studied and to understand the link between them. The figure 2.5 shows an extract of document classification based on their typology and chronological order for the programming stage.

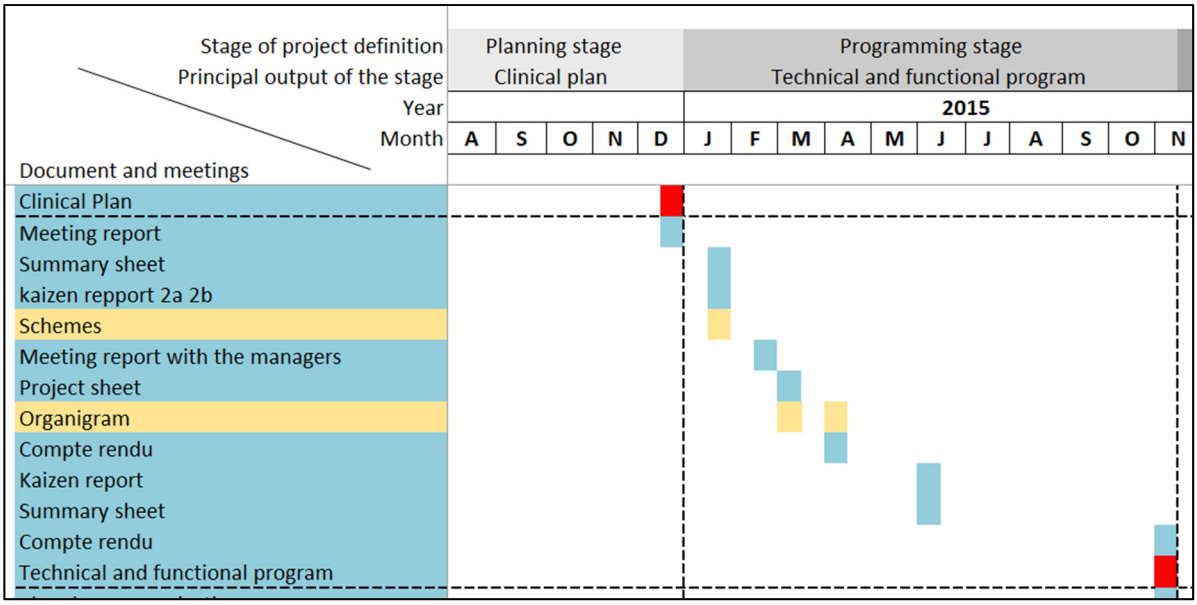


Figure 2.5 Examples of document classifications: chronological order

Subsequently, based on the documents of each stage, we identified the number and the typologies of activities realized in order to define the project. In fact, we have identified, two kinds of activities: 1) meetings, 2) workshops. The meetings refer to the ones of the clinical department, transition and logistics committee, or administrative committee. The workshops refer to the different *kaizen*, *kaizen blitz*, complementary workshop, or focus group.

For each activity we tried to answer several questions such as “what is the objective of the activity”, “who participated and who organized”, “why”, “what are the tools and methods used”, “when”. Also, using as reference our conceptual framework (the seven alignment

categories identified in chapter 2), we tried to understand if there is an alignment factor addressed during the activities and "what is it". For instance, the objective of a complementary workshop was to coach and train the participants in order to understand the Lean methods and tools. It was organized in June 2014, by the clinical department of the project with the participation of the future users (including the patients) and the project managers. Several techniques have been used such as serious games which objectives was to train the different participant and to share knowledge. We after that, compared this interpretation with the conceptual framework developed in the previous and demonstrate that the alignment factor address was the training, which is related to the skill category (see chapter 3).

Therefore, based on all of the above-mentioned, we schematized the different activities realized that leads to the development of the project definition output (see ANNEX IV). Figure 2.6 presents an extract from the mapping.

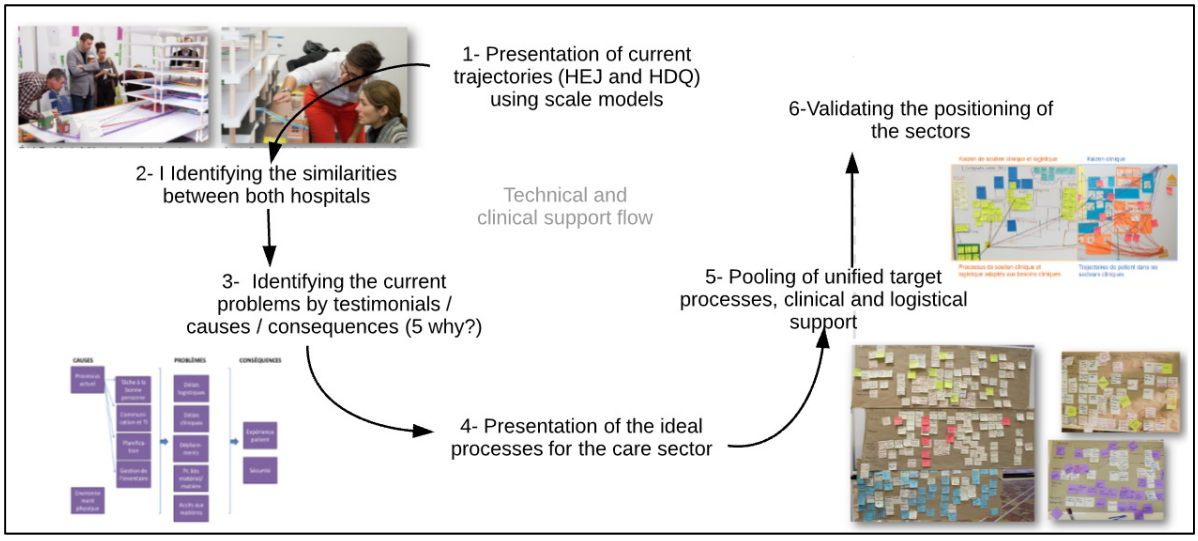


Figure 2.6 Project definition process mapping: example of *kaizen* 2B

This mapping helps to quickly perceive the different methods used and the objectives achieved of each activity during the process. Also, we identified based on the conceptual framework previously identified (chapter 3), the different alignment factors addressed during each stage and thus each analyze subunit.

The result obtained from the documentation review, which took about 8 months of work, represents a qualitative pre-analysis of all the data, the first quick and cross-sectional reading that allows us to capture the main alignment factors. It represents our background knowledge prior to the interview step. However, documentation review does not answer all questions that we need, for instance, deal with hidden motives and alignment barriers.

Therefore, to further study we use other qualitative data collection methods which are interviews.

2.3.2.2 Interviews

Interviews facilitate access to the present and the past (memory). The aim is to explore opinions, experiences, motivations, perceptions, and beliefs of individuals on a specific topic. In this study, interview was an important supplement as well as to compensate for the limitations of other methods. It acts as a method to cross validate information gathered from documentation. Two kinds of interviews: focus groups and semi-structured were conducted as means for triangulation. According to Patton (2002) they represent the best methods for a case study. Both allow for an open response in the participants ‘own words rather than closed questions. They offer sufficient flexibility while still covering the same areas of data collection.

However, the focus group represents a dynamic discussion between the members of the group, which makes it different from semi-structured interview that should be more adjusted for each participant since the discussion is between an interviewer and a participant. Further, focus groups gather preliminary information or opinions of many people for comparatively time and expense (Longhurst, 2003). However, this method allows the respondents to express themselves and to leave the areas often to be explored in order to bring more relevant details to the study (Britten, 1995).

Three criteria guided the selection of representative profiles sample to interview. The first one was to interview at least one person in each category of profile involved in the project definition. In fact, documentation reviewed helped us acquire first-hand knowledge of the organigram of the project studied, we found in the SharePoint two types of profiles involved (Figure 2.7): 1) the clients and 2) the professionals.

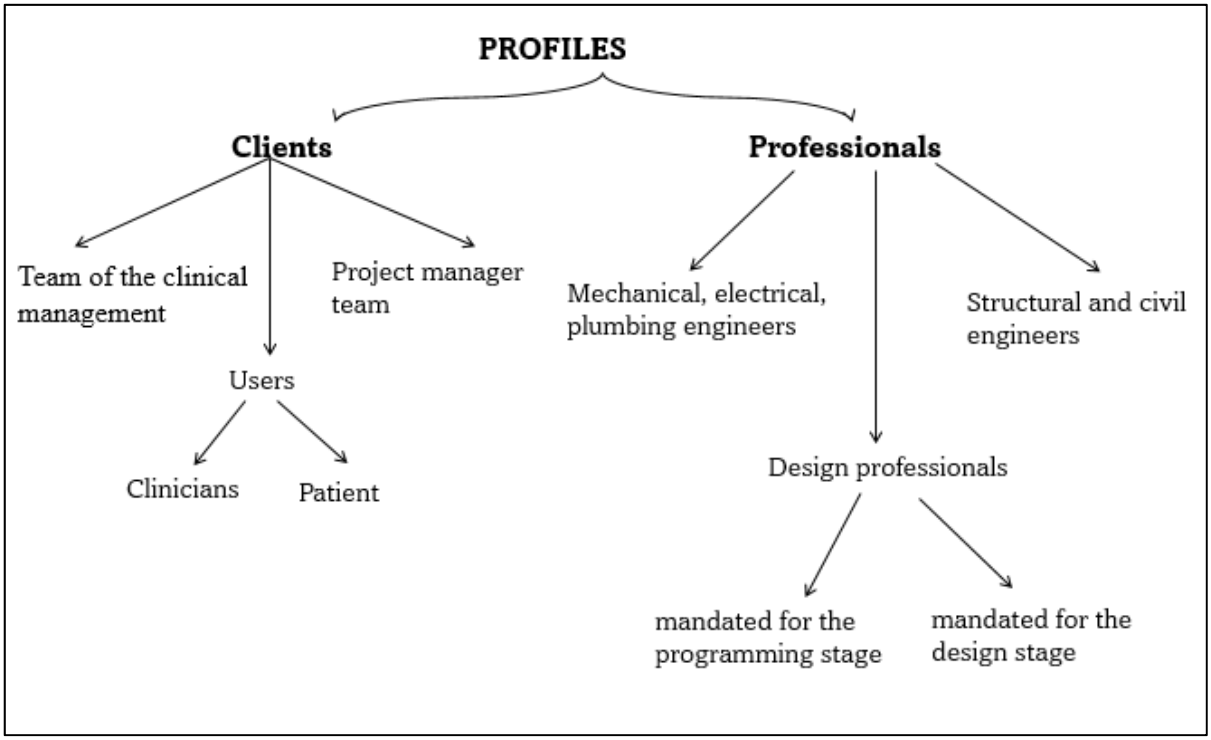


Figure 2.7 Profiles involved in the project definition process of NCH project

The clients represent the users (patients, clinicians: doctors, nurses, etc.), clinical managers and project managers. The professionals could be design professionals mandated for the programming stage, design professionals mandated for the design stage or mandated for both, mechanical, electrical, plumbing, structural and civil engineers.

The second criterion was to interview at least an organizer and a participant or observer of each activity realized during the project definition. We also involved Lean agent. And the third criterion was to prioritize those who have organized or participated in more than one project definition activity.

Thus, after criteria of selection, we used the snowball sampling technique in order to recruit participants in the research work. This technique relies on recommendations from starting subjects generating additional interviewees (Johnston & Sabin, 2010). The reason for choosing this technique was related to the fact that the majority of the project definition participants were no longer involved in the project, which makes the first contact difficult. Thus, in order to deal with that, we began the process of a meeting with a manager in the clinical direction and a project manager who introduced us to the first interviewees. Thereafter, a process of snowballing began.

In total twenty-eight interviews were carried out between 2019 and 2020. The interviewees received a first email explaining what the research project is with a consent form to sign in accordance with the requirements of the Ethics Committee *École de technologie supérieure*. Following the appointment proposed, a confirmation email was sent to confirm the time and place of the appointment. Then, a final reminder email was sent the day before the meeting.

The interview protocol, in both 2019 and 2020, was developed in two steps based on the interview method described by McCracken (1988). The first step, a draft of the interview guides was developed concurrently taking advantage of interesting data that we came across during the document analysis results. They were tested with a clinical manager, a project manager, a construction professional and a hospital user. Based on their contributions we modified the final interview protocol version, for instance, adding or eliminating some questions.

Moreover, we prepared four types of questionnaires adapted for each interlocutor context: 1) the design and construction professionals, 2) clinical managers, 3) project managers, 4) clinicians and patients. However, all of the questionnaires follow the same lines of discussion (participation in the process, general perception of the Lean-led Design approach: benefits and/or barriers), only a few questions change their wording. This keeps a clear structure in the ranking of data and allows it to compare the results. Thus, four interview questionnaires are presented in ANNEXE V of this thesis.

Further, to avoid responses that could be artifacts of the interview process itself, we deliberately did not ask leading questions regarding the facilitating or inhibiting alignment factors. We in fact did not use questions directly related to the study's question. Instead of using a deductive approach to research and guide our analysis, we preferred to gather data more freely and let the interviewees 'natural, undirected commentary support, deny, or extend the conceptual framework. An important benefit of this approach is that respondents may identify factors that impact the alignment other than those anticipated by the study's theory (chapter 3).

Interviews in 2019

Three focus groups and eight semi-structured interviews with different professionals and clients were conducted in parallel with documentation reviews. Table 2.5 provides more details about the interviewees, interview duration and date when the interview was realized.

Table 2.5 Profiles interviewed in 2019

Interviewee	**Duration**	**Date**
Semi-structured interviews		
Members of the clinical management	120 min	28-02-2019
	60 min	04-04-2019
Lean agent	60 min	28-02-2019
Mechanical, electrical, plumbing engineers	60 min	11-03-2019
	40 min	14-03-2019
Structural and civil engineers	45 min	06-04-2019
Design professionals mandated for programming stage	60 min	13-03-2019
	60 min	07-05-2019
Focus group		
Construction professionals (3 pers.)	90 min	26-03-2019
Project managers (3 pers.)	60 min	28-03-2019
Design professionals mandated for the design stage (4 pers.)	70 min	07-05-2019

The duration of the interviews is ranging from one and two hours and they were held at their NCH project offices in Quebec City. The duration varied depending on how much an interviewee had to say. The objective of the focus group was the validation of the activities and the practices

that have supported the project definition development, as well as facilitating the understanding of some information found on SharePoint. And the focus of the semi-structured interviews was the validation of facilitating alignment factors found in the documentation review.

Interviews in 2020

Seventeen semi-structured interviews were carried out with different professionals and clients. The focus of these was the main challenges regarding alignment development between the needs and the architectural solution in that project and understanding of the choices made during the project definition process. However, due to the COVID-19 situation seven interviews planned with clinicians have been cancelled or sometimes postponed from February to August. Further, for the same reason in 2020, all of the interviews were conducted by Skype or phone, unlike in 2019 where all of them were conducted in the NCH project offices. Another challenge was the duration of the interviews with the clinicians. Indeed, some of them could give us only thirty minutes to answer our questions. Thus, the majority of interviews lasted an hour and a half, but a few only lasted thirty minutes and one two hours. The summary of the interview profiles is presented in Table 2.6.

All interviews conducted were recorded in audio format on tape (always with the prior agreement of the subjects) rather than taking notes of the respondent's answers. By taking notes, we might miss some statements that later turn out to relevant information. Also, all interviews were transcribed providing us with the complete interview text and classified by profiles in order to facilitate its analysis. Even though, a full transcription of the recorded interview is very time-consuming process, we choose this method to avoid the loss of relevant information. By studying the word-for-word transcription, we got a complete repetition of all elements highlighted by the interviewees.

Table 2.6 Profiles interviewed in 2020

Interviewee		**Duration**	**Date**
Users	Clinicians	15 min	22-08-2020
		25 min	25-09-2020
		40 min	13-09-2020
	Patients	40 min	04-03-2020
		45 min	09-03-2020
		40 min	05-05-2020
Members of the clinical management		60 min	15-01-2020
		60 min	19-02-2020
		60 min	10-03-2020
Project managers		75 min	18-02-2020
		60 min	24-02-2020
Design professionals mandated for both programming stage and design stage		60 min	11-05-2020
Design professionals mandated for only design stage		60 min	18-02-2020
Mechanical engineer		60 min	13-03-2020
Structural and civil engineer		60 min	04-03-2020
Lean agent		120 min	24-02-2020

This process took approximately one month, and half of work and it constituted approximately 130 standard pages of text. In this manner, we were able to use these transcriptions directly for the coding of data in the subsequent analysis step.

Coding Interview Data

The original idea of our qualitative analysis step was to use the data collected in order to validate our conceptual framework developed in the chapter 3. This means, using a strict coding based on the conceptual framework. However, the interviews led us to a completely different direction. We naturally adopted another analysis strategy, which a hybrid approach that acknowledges theoretical guidance (or bias) and permits empirical flexibility (or theory revision). Thus, the coding contains elements of both theory building and testing. This method has also been adopted by other authors such as Malina et al., (2001).

We opted for three levels of coding using the qualitative research aid software NVivo 11. This software represents one of the most widely used and allows for the creation of nodes and provides storage areas in NVivo for references to coded text (Hutchison et al., 2010). The following figure 2.8 shows an extract of the different levels of coding obtained and the interconnections between the alignment factors through a conceptual map.

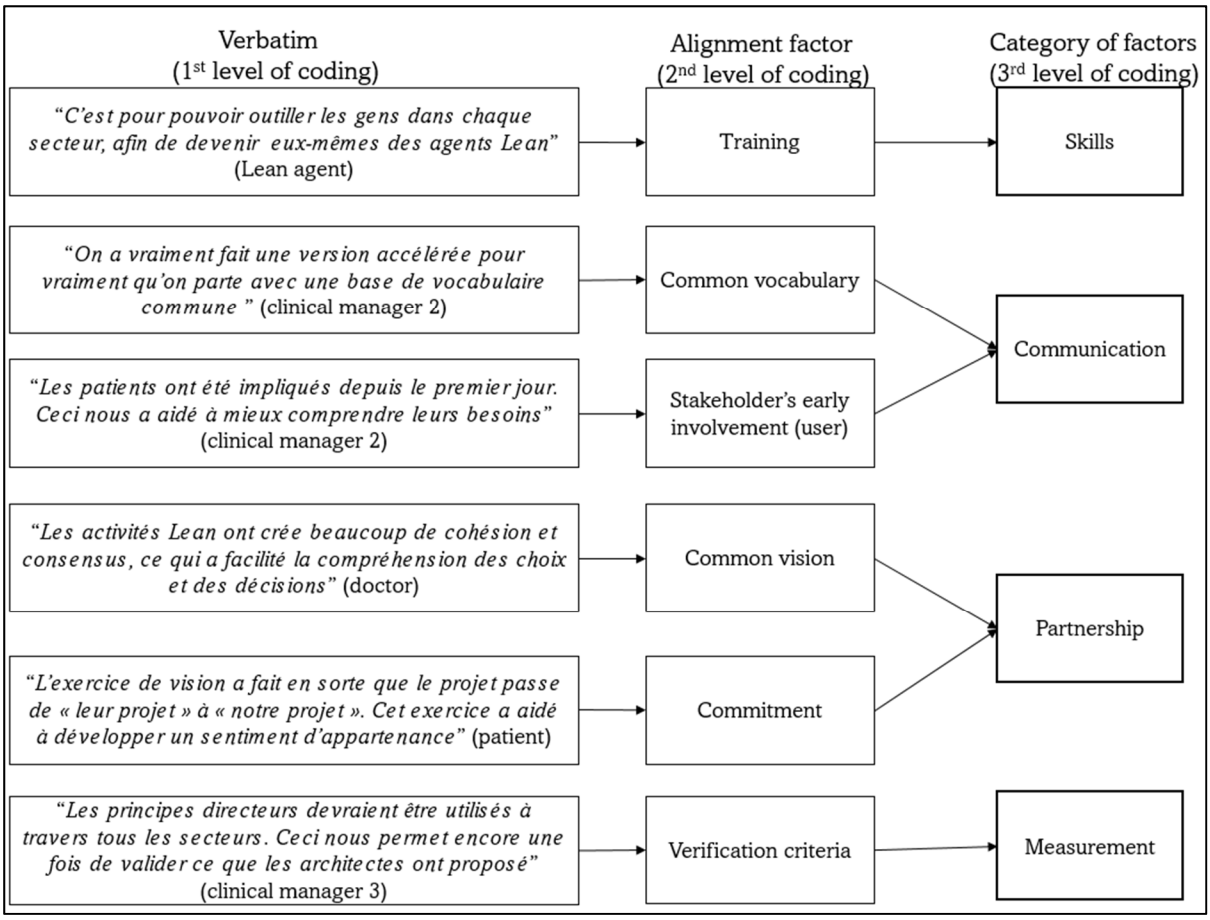


Figure 2.8 An example of coding (facilitating alignment factors)

- **First level of coding**

At the base, we thought we would do our first step of coding by referring to our conceptual framework. However, the conduct of the interviews led us to carry out the first phase of coding in accordance with the spirit of grounded theory according to (Corbin & Strauss, 1990), because we had fewer preconceived ideas and the interviews were more general than our original topic. In that sense, our first coding was very disparate, and we coded everything that

we thought was relevant "verbatim." During open or initial coding, we used linked memos to facilitate analytical thinking. At that stage, we ended up with a lot of codes, but without a structure linking those codes. This first level of coding was important in order to gather a maximum of information from the interviews without being conditioned by the theory.

- **Second level of coding**

The more first coding step progressed, the more we could see a structure appear, it was this structure that we put forward during the second coding. The second level represents a selective coding by analyzing the initial codes, we have identified the most important codes that represents the alignment factors. These second-level codes could incorporate several first-level codes or just one (e.g., common vocabulary). Some codes reflect additional factors, revealed in the coding process (e.g., verification criteria).

- **Third level of coding**

The third coding was our last. We have formed links between the second-level codes. We created links and connection between them in order to classify them into different alignment categories as we did in the step 1 (see chapter 3). As an example of the third level of coding the communication category (see the conceptual framework in chapter 4, section 4.4).

We made a back-and-forth process between different levels of coding. Far be it from us to pretend that we have done coding in a linear and one-time manner. We present the coding process in a linear way, but the process was much more iterative than that.

Thus, at the end of the step 2 (that took about 10 months of work), we were able to falsify or confirm to the validity of the conceptual framework developed during the step1.

2.3.3 Step 3: Revising the framework based on the case study's findings

While, step 2 aims to falsify or confirm the validity of the conceptual framework, this step aims to propose a revised framework based on the new factors identified (case study).

2.4 The validity, reliability of the methodology chosen

Because each research design is supposed to represent a logical set of statements, four tests have been commonly used to establish the quality of any empirical research including case studies (Yin, 2009): construct validity, internal and external validity, and reliability.

Construct validity: several techniques have been proposed to increase construct validity. For instance, the use of multiple sources of evidence in the data collection for triangulation in order to protect against researcher bias (Perakyla, 1997). In our case, we used three sources of data: documents, semi-structured interviews and focus groups. This helped us to establish a chain of evidence, that is, the use of notes, verbatim interview transcripts and citations, as suggested by Hirschman (1986). Also, we reviewed the report writing of the case study including the interview transcription and the findings by the research assistants is necessary in order to increase the construct validity. It helps to change and modify unclear aspects if necessary and thus, improve the accuracy of the case study data Yin (1994).

Internal validity: our research presents a global view of the alignments factors that impacts the project definition process when using a Lean-led Design approach, based on the different actors 'perspectives (construction professionals and clients), documentation. Thus, to ensure an internal validity, we used the analytical tactic of *pattern matching* technique. Such a technique compares empirical based pattern with a predicted one, if patterns coincide, it can help to strengthen the internal validity, as explained by Yin (1994). We also used several mapping and illustrations in the data analysis step, to assist the explanation building, as recommended by Miles and Huberman (1994).

External validity: the third test deals with the problem of knowing if findings are generalizable beyond the immediate case study. Critics typically state that single case study offers poor base of generalizing. However, according to yin (2009) such critics are implicitly contrasting the situation to quantitative research. In fact, unlike quantitative surveys that aims at statistical generation, case studies aim on *analytical* generalizations. In analytical

generalization, the researcher is striving to generalize a particular set of results to some broader theory. In the same line, Shanks and Parr (2003) explains that a single case study should be seen very differently, because "*participants are separately interviewed in data collection but their responses are consolidated at "unit of analysis" level. For example, in Sarker and Lee's (2000) case study, the concept of ERP implementation success is determined for each phase of the process of ERP implementation by consolidating evidence from several participants. They each contributes to a single view of "success"*(Shanks & Parr, 2003, p. 9). This example is similar to what we did in our research. We have in fact, studied the alignment in each stage of the project definition and we compared that to the conceptual framework developed based on literature. According to Yin (2003), the use of a theory in a single case study reinforces the external validity of our research.

Reliability: is probably the simplest one to defend, as we provide the data collection treatment protocol, the interview guide and our analysis strategy including the coding process, which facilitates the reproducibility of research results. In addition, we used tables and patterns to compare the subunits' cases in order to identify theoretical proposals in order to make the case more reliable because of the rich presentation of evidence, as proposed by Eisenhardt and Graebner (2007).

After presenting the methodology in this chapter, chapters 3 and 4 aim to present the results regarding the alignment factors obtained on the basis of a systematic review and a case study, develop a conceptual framework based on these factors and evaluate its validity. However, before presenting these results, we will try to first answer the following questions: What does an "alignment" mean and what are its dimensions?

CHAPTER 3

NEEDS-SOLUTION ALIGNMENT FACTORS: LITERATURE

In this chapter, based on a systematic qualitative literature review, we will try to answer our research question: What are the factors that impact alignment between client needs and conceptual design solutions during project definition of a hospital?

Thus, the aim of this chapter is to present the results regarding alignment factors, and develop a conceptual framework considering alignment. This framework represents an important output of this research that will help in our case study analysis and will subsequently be falsified or validated for hospital projects in general. In order to better understand and analyze the factors addressed in the literature, it was important to first present an overview of different definitions of alignment and its three dimensions, as well as the different categories of factors used during this research.

3.1 Alignment definitions and dimensions

Several terms have been used in the literature to refer to alignment, including “fit”, “linkage”, “harmony”, “fusion”, “correspondence”, and “integration” (Chan & Reich, 2007; Griffith & Gibson, 2001; Venkatraman et al., 1993).

It is noteworthy that there is no single way of defining alignment and it has been conceptualized in the literature in various ways. According to Chan and Reich (2007), existing definitions are not helpful in expressing what exactly constitutes the concept of alignment and how it might be measured, due to their lack of precision. However, researchers still tried to propose definitions from different perspectives. On the one hand, there are those who define alignment according to its purpose. Griffith and Gibson (2001, p. 70) propose that alignment is “*the condition where appropriate project participants are working within acceptable tolerances to develop and meet a uniformly defined and understood set of project objectives*”. With the same

perspective, Abraham (2006, as cited in Chan & Reich, 2007, p. 300) defines alignment in a metaphorical manner as: "*everyone rowing in the same direction*".

Other authors including Beaufort et al. (2008) point out that alignment does not only occur between individuals but also between elements via establishing a maximal correspondence. Argyris (1999) adds that alignment occurs when there is a match between intentions and outcomes.

On the other hand, some authors define alignment according to its components. For instance, Jenkin and Chan (2005) argue that the concept of alignment is composed of two components: process of aligning and its outcome. The process of aligning represents the sequence and flow of events until achieving the outcome of the project which is the final result. Venkatraman et al. (1993) agree with this conceptualization and emphasize that alignment is both internal and external referring to the main elements and the sub elements that make up the main elements, respectively.

Considering the various definitions of alignment, three main dimensions emerge. Ghobadian et al. (2007) propose two dimensions, namely vertical and horizontal. The vertical alignment refers to the configuration of strategies, objectives, action plans, and decisions throughout the various hierarchical levels of an organization, while the horizontal alignment refers to coordination of efforts across the different organizations. Considering this dimension, all the strategies, objectives, and decisions of an organization should complement and support one another (Ghobadian et al., 2007). Griffith and Gibson (2001) suggest another alignment dimension (Figure 3.1), namely longitudinal. The longitudinal dimension involves the alignment of objectives throughout project definition stages. The same authors argue that in order to achieve alignment, all three dimensions should be addressed, and a failure to address any one of them can cause a serious breakdown (Alm Lönnefjord & Johansson, 2018).

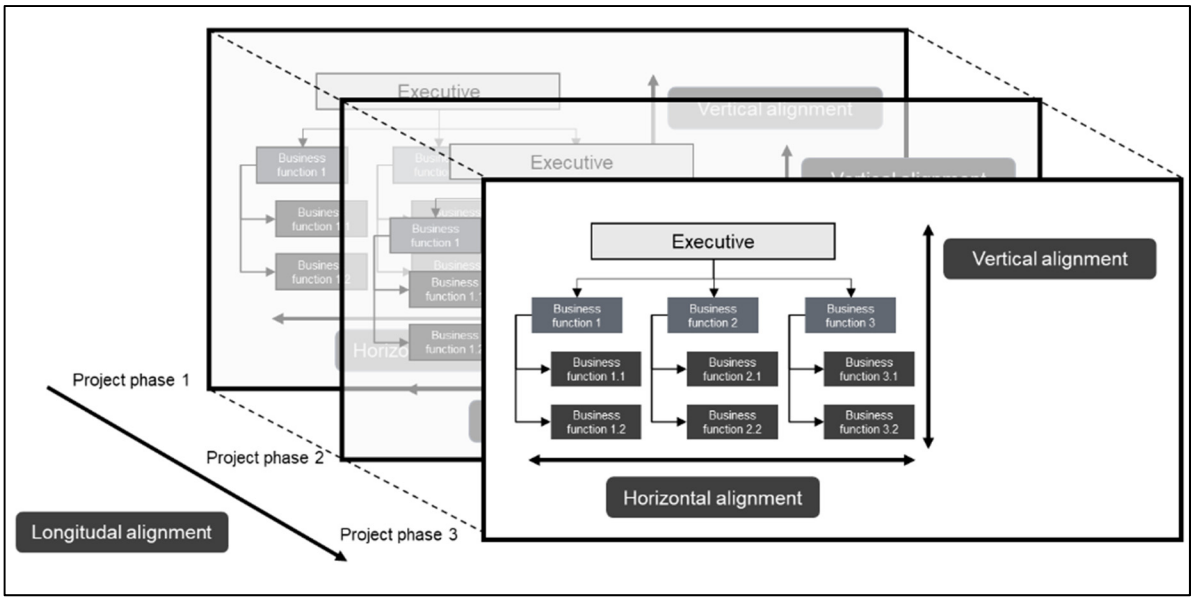


Figure 3.1 Alignment dimensions (vertical, horizontal and longitudinal)
Taken from Alm Lönnefjord and Johansson (2018)

Even though the importance of considering the three alignment dimensions have been emphasized since almost 2001, the existing literature deals only with vertical and horizontal alignment and very often neglects the longitudinal dimension. In our point of view, this dimension has been ignored and requires more attention and applied research not only in construction projects, but also in other areas (Karanikas, 2017; Salimian et al., 2012).

For this reason, we will be focusing on the longitudinal dimension, following the definitions proposed by Jenkin and Chan (2005). This means that our focus will be on studying alignment between needs (intentions) and solutions (outcome) during planning, programming, and preliminary design stages.

Researchers in the areas of construction project management and information technologies (IT), have tried to identify factors that facilitate or impede different forms of alignment (Bingham and Gibson (2017); Luftman and Kempaiah (2007); Luftman et al. (2017); Zhang et al. (2019) and achieving alignment, of course, requires maximization and minimization of the facilitating and inhibiting factors, respectively.

Following the same logic, to investigate our research question we conducted a systematic literature review on the factors that impact this alignment during project definition stages of healthcare projects in the context of Lean-led Design. However, as previously explained in chapter 2, due to the limited number of papers found, it was decided to broaden the scope of the literature review to include studies that address alignment issues in construction project management and Information technology areas.

3.2 Rationale for the review of alignment factors in construction management and Information technology areas

In construction project management context, various studies on the topic of alignment exist in the literature with some of them dating back to 1980s. The objective of these studies has been to suggest key factors in order to achieve a horizontal (across organizational) and vertical (strategical) alignment during the early stages of project definition. For instance, Griffith and Gibson (2001) developed a list of the most critical alignment hindering factors in industrial capital facility projects. Ibrahim et al. (2015) discussed the key factors of team alignment in infrastructure projects. With a similar approach, Bingham et al. (2019) investigated the factors impacting team alignment in transportation projects (e.g., highways) as a function of different delivery methods.

Alignment has also been studied in other areas such as information technologies (IT) for more than two decades. In this area, the focus is on IT-business alignment, which refers to the match between IT solutions and business needs (Kritikos et al., 2017). In this context, the aim is to increase business value and gain a competitive advantage with IT. In order to identify the necessary actions, authors have suggested facilitators and inhibitors to relevant to strategic alignment (horizontal and vertical) between IT solutions and business needs (Luftman et al., 2017; Luftman et al., 1999).

With this in mind, we decided to compare factors that impact the needs-solution alignment in construction projects with IT projects for two main reasons.

The first and foremost being project complexity as well as its dynamic nature (Li et al., 2005). For example, in hospitals as our case study, the large number of end users involved contributes to its complexity while the rapid changes in technology, long implementation times, and the dynamic nature of strategic IT plans, contribute to its dynamic nature (Luftman et al., 1999). Another similarity between IT and projects involving hospitals is related to the issue of deregulation (or more regulation).

The second reason for our choice was that unlike needs-solution alignment in hospital projects, IT-Business alignment issues have been widely studied and hundreds of cases have been published on the factors that influence that (Berberat & Baudet, 2019). Furthermore, many different maturity models have been identified, developed, and validated in the literature to facilitate the alignment assessment of these organizations.

Besides the comparison between the IT and construction projects, we tried to investigate and compare the factors that impact alignment in studies on construction projects which adopted a construction project management and Lean construction approach in the early stages of the project life cycle. To do so, we included all the studies that addressed the alignment issue during project definition no matter what the type of construction project was.

In this respect, papers from two areas were included in the review: 1) Construction: i) Lean, ii) construction project management, and 2) IT. The following definitions were considered for the included areas in the review:

1) Construction in two subcategories:
   - Lean: all studies regarding construction investigating client needs and conceptual design solution alignment during project definition, using Lean approaches (i.e., Lean-led Design, Lean project delivery system), irrespective of the type of project.
   - Construction project management: all studies regarding construction, investigating team or client needs and conceptual design solution alignment during project definition, adopting approaches other than Lean, irrespective of the type of project.
2) IT: all studies addressing the alignment between business needs and IT solutions.

Based on these definitions and criteria, different alignment factors were identified that will be classified and presented in next sections.

3.3 The classification of the alignment factors

Due to the large number of the identified factors, based on the literature review (175), it was not possible for a single researcher or even research group to successfully and efficiently evaluate all of them simultaneously. For this reason and in order to identify efficient management decisions concerning alignment, it seemed necessary to group and classify the identified factors not only into research areas, but also into categories and subcategories. This approach helped to allocate each factor a proper weight and priority and facilitated the understanding of the similarities and contrasts among factors.

To this end, the identified factors were classified into seven categories: 1) communication, 2) partnership, 3) governance, 4) measurement, 5) skills, 6) technology and techniques, and 7) external change. The first six categories were adapted from the strategic alignment maturity model (SAMM) proposed by Luftman (1999) for facilitator and inhibitor factors of IT-Business alignment (Figure 3.2). The last one represents a new category that we added to the already established model, based on the literature review in both areas of construction and IT, which includes most of the hindering factors related to external changes that were not considered in the other six categories of SAMM.

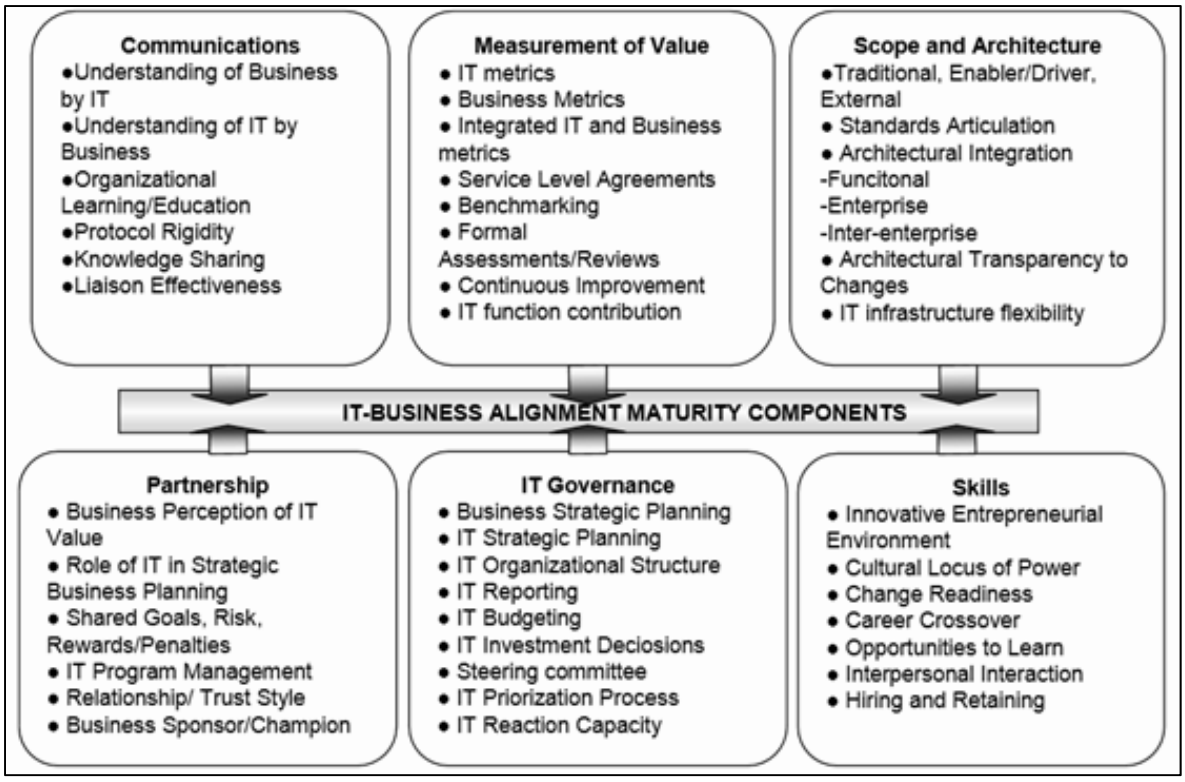


Figure 3.2 Strategic Alignment Maturity Model (6 categories, 41 factors)
Taken from Luftman, Dorociak, Kempaiah, et Rigoni (2008, p. 2)

The selection of the SAMM classification for IT-business alignment factors can be justified by four main arguments:

Firstly, unlike the IT-business domain, it was not possible to reach a consensus regarding alignment factor classification in construction project management literature since the majority of the studies have not classified the factors (such as Bingham et al., 2019; Sidwell & Kennedy, 2004), and in the Lean context almost none of the included papers explicitly discuss alignment factors and thus do not classify them (Grunden & Hagood, 2012; Whelton et al., 2003).

Secondly, although SAMM is not the only model in the literature that proposed a classification of alignment factors, unlike others, it can be applied in a generic manner to other organizational contexts and covers most of the important views in alignment research (Berberat & Baudet, 2019).

Thirdly, SAMM has been validated by Sledgianowski et al. (2006) and Luftman and Kempaiah (2007), thus there is enough evidence to believe that it is a reliable model that is still in use in research and practice.

Fourthly, SAMM remains to be the most well-known and widely used model in the alignment field (Berberat & Baudet, 2019; Gerow et al., 2014) and has inspired many authors (Chan & Reich, 2007; Dwivedi et al., 2009; Hussin et al., 2002; Reich & Benbasat, 2000; Wang & Rusu, 2018) who found it useful in their pursuit to achieve alignment.

Besides sorting the alignment factors of each area into seven categories, we developed two subcategories for each factor, namely a facilitating and/or hindering subcategory. The objective of this subclassification was to highlight the positive impact fostering and negative impact impeding alignment. As discussed by Mavengere et al. (2020), managers and companies need to be aware of "*both sides of the coin*".

The proposed classification of alignment factors, presented in more details below, will be helpful for the development of our conceptual framework and assist our case study. It is important to note that the conceptual framework developed in this chapter will be further discussed and evaluated in the context of our case study (see chapter 2).

3.4 Alignment factors

Figure 3.3 presents the conceptual alignment framework developed that summarizes all the most significant factors identified, having a direct or indirect effect on the alignment in IT and construction projects combined, and categorize them based the previously presented classifications. This framework represents a total of 41 alignment factors: 26 of which are facilitating (green colour, e.g., common vocabulary) and 15 hindering (red colour, e.g., changing needs).

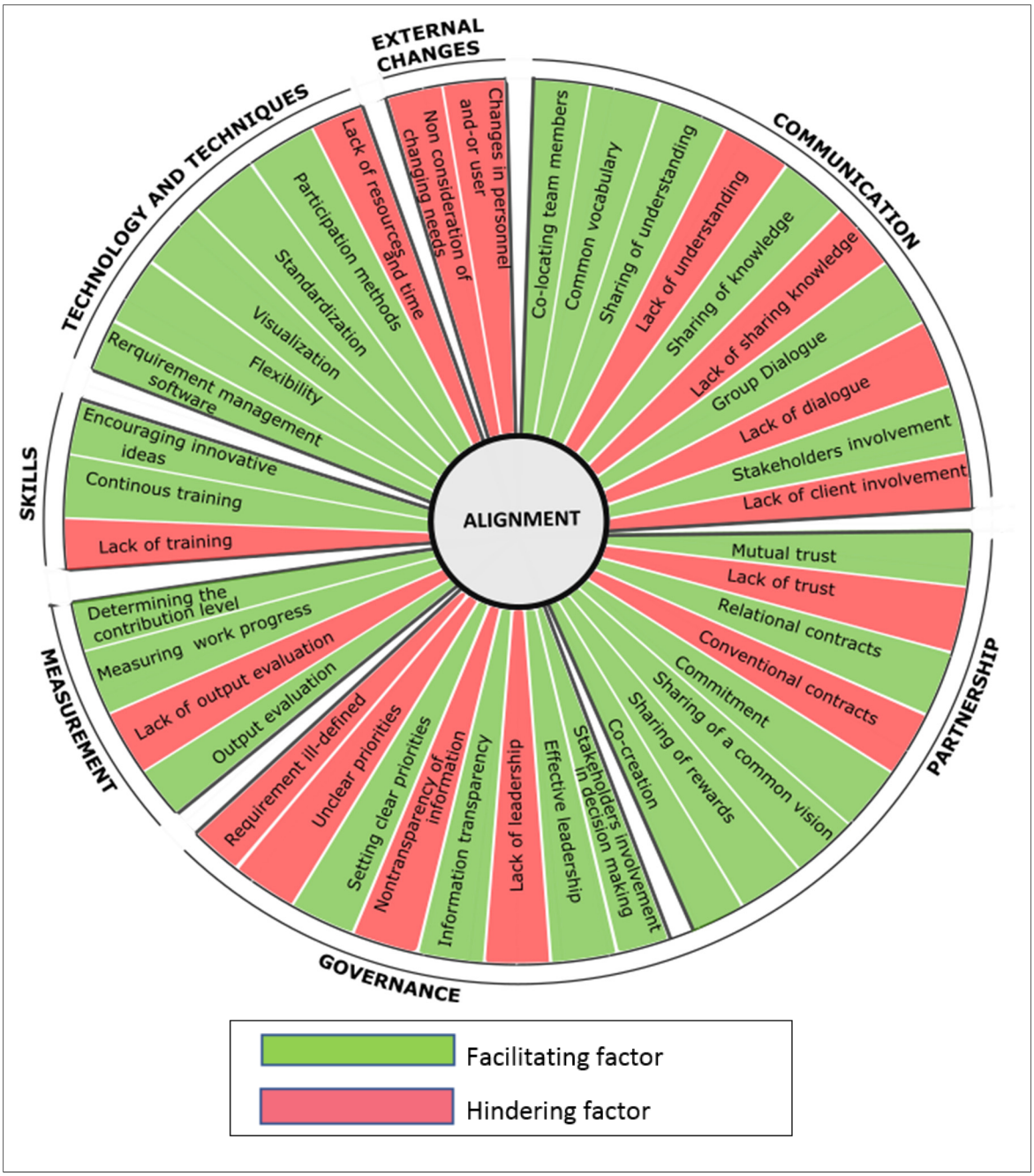


Figure 3.3 Alignment framework: 26 facilitating and 15 hindering

Subsequent sections present in detail each component of this framework: category, subcategory, and factor. Each factor will be discussed and if possible, compared in the contexts of Lean, construction project management and IT.

3.4.1 Communication

Deriving from the Latin word “commūnicāre” meaning “to share”, communication represents the process of sharing a message through the exchange of knowledge, information, ideas, and feelings as by speech, gestures, or writing (Dima et al., 2014). Every communication involves at least a sender, a message (e.g., information), a medium, and a recipient and it is completed and effective once the receiver understands the sender’s message.

In other words, alignment between the conveyed message by the sender and the understanding of the receiver is achieved through an effective communication associated with several other factors that could hinder or facilitate this process. Thus, our first category, namely “communication”, represents a group of factors that could potentially facilitate or hinder the alignment between IT business, team, and/or needs-solution.

3.4.1.1 Facilitating factors

Table 3.1 summarizes the results of our comprehensive literature review regarding the facilitating alignment factors associated with the communication category in our model of choice.

Table 3.1 Alignment facilitating factors: communication

Facilitating factors	IT	Construction	
		Project management	Lean
Sharing of knowledge	[1] [2][3][4]	[11]	[25]
Sharing of understanding	[5][6][2]	[15]	[23][16]
Group dialogue	[1]	[10][11][12][13]	[16][17][18][19] [20][21][22][23]
Stakeholders (user) early involvement		[13], [35]	[16][28][29][17] [18][30]
Common vocabulary	[31]		[25][26] [27]
Co-locating team members		[14][31][32][33] [34]	

[1] (Luftman, 2003), [2] (Chan et al., 2006), [3] (Gutierrez & Lycett, 2011), [4] (El-Masri et al., 2015), [5] (Obeng & Mkhize, 2017), [6] (Reich & Labes, 2017), [7] (Panda & Rath, 2017), [8] (Padayachee & Shano, 2019), [9] (Tarafdar & Qrunfleh, 2010), [10] (Construction Industry Institute, 1995), [11] (Pinto & Pinto, 1990), [12] (Griffith & Gibson, 2001), [13] (Bingham et al., 2019), [14] (Heineman & Zeiss, 2002), [15] (Alm Lönnefjord & Johansson, 2018), [16] (Whelton & Ballard, 2002), [17] (Johnson et al., 2017), [18] (Hicks et al., 2015), [19] (Forgues et al., 2018), [20] (Mazur et al., 2017), [21] (Emmitt, 2001), [22] (Reijula et al., 2014), [23] (Ballard, 2008), [24] (I. Smith et al., 2020), [25] (Whelton et al., 2001),[26] (Chocron & Schorlemmer, 2020), [27] (Mazur et al., 2017), [28] (Sengonzi et al., 2009), [29] (Barrett & Stanley, 1999), [30] (Blyth and Worthington, 2011), [31] Van den Bulte and Moenaert (1998), [32] (Forgues & Lejeune, 2011), [33] (P. Dietrich et al., 2010), [34] (Bond-Barnard et al., 2018), [35](Othman et al., 2005)

Sharing of knowledge

Knowledge "*resides in people's minds and one of the most important resources to an organization*" Lee and Egbu (2006, p. 5). Sharing of knowledge is the "*push and pull found in the multiple, directional movement of data, information between individuals and groups for mutual benefit*" (Bond-Barnard et al., 2018, p. 436) which has been classified as one of the top alignment enablers in the areas studied.

Many authors such as El-Masri et al. (2015); Gutierrez and Lycett (2011); Luftman (2003) considered the sharing of knowledge as the strongest predictor of IT-business alignment. According to Chan and Reich (2007), when there is a high level of knowledge sharing between IT and business staff, mutual understanding is high and thus communication will be more effective.

In the same light, sharing of knowledge in construction project management is considered as one of the greatest team alignment factors (Alm Lönnefjord & Johansson, 2018; Bingham et

al., 2019; Construction Industry Institute, 1995; Griffith & Gibson, 2001). Moreland et al. (1998) suggested that addressing this factor could significantly reduce high personnel turnover that characterizes complex projects.

In parallel, authors that adopt Lean approach such as Whelton et al. (2001) propose that sharing of knowledge occurs continuously over the course of a project definition. Design professionals interact with clients physically or via remotely, however, using verbal communication (face-to-face, virtual meetings) in order to make design decisions. According to Grunden and Hagood (2012), implementation of Lean-led Design should speed up sharing of knowledge between stakeholders by involving them throughout the project definition process. Hicks et al. (2015) points out that involving the users in Lean activities made them more knowledgeable not only regarding the project evolution but also of their own needs and this consequently facilitated the alignment between the needs, requirements, and design solutions.

Sharing of understanding

Sharing of understanding is defined as "*similarity in the individual perceptions of actors about a subject*" (Kleinsmann & Valkenburg, 2008, p. 371) and has been identified as a facilitating factor.

In the area of IT, Tarafdar and Qrunfleh (2010) argue that sharing of understanding increases the awareness of technical specialists about the business needs. Berberat and Baudet (2019) emphasize that when people understand each other, the level of trust and commitment to the collaboration increases thus sharing of understanding has a central role in construction project management. Alm Lönnefjord and Johansson (2018) propose, sharing of understanding about goals and work processes is crucial for an effective team alignment.

In that light, authors adopting Lean construction approach such as Ballard (2000), argue that open dialogue and sharing of knowledge facilitate mutual understanding. Forgues et al. (2018) suggest that Lean-led Design facilitates a mutual understanding between clients and professionals in terms of their needs and design solutions, respectively, through a collaborative

process between them. Further, Whelton et al. (2001) point out that sharing of understanding empowers decision makers for more informed choices and informing the clients about design constraints since for example, Grunden and Hagood (2012) claim that the client cannot fully understand the design solution and constraints until they see the space mockup.

Even though sharing of understanding is an important factor to support alignment, it is never perfect in teams and in complex contexts (Whelton et al., 2001).

Group dialogue

Group dialogue represents a communication strategy used to understand other people's perspectives that are involved in a mutual activity (Huang & Yang, 2015; Rhodes, 2000) which has been identified as an alignment enabler in both IT and construction projects.

In Lean construction context, Whelton et al. (2001) argue that the development of a dynamic group dialogue should facilitate sharing of knowledge among the construction professionals and the clients all throughout the project definition process and highlight the important role of a project moderator to facilitate and manage the conversation between the two parties, namely clients and design professionals.

The creation of a group dialogue should contribute to understanding the collective perspective of the participants, facilitating the creation of a high information quality (Whelton, 2004), and setting reasonable project goals (Emmitt, 2001) as well as helping the development of collaborative learning between stakeholders (Smith et al., 2020) which is, according to the project management literature, the basis for an effective organizational team building (Bond-Barnard et al., 2018).

Further, an open dialogue in both areas of construction project management and IT has been identified as a facilitating factor for alignment. Griffith and Gibson (2001) point out that an open conversation among all members of the team in the pre-project planning stage is essential and this should improve the alignment between them. Furthermore, Luftman (2003) argues

that an open dialogue between IT and business staff is extremely valuable to accomplish a correspondence between them along with Reich and Labes (2017) highlighting the importance of this factor in creating a shared understanding of each other's vision.

Stakeholders (user) early involvement

Stakeholder involvement, defined as the process of integrating people with different needs, goals, and cultures in a single cohesive and mutually supporting unit (Baiden et al., 2006), is classified by the authors as a facilitating alignment factor in the construction projects.
In the context of construction project management, Bingham et al. (2019) propose that proper alignment requires an early involvement of the different stakeholders (owners, engineers, architects, and maintenance responsible).

In the same research line and in the Lean construction context, Ballard (2008) states that alignment is achieved through conversation with all stakeholders starting with users. Johnson et al. (2017); Whelton and Ballard (2002) agree with that conception and emphasize the importance of user early involvement, namely voice of the customer, in order to create a mutual understanding of the needs, project problems, and potential solutions. In fact, unlike the non-participative approach in which users provide their needs and feedback individually to the designers without understanding the "bigger picture", in a Lean-led Design approach, users are part of the process, as explained in chapter 1. As a result, user early involvement should make a valuable contribution to the client's need interpretation and translation process. Moreover, client participation should change the balance of power between users and the construction professionals (Forgues et al., 2018), hence facilitating the alignment between them.

Common vocabulary

Vocabulary could be defined as a set of familiar words within a person's knowledge of a language. Authors, in the Lean construction context, have highlighted the importance of developing a common vocabulary to facilitate the understanding and communication between construction professionals and clients (Blyth & Worthington, 2010; Mazur et al., 2017; Whelton et al., 2001). Chocron and Schorlemmer (2020) point out that development of

common vocabulary ensures efficient information interpretation and translation for both sides of the project. According to these authors, when users and construction professionals use different vocabulary it is comparable to the situation in which "*An English speaker trying to get a glass of wine in Italy*"(Chocron & Schorlemmer, 2020, p. 70). Developing a common vocabulary is in fact an important factor specially in complex contexts such as hospitals where personnel from different backgrounds interact and contribute to the project with their own knowledge (Whelton et al., 2001).

This factor is also raised in the area of IT. Chan and Reich (2007) highlight the necessity of using the same vocabulary during the dialogue between IT and business staff.

Co-locating team members

What is meant by co-locating team members is the idea of sharing the same workspace (Bond-Barnard et al., 2018). Co-locating team members were identified as a facilitating alignment factor only in construction projects. Heineman and Zeiss (2002) outline that when team members are co-located, the face-to-face communication and thus the alignment between them is promoted. Van den Bulte and Moenaert (1998) also share the same take on the matter add that co-locating improves frequency of communication among team members.

Other empirical studies have shown positive relationships between co-locating people and collaborative behaviour; and a higher level of shared understanding between actors (Bond-Barnard et al., 2018; P. Dietrich et al., 2010; Forgues & Lejeune, 2011).

3.4.1.2 Hindering factors

Table (3.2) summarizes the hindering factors associated with alignment regarding the communication category.

Table 3.2 Alignments hindering factors: communication

Hindering factors	IT	Construction	
		Project management	Lean
Lack of sharing knowledge	[3] [4]	[9]	
Lack of understanding		[25]	[16] [12] [24] [15]
Lack of dialogue	[1], [2]	[6][7][8] [9] [10] [11]	[22] [17]
Lack of client (user) involvement		[18] [26]	[20] [21]

[1] (Luftman et al., 1999), [2] (Chen, 2010), [3] (Wang & Rusu, 2018), [4] (El-Mekawy et al., 2015), [5] (Chan & Reich, 2007), [6] (Feng & Tommelein, 2009), [7] (Bingham et al., 2019), [8] (Kamara & Anumba, 2001), [9] (Construction Industry Institute, 1995), [10] (Bingham et al., 2019), [11] (Jalava et al., 2010), [12] (Saarelainen & Hotti, 2011), [13] (Oberlender & Trost, 2001), [14] (Leinonen & Huovila, 2000), [15] Koskela and Ballard (2006), [16] (Tillmann et al., 2012), [17] (Whelton, 2004), [18] Whelton et al., 2005, [19] (Barrett & Stanley, 1999), [20] Schouten et al. (2020), [21] Whelton and Ballard (2002), [22] (Whelton et al., 2005), [23] Kleinsmann and Valkenburg (2008), [24] Tillmann (2012), [25] Shen et al. (2012), [26] (Tzortzopoulos et al., 2006)

Lack of sharing knowledge

Lack of sharing knowledge refers to lack of information shared between individuals or groups. Authors including El-Mekawy et al. (2015); Wang and Rusu (2018) classified lack of sharing as a hindering factor for business and IT staff relations. Chan and Reich (2007) hold that when IT executives are not knowledgeable about business strategies and organizational leaders are not privy to IT strategies, a lack of sharing knowledge and understanding is thus created between both sides. In the context of construction project management, Construction Industry Institute (1995) point out that lack of sharing knowledge between team members impacts the alignment between them.

Lack of understanding

Lack of understanding refers to incomprehension regarding a subject which is classified as a hindering alignment factor in construction projects. According to Kleinsmann and Valkenburg (2008) a lack of understanding causes unnecessary iterative loops as well as reducing the quality of the final product due to the unresolved issues in the beginning.

Authors that adopt the Lean approach including Koskela and Ballard (2006); Tillmann (2012) specified that the lack of client-self-understanding is a hindering alignment factor. According to them, the traditional approach assumes that clients already know what they need and based

on which the experts provide the solution. However, clients generally cannot differentiate between desires and needs which causes conflicts between client (Koskela & Ballard, 2006). This self-misunderstanding is provoked by the poor knowledge and communication issues and have a major negative impact on the decision-making process in a project (Saarelainen & Hotti, 2011).

From the construction project management perspective, authors such as Shen et al. (2012) and Tzortzopoulos et al. (2006) point out that it is not always easy for users to understand the proposed design solution by professionals since they do not have the knowledge of that. Not all users are able to read and understand preliminary drawings (Shen et al., 2012).

Lack of dialogue

A lack of dialogue refers to insufficient exchange of ideas, information, etc., between individuals or groups of individuals (Huang & Yang, 2015; Rhodes, 2000) and is considered as a hindering factor for alignment in both IT area according to Chen (2010); Luftman et al. (1999). Wang and Rusu (2018) argue that when dialogue is unilateral from business to IT or IT to business, it has an impact on the understanding and knowledge of both sides.

Considering construction project management, Bingham et al. (2019) and Jalava et al. (2010) argue that the lack of dialogue between the clients and the designers leads to unclear and uncertain needs during the planning stage as well as unrealistic client expectations. However, according to Tillmann et al. (2012) uncertainty of needs depends not only on the lack of dialogue but also on the lack of client self-understanding about their needs.

In the Lean construction context, researchers emphasize that lack of dialogue generates other hindering factors including ill-defined needs (Whelton et al., 2005) and requirements with an unrealistic budget and schedule (Whelton, 2004).

Lack of client (user) involvement

Involvement could simply be defined as the act of participating in something. Authors adopting the Lean construction approach, including Whelton and Ballard (2002), classify the lack of

user involvement during project definition as a hindering factor for alignment. Schouten et al. (2020) discuss that lack of user active involvement results in more effortful need translation process and less engagement of the user in the process.

3.4.1.3 Summary

The following table summarizes the different factors identified in the communication category.

Table 3.3 Facilitating factors vs. hindering factors: communication

communication			
Facilitating factors		**Hindering factors**	
Factor	**Definition**	**Factor**	**Definition**
Sharing of knowledge	"*push and pull found in the multiple, directional movement of data, information between individuals and groups for mutual benefit*" (Bond-Barnard et al., 2018, p. 436)	Lack of sharing knowledge	lack of information shared between individuals or groups
Sharing of understanding	*"similarity in the individual perceptions of actors about a subject"* (Kleinsmann & Valkenburg, 2008, p. 371)	Lack of understanding	To incomprehension regarding a subject
Group dialogue	A communication strategy used to understand other people's perspectives that are involved in a mutual activity.	Lack of dialogue	Insufficient exchange of ideas, information, etc., between individuals or groups of individuals
Stakeholders (user) early involvement	Early integration of different people with different needs, goals, cultures in a single cohesive and mutually supporting unit.	Lack of client (user) involvement	Lack of the client 'participation in the process
Common vocabulary	A set of familiar words within a person's knowledge of a language		
Co-locating team members	Team members sharing the same workspace		

In this category, we have identified a total of 10 alignment factors: 6 factors are classified as facilitating and 4 factors as hindering. Furthermore, four hindering factors are simply the

inverse of the facilitating ones. In addition, while some factors are identified only in construction area such as co-locating team members, the majority are identified in both in construction and IT areas. In fact, the literature in both areas shows that effective alignment of client needs, and the final solution is related to whether or not team members and clients communicate. Addressing this category of factors facilitates alignment and ignoring them could potentially hinder it.

3.4.2 Partnership

Partnership can be defined as "*a form of a cooperative relationship between two parties or more on the basis of agreement and mutual interests to improve capability in a particular field or purpose, so as to obtain better results*" (Khumaidi, 2019, p. 2) referring to the level of relationship between two sides or more (Luftman et al., 2017). In this research, partnership represents a group of factors that could facilitate or hinder the IT-business, team, and/ or needs-solution alignment.

3.4.2.1 Facilitating factors

The following Table (3.4) summarizes the alignment facilitating factors associated with the partnership category.

Table 3.4 Alignment facilitating factors: partnership

Facilitating factors	IT	Construction	
		Project management	Lean
Mutual trust	[12] [13]	[3] [4] [15] [17] [18]	[14] [16]
Relational contracting		[5]	[16] [26]
Commitment	[1]	[3] [4]	[8] [9] [10] [11]
Sharing of a common vision	[19] [20]	[5] [6]	[21]
Sharing rewards	[22] [25]	[6] [5] [23]	
Co-creation			[16] [21] [24]

[1](Chan & Reich, 2007), [2] (Belfo & Sousa, 2012), [3] (Construction Industry Institute, 1995), [4] (Ibrahim et al., 2015), [5] (Bingham et al., 2019), [6] (Griffith & Gibson, 2001), [7] (Rowlinson & Cheung, 2008), [8] (Pennanen et al., 2005), [9] (Sengonzi et al., 2009), [10] (Smith et al., 2020), [11] (Mazur et al., 2017), [12] (Chan et al., 2006), [13] (Luftman, 2003), [14] (Emmitt, 2010), [15] (Smyth & Pryke, 2009), [16] (Grunden & Hagood, 2012), [17] (Cheung & Lee, 2006), [18] (Scherer, 2019), [19] Douma et al. (2000), [20] Preston and Karahanna (2009), [21] Schouten et al. (2020), [22] Luftman et al. (2017), [23] Bond-Barnard et al. (2018), [24] (Hicks et al., 2015), [25] (Jobarteh et al., 2019), [26] (Forgues et al., 2018)

Mutual trust

Trust is defined by Golbeck (2006, p. 2) as '*a commitment to an action based on a belief that the future actions of that person will lead to a good outcome. We could say Alice trusts Bob about an email if she chooses to read the message (commits to an action) that Bob sends her (based on her belief that Bob will not waste her time)*'. It is classified in the literature in both IT and construction areas as an alignment facilitating factor.

Chan et al. (2006) propose that the mutual trust between IT and business staff promote the partnership. In fact, trust is created, according to Luftman (2003) by the open dialogue between both sides.

Having the same perspective and adopting the Lean construction approach, Emmitt (2010) highlights that trust among team members is established through interaction and open communication. As team members start interacting and engaging in a dialogue, they begin to understand each other's opinions and hence trust each other. However, in the context of

construction management, Smyth and Pryke (2009) have another point of view, arguing that trust is not all about open dialogue and claiming that there is no need for trust if there is a complete transparency of information. Trust is needed just in case of uncertainty and non-transparent sharing of information.

Furthermore, Construction Industry Institute (1995); Ibrahim et al. (2015), propose that trust amongst team members is built once a good relationship is established, therefore it represents a long-term building process (Cheung & Lee, 2006). According to Scherer (2019), the challenge is to build a trustworthy relationship in a complex project where stakeholders do not know each other or do not have the necessary expertise in each other domains. For that purpose, in the Lean context, Grunden and Hagood (2012) have proposed to promote the trust among participants by using the serious games, which is learning through games such as a simple wooden blocks game. The objective is to make people work together, helping each other thus realizing that trusting each other in a collaboration does produce the best results.

Relational contracting

A contract is "*an agreement or promise made between two or more parties that the courts will enforce. In other words, it is a set of rules governing the relationship, content and validity of an agreement between two or more persons*"(Junyu, 2020, p. 1). According to Rahman and Kumaraswamy (2002, p. 46) relational (or relationship) contracting is based on a "*recognition of mutual benefits and win–win scenarios through more cooperative relationships between the parties*" and represents one of alignment facilitating team factors in construction projects. Construction manager at risk (CMAR), construction manager–general contractor (CMGC) and integrated project delivery (IPD) are examples of these contracts.

Based on the study by Bingham et al. (2019) in which alignment factors are compared under different contractual methods, CMAR turns out to be one of the best and in fact promotes coordination and communication between team members better than the traditional design-bid-build (DBB) method. Another study realized by Jobidon et al. (2019) that compared Quebec project delivery methods, found that CMGC/IPD represent the most relation project

delivery method available where the public client has an active involvement during the different phases of the project.

Similarly and in the Lean construction context, IPD, also known as integrated facility design (IFD), is gaining popularity in hospital building programs since it enables team alignment (Forgues et al., 2018; Grunden & Hagood, 2012). In such contracts all major players in a project including architects, engineers, etc., have a single contract with a shared responsibility and effort, unlike BDD that relies on individual contracts for each discipline. This leads to more collaboration between project stakeholders and innovation in designing and building a facility, unlike the traditional design-bid-build (DBB) method which offers limited opportunities for collaboration. According to Jobidon et al. (2019), IPD contracts provide more relational integrated teams that those of CMAR.

Commitment

Commitment is defined as the "relationship between the employee and the organization basing upon the exchange of benefits. Employees spend their time, energy, and skills in the better interest of organizations, and organizations take care of financial needs of employees, employees would remain loyal to an organization until he does not get a better alternative. This mutual dependence creates a sense of obligation, undertaking between employee and the organization" (Mahmood et al., 2016, p. 1053). Commitment represents one of the important enablers of alignment in the IT and construction areas.

Ibrahim et al. (2015) argue that commitment to values, goals, and vision among project team members is crucial for a successful project. Furthermore, it facilitates the implementation of a successful management of relationships or organizational changes (Rowlinson & Cheung, 2008).

Mazur et al. (2017) in the Lean construction context, highlight that the commitment to values, goals, and vision are important to achieve alignment between clients and construction professionals. Not only should the professionals be committed but also the client (user). In IT

area, Chan and Reich (2007) emphasize that commitment should start from the top management. Commitment represents an iterative process specially in complex projects and it could be stimulated by an open dialogue among the actors (Pennanen et al., 2005).

Sharing of a common vision

Sharing a common vision refers to reaching a collective understanding of '*why an organization, or a project exists and what it is seeking to accomplish (mission)*' Cady et al. (2011). It also involves sharing specific project goals that leads to the achievement of the organization's mission and is, of course, considered an alignment facilitating factor in both IT and construction areas.

In the area of IT, Douma et al. (2000) argued that a shared vision between IT and business staff leads to an effective partnership. Preston and Karahanna (2009) suggest that the best way to develop a shared vision is through sharing knowledge and gaining a high level of trust between both sides. The same authors add that very often people will not successfully work together if they have different goals and visions.

In the area of construction management, Bingham et al. (2019) state that sharing a common vision helps align project team members' attitudes by reducing conflict among them and promoting their acceptance rather than compliance. However, according to Griffith and Gibson (2001), the literature provides little information on how to achieve common visions, goals, and commitment to them, especially during the early stages of projects that involve different stakeholders. In the Lean construction context, Schouten et al. (2020) suggest that the challenge is not only to share vision but also to maintain the continuity and the commitment of the stakeholders to this vision.

Sharing of rewards

Rewards "*could range from monetary incentives such as bonuses to non-monetary awards such as dinner gift certificates to awards such as praise and public recognition that do not have a monetary equivalent value*." (Bartol & Srivastava, 2002, p. 66). Sharing rewards and

benefits is crucial to develop loyalty and motivation in cross-functional teams in both IT and construction areas. In fact, once people are rewarded, their commitment to work increases (Mahmood et al., 2016).

The importance of not only sharing rewards but also risks in improving the trust between IT and business staff is discussed in the area of IT by Luftman et al. (2017). However, Jobarteh et al. (2019) argue that very often, organizations are unbalanced and the business side enjoys more rewards and fewer risks compared to the IT side.

In construction project management area and according to Bond-Barnard et al. (2018), sharing rewards and risks between project team members improve their level of collaboration. Griffith et Gibson (2001, as cited in Bingham et al., 2019) emphasize that sharing rewards and recognition enhances the chances of achieving project objectives and reduces conflict. For that reason, managers should develop and implement a reward and recognition system for team members and contractors that support project objectives.

Co-creation

Co-creation could be defined as any act of collective creativity (Hicks et al., 2015). It has been classified by authors adopting participative approaches including Lean-led Design as an alignment facilitating factor.

In the Lean-led Design context, co-creation refers to active involvement of users in the design process of the hospital along with the architects. Hicks et al. (2015) suggest that this leads to better products and usable services, beneficial for both sides involved in the process (users and architects). In a recent study, Schouten et al. (2020) argue that co-creation is a critical mechanism to generate a participative and collaborative attitude toward the new facility and suggest that this factor is also an important enabling factor for implementing innovations in the healthcare sector.

To support co-creation, Grunden and Hagood (2012) propose different techniques including the seven flow workshops and value stream mapping full-scale mockups among others (see section 3.4.6.1).

3.4.2.2 Hindering factors

The following table summarizes alignment hindering factors associated with the partnership category.

Table 3.5 Alignment hindering factors: partnership

Hindering factors	IT	Construction	
		Project management	Lean
Lack of trust	[1] [2]	[3]	[4]
Conventional contracting		[5]	[4] [6]

[1] (Luftman, 2003), [2] (Jobarteh et al., 2019), [3] (Rowlinson & Cheung, 2008),[4] (Grunden & Hagood, 2012), [5](Bingham et al., 2019), [6] (Tzortzopoulos et al., 2020)

Lack of trust

While trust plays a critical role in the relationship between individuals, as explained previously in section (3.4.2.1), lack of trust is classified in the literature in both IT and construction areas as an alignment hindering factor.

According to Jobarteh et al. (2019), lack of trust and openness in IT area is often due to the imbalance between IT and business staff regarding the management of organization strategies and decision-making. Luftman (2003) argues that lack of trust impacts the level of cooperation between both parties, thus impacting commitment and achievement of project objectives as discussed by Rowlinson and Cheung (2008) in the construction project management area. Similarly, in the Lean construction context, Grunden and Hagood (2012) believe that when there is a low level of trust in an organization, employees do not cooperate due to fear of criticism or professional risk, consequently resulting in lots of conflicts.

Conventional Contracting

Unlike relational contracting, the conventional contracting are classified as alignment hindering factors in construction projects, especially in complex ones, since every stakeholder has their own priorities, obligations, budget, and schedule to maintain and respect (Bingham et al., 2019). Tzortzopoulos et al. (2020) in agreement with Grunden and Hagood (2012) in Lean construction context, hold that communication and partnership remain difficult when architects, engineers, project managers, and even subcontractors have individual contracts with the client. In order to deal with that, the same authors propose methods such as integrated project delivery (see section 3.4.2.1).

3.4.2.3 Summary

The following table summarizes the different factors identified in the partnership category. In this category, we have identified a total of 8 alignment factors: 6 factors are classified as facilitating and 2 as hindering. In accordance with the communication category, both hindering factors represent the inverse of the facilitating ones. In addition, while some factors are identified only in construction area (e.g., co-creation), others are identified in both construction and IT areas (e.g., commitment). In fact, the literature in both areas support the notion that effective alignment between client needs and the final solution are related to the existing relationship between team members.

Table 3.6 Facilitating factors vs. hindering factors: partnership

Partnership			
Facilitating factors		**Hindering factors**	
Factor	**Definition**	**Factor**	**Definition**
Mutual trust	*"a commitment to an action based on a belief that the future actions of that person will lead to a good outcome"* Golbeck (2006, p. 2)	Lack of trust	"A lack of commitment to an action based on a belief that the future actions of that person will lead to a good outcome" Golbeck (2006, p. 2)
Relational contracting	"*Recognition of mutual benefits and win–win scenarios through more cooperative relationships between the parties*" Kumaraswamy (2002, p. 46)	Conventional contracting	Every stakeholder has his own contract and obligation (e.g., cost, schedule) to maintain and respect
Commitment	Loyalty to an organization		
Sharing of a common vision	Reaching a collective understanding of *"why an organization, or a project exists and what it is seeking to accomplish (mission)"* Cady et al. (2011).		
Sharing of rewards,	*"could range from monetary incentives such as bonuses to non-monetary awards such as dinner gift certificates to awards such as praise and public recognition that do not have a monetary equivalent value."* (Bartol & Srivastava, 2002, p. 66).		
Co-creation	Any act of collective creativity		

3.4.3 Governance

Governance or the act of governing means controlling the direction of something including a project or an organization. It involves the choices that organizations make such as prioritizing projects and controlling budgets (Henderson & Venkatraman, 1999). In the context of our research,

the category of governance represents a group of factors that could facilitate or hinder the IT-business, team, and/or needs-solution alignment.

3.4.3.1 Facilitating factors

The following table summarizes the alignment facilitating factors associated with the governance category identified in reviewed studies.

Table 3.7 Alignment facilitating factors: governance

Facilitating factors	IT	Construction	
		Project management	Lean
Effective leadership	[2], [9], [20]	[4] [16] [18]	[6], [7], [8]
Setting clear priorities	[3] [17]	[4] [18]	[19] [21]
Transparency of information		[24]	[5] [22] [23] [19]
Stakeholder (user) involvement in decision-making	[1] [10] [11]	[12] [13]	[14] [15]

[1] (Luftman et al., 1999), [2] (Panda & Rath, 2017), [3] (Luftman, 2004), [4] (Bingham et al., 2019), [5] (Pennanen et al., 2005), [6] (Whelton et al., 2001), [7] (Reijula et al., 2014), [8] (Schouten et al., 2020), [9] (Lear, 2012), [10] (Henderson & Venkatraman, 1999), [11] (Gutierrez & Lycett, 2011), [12] (Lingard et al., 2007), [13] (Rowlinson & Cheung, 2008), [14] (Brammer & Millington, 2004), [15] (Pajunen, 2006), [16] (Piderit, 2000), [17] (Luftman et al., 2008), [18] (Griffith & Gibson, 2001), [19] (Whelton, 2004), [20] (Chan et al., 2006), [21] (Grunden & Hagood, 2012), [22](Baldauf et al., 2020), [23] Schöttle et al. (2014), [24] (Dietrich et al., 2010).

Effective leadership

Leadership has been defined by Ireland and Hitt (1999, p. 43) as "*a person's ability to anticipate, envision, maintain flexibility, think strategically and work with others to initiate changes that will create a viable future for the organization*". This factor has been studied in both areas of construction and IT.

Panda and Rath (2017) claim that effective leadership helps organizations enhance performance. It should also motivate people throughout the organization and thus facilitate the choice of good initiatives that can push the company forward (Lear, 2012). Chan et al. (2006) believe that active leadership is a key for establishing and sustaining a collaborative culture which is necessary for IT-business alignment.

In line with this notion, Bingham et al. (2019) highlight the importance of effective leadership whose role is to facilitate interaction and coordination among project team members within an organization in the area of construction project management. Piderit (2000) consider an effective leadership as a key factor in reducing conflict between team members achieving common goals and visions. In the same perspective, Griffith and Gibson (2001) emphasize the importance of team leadership in promoting trust and honesty among team members.

Researchers adopting the Lean construction approach, including Reijula et al. (2014) also emphasize the importance of leadership in successful project definition. Schouten et al. (2020) claim that supportive leadership has a positive impact on innovation. Furthermore, the same authors propose that consistent leadership during the project definition facilitates the continuity of vision and strategy.

Setting clear priorities

Priority setting is defined here as deciding what needs, objectives, or condition of being should be treated as more important. In both IT and construction areas, setting clear priorities represents an alignment facilitating factor.

According to Luftman et al. (2008), the organization should match business priorities to IT priorities, budgeting, and planning. For that purpose, the decision-making authority should make clear the priorities, the allocation of resources, and strategic goals at different levels of organization: strategical, tactical, and operational (Luftman, 2004). This facilitates the mutual understanding between IT and business staff about the expectations of each, hence, the decision-making process.

In the construction project management area, this factor refers to clear priority definition regarding costs, schedules, and requirements of the project (Bingham et al., 2019; Griffith & Gibson, 2001). These priorities should assist team members for correct decision-making regarding project objectives. In addition, when managers establish priorities early, they can

focus on the most important issues and thus resulting in more efficient and fruitful decision-making (Griffith & Gibson, 2001).

In the Lean context, Whelton (2004) states that defining requirement priorities during project definition is a complex task, especially in the case of a hospital. In this context, priorities are subjective and are related to stakeholders' perceptions, experiences, roles, and responsibilities. According to Whelton (2004), the project manager has an important role in trying to reconcile such differences through conversation. Grunden and Hagood (2012) argue that the active client involvement when using approaches such as Lean-led Design is the key solution to reduce conflict. Involving the client stakeholders in the process of defining the functional needs should facilitate the decision-making.

Transparency of information

Transparency of information means in this context its clearness, traceability, and accessibility to all stakeholders. This factor was only identified in construction projects as a facilitating alignment factor by authors adopting or not Lean approach (A. Dietrich et al., 2010; Pennanen et al., 2005).

Transparency between team members is fundamental to their mental alignment. Schöttle et al. (2014) explained that transparency is not necessary to share information, but it impacts the sharing understanding. Further, with transparency comes trust, cohesion between actors and thus team performance (Dietrich et al., 2010).

Whelton (2004) states that greater transparency of information and decision-making during project definition enable all stakeholders to fully understand project objectives, constraints, and decisions. Managing requirements systematically could be useful for keeping records and traceability of information, and provide a transparency of decision-making during the process of project definition (Baldauf et al., 2020; Miron & Formoso, 2003).

Stakeholder (user) involvement in decision-making

Involvement in decision-making refers to the participation in the process through which an individual or a group of individuals influence and share control over priority setting, resource allocations, etc. (Thuo, 2012), seen as the mechanism for specifying IT decision-making capabilities within the organization and with strategic alliances and partners in the IT area (Henderson & Venkatraman, 1999). In fact, authors including Luftman et al. (1999) emphasize the importance of a high level of staff participation in the development of business strategies representing, according to them, one of the top enablers of IT-business alignment. This participation leads to a sharing of understanding between both sides hence contributing to correct decisions about project priorities (Gutierrez & Lycett, 2011).

In construction project management, various authors have shown that involving the stakeholders in the decision-making process has a positive impact on trustful relationships (Lingard et al., 2007). This process involves the identification of objectives and the negotiation between the stakeholders until achieving these objectives (Rowlinson & Cheung, 2008).

Considering the Lean context, Whelton et al. (2001) emphasize the important role of active client (user) participation and empowerment to make decisions regarding project definition. This involves giving the opportunity to the client to take initiatives and make decisions during the process. The objective is to avoid feelings of powerlessness in clients and improve project performance through collaboration (Brammer & Millington, 2004; Pajunen, 2006).

3.4.3.2 Hindering factors

The following table summarizes four alignment hindering factors associated with the governance category. These factors represent the inverse of the facilitators.

Table 3.8 Alignment hindering factors: governance

Hindering factors	IT	Construction	
		Project management	Lean
Poor leadership	[2], [4]	[6] [7]	[14]
Unclear priorities	[1], [2], [3]	[8] [9]	[11] [10] [12] [13]
Non-transparency of information	[15]	[17]	[16]
Ill-defined: needs/requirements			[10] [18]

[1](Chen, 2010), [2] (Luftman et al., 1999), [3] (Jobarteh et al., 2019), [4] (Chen, 2010), [5](El-Mekawy et al., 2015), [6] (Construction Industry Institute, 1995), [7] Sawiris et al., 2015, [8] (Green, 1994), [9](Bingham et al., 2019), [10] (Whelton, 2004), [11] (Whelton et al., 2005), [12] (Whelton & Ballard, 2002), [13] (Grunden & Hagood, 2012), [14] (Schouten et al., 2020), [15] Wang and Rusu (2018), [16] Whelton and Ballard (2002), [17] Schade et al. (2011), [18] (Barrett & Stanley, 1999)

Poor leadership

Poor leadership is characterized by passive behavior that "*is unable to take control and correct decision*" (Bryman et al., 1996). While an effective leadership is a facilitating alignment factor, poor leadership is indeed an alignment hindering factor which has been identified in both IT and construction area.

According to Chan and Reich (2007), organizations with autocratic or indecisive leadership exhibit a lower level of IT-business alignment. Furthermore, Construction Industry Institute (1995) argues that excessive or poor change order management could negatively impact team alignment during project definition. These changes are generally related to the lack of managerial consistency and leadership in the project definition process (Schouten et al., 2020). Sawiris et al. (2015) agree with this notion and add that poor leadership increases uncertainty, leading to unmotivated team members and poor decision quality, hence, hindering the needs-design solution alignment.

Unclear priorities

When project priorities are unclear, team members do not know which need or objective should be treated as more important. Lack of prioritization is a well-known alignment hindering factor in both IT and construction areas.

In the IT area, according to Wang and Rusu (2018), setting unclear priorities leads to incorrect decisions regarding the project and wasting of time. To deal with it, researchers including El-Mekawy et al. (2015); Luftman (2003) emphasize the importance of shared understanding and dialogue between IT and business staff.

Similarly, in the construction area, Hicks et al. (2015) argue that the lack of understanding and consensus between stakeholders about needs and project objectives makes priority setting difficult, which is classified by Whelton (2004) as one of the most important challenges. Whelton et al. (2005) and Bingham et al. (2019) state that the majority of projects are unsuccessful when managing and prioritizing client needs within budget. Usually, priority is given to the client sponsor rather than the user, which means that financial matters dominate the hierarchy (Green, 1994). Grunden and Hagood (2012) add that in a hospital the priorities during project definition are often given to technical rather than functional issues. These unbalanced priority management has a negative impact not only on alignment but also on patient safety and workspaces (Hicks et al., 2015).

Non-transparency of information

Non-transparency of information refers to unclear, untraceable, and inaccessible information and is indeed considered an alignment hindering factor.

In IT area, Wang and Rusu (2018) state that non-transparency of information increases the level of uncertainty. Furthermore, Whelton and Ballard (2002) consider unclear flow and non-traceability of information as a barrier for alignment specially in a dynamic context where staff change over time. When the information is not transparent, project team members often spend a lot of time in order to understand project objectives, which impacts the level of trust amongst them (Bew & Underwood, 2010; Brady et al., 2018; Whyte et al., 2010). Schade et al. (2011) add that a non-transparent information flow creates ambiguity among stakeholders about project objectives, negatively impacting the solutions proposed by architects and leading to delays in decision-making processes concerning the project.

Ill-defined: needs/requirements

As previously explained in chapter 1 (see section 1.3), in this study needs are regarded as client priority and choice expressed in natural language, whereas a requirement refer to translation of the needs into functional specifications (Kamara, Augenbroe, et al., 2002; Kometa et al., 1995; Thyssen et al., 2010).

Whelton (2004), adopting the Lean construction approach, classified uncertainty associated with client needs and thus with the requirements, as an alignment hindering factor and argues that within the project definition process, client needs are more difficult to establish in dynamic and complex projects characterized by regular change of needs and involvement of various stakeholders. Since client priorities and choices are not inherently evident, there is often an ambiguity when transforming uncertain client needs into design requirements. To deal with this issue, Barrett and Stanley (1999) propose a key solution which is client involvement in the team, in the process of decision-making.

3.4.3.3 Summary

The following Table (3.9) summarizes the alignment facilitating factors associated with the governance category.

Table 3.9 Facilitating factors vs. hindering factors: governance

Governance			
Facilitating factors		**Hindering factors**	
Factor	**Definition**	**Factor**	**Definition**
Effective leadership	"a person's ability to anticipate, envision, maintain flexibility, think strategically and work with others to initiate changes that will create a viable future for the organization" Ireland and Hitt (1999, p. 43)	Poor leadership	leadership unable to take the correct decision and control. It is also characterized by passive behaviour.
Setting clear priorities	The process of decision (e.g., what needs, objectives, condition of being should be treated as more important) is clear	Unclear priorities	The process of decision (e.g., what needs, objectives, condition of being should be treated as more important) is unclear
Transparency of information	Information clearness, traceability, and accessibility to all stakeholders.	Non-transparency of information	Information not clear, untraceable and inaccessible to all stakeholders.
Stakeholders (user) involvement in decision-making	Involvement in decision-making refers to the participation in the process through which an individual or a group of individuals influence and share control over priority setting, resource allocations, etc.	Ill-defined: needs/requirements	The description of what are the needs, and the requirement is not clear and vague.

In this category, we have identified a total of 8 alignment factors: 4 factors are classified as facilitating and 4 as hindering. It is noteworthy that 3 out of the 4 hindering factors represent the inverse of the facilitating ones. In addition, while some factors are only identified in construction projects (e.g., transparency of information), the majority are identified in both construction and IT areas (e.g., setting clear priorities). In fact, the literature in both areas

shows that effective alignment between client needs and the final solution is related to the existing governance of the organization.

3.4.4 Measurement

Measurement refers to the use of metrics to make decisions and strategic choices. This includes the evaluation of what went right and wrong for continuous improvement in the process. In our research, "measurement" represents a group of factors that could facilitate or hinder the IT-business, team, and/or needs-solution alignment.

3.4.4.1 Facilitating factors

The following table summarizes the alignment facilitating factors associated with the measurement category as identified in the reviewed studies.

Table 3.10 Alignment facilitating factors: measurement

Facilitating factors	IT	Construction	
		Project management	Lean
Output evaluation			[9][10][11][6] [7][8] [12]
Measuring the work progress	[3] [14] [15]	[4] [5]	
Determining the contribution of each other	[1][2][3]		

[1] (Gutierrez & Lycett, 2011), [2] (Daniels & Friborg, 2016), [3] (Luftman, 2004), [4] (Griffith & Gibson, 2001), [5] (Bingham et al., 2019), [6] (Whelton, 2004), [7] (Ballard & Zabelle, 2000), [8] (Forgues et al., 2018), [9] (Whelton & Ballard, 2002), [10] (Mazur et al., 2017), [11] (Pennanen et al., 2010), [12] (Demir & Theis, 2016), [13] Luftman (2003), [14] Daniels and Friborg (2016), [15] Kappelman et al. (2016)

Output evaluation

Evaluating the output and the solution of each stage was presented by authors adopting Lean construction approach as a facilitating alignment factor. Whelton et al. (2001) hold that in order to evaluate and test the design solution, a set of criteria should be considered. Criteria act as "*a*

translation of needs for designers to generate concepts" (Whelton, 2004, p. 19). This means that in order to define well these criteria, designers should first understand well the client 'needs. Another technique proposed by the authors to control the evaluate the output of each stage with the project purpose, is short and rapid loop feedback regulation (Grunden & Hagood, 2012). The objective of this approach is to allow flexibility, detect and reduce the discrepancies between the current situation and the goal (Mazur et al., 2017; Pennanen et al., 2010; Simon, 2019). In an ideal case, the feedback loop should continue until client satisfaction and the perfect solution is achieved (Demir & Theis, 2016), however, its application comes with difficulties in complex projects since in these projects, the environment is uncertain, and the level of detail of tasks is unclear. Furthermore, according to Biotto (2019), this method is recommended for small teams with a maximum of 20 members. Identifying alignment factors could thus be the first step allowing a better measurement and assessment.

Measuring the work progress

Measuring or evaluating the work progress has been identified in both IT and construction areas as an alignment facilitating factor. According to Daniels and Friborg (2016); Kappelman et al. (2016), measuring IT-business work progress represents an important facilitating factor. Luftman (2004) confirms and adds that for a more efficient management of the work, measurements are necessary. Luftman (2003) also argues that organizations should devote significant resources to continuously assessing the work progress in order to understand the problems associated with the current situation and to improve the current situation.

Considering construction project management, authors including Griffith and Gibson (2001) and Bingham et al. (2019) suggest that measurement of work progress is one of the most important alignment factors. Several techniques have been proposed to achieve this goal, for instance, documenting project details including shortcomings and success and using planning tools (e.g., checklists, simulations, and workflow diagrams, etc.), among others.

Determining the contribution level

Determining contribution level refers to establishing the value that each party in a collaboration adds to the cause. In the IT area, Gutierrez and Lycett (2011) and Luftman et al. (2008) consider

it as an alignment facilitating factor. For that reason, a balanced "dashboard" is required to demonstrate the level of contribution of each party. In fact, determining the value that the IT side contributes to the business side, facilitates future management decisions and strategic choices of the organization. This includes IT assessments and reviews in order to ensure a continuous improvement. Although this factor was only identified in IT-business projects, it could also have been addressed in the construction context which is determining client contribution to project definition in order to make better decisions, reach the goals of each stage, and evaluate the results.

3.4.4.2 Hindering factors

The table below presents the only alignment hindering factor identified based on the literature review, associated with the measurement category.

Table 3.11 Alignment hindering factors: measurement

Hindering factors	IT	Construction	
		Project management	Lean
Lack of output evaluation	[1], [2]		[3]

[1] (El-Mekawy et al., 2015), [2](Weiss & Anderson, 2004), [3](Whelton & Ballard, 2002)

Lack of output evaluation

El-Mekawy et al. (2015); Weiss and Anderson (2004), in the context of IT, classify the lack of output and solution evaluation as a hindering factor. This factor has also been identified by authors that adopt the Lean approach during project definition. Whelton and Ballard (2002) argue that not evaluating the output of each stage of the project could hinder the correspondence between needs and the solution. With a lack of measurement, managers cannot easily identify the problems and evaluate and develop potential solutions.

3.4.4.3 Summary

The following table (3.12) summarizes the facilitating alignment factors associated with the measurement category in the areas studied.

Table 3.12 Facilitating factors vs. hindering factors: measurement

Measurement			
Facilitating factors		**Hindering factors**	
Factor	**Definition**	**Factor**	**Definition**
Output evaluation	Evaluate the match between the needs and the solution proposed at each step of the project	Lack of output evaluation	Lack of evaluating the match of the output or the solution proposed at each step of the project.
Measuring the work progress	Evaluating the work progress		
Determining the contribution level	Determining the value added to each other		

In this category, we have identified a total of 4 alignment factors: 3 are classified as facilitating and 1 as hindering factor. This hindering represents the inverse of the facilitating one (output evaluation). In spite of the fact that 1 (determining the contribution of each other) out of 4 factors are only identified in IT area, it could also be adopted in the construction context.

3.4.5 Skills

In our context, skills could be defined as “certain attributes or abilities that an executive should possess in order to fulfill specific tasks in an organization” (Junyu, 2020, p. 57). It represents a specific requirement to perform a job, hence, vital for any organization to succeed and achieve its goals. In our research, the category of skills could potentially facilitate or hinder the IT-business, team, and/or needs-solution alignment.

3.4.5.1 Facilitating factors

The table below presents the alignment facilitating factors associated with the skills category identified in the reviewed studies.

Table 3.13 Alignment facilitating factors: skills

Facilitating factors	IT	Construction	
		Project management	Lean
Continuous training	[2]	[5]	[6]
Encouraging innovative ideas	[2] [3]	[4]	

[1] (Obeng & Mkhize, 2017), [2] (Luftman, 2003), [3] (Street et al., 2017), [4](Griffith & Gibson, 2001), [5] (Lee, 2005) [6] (Grunden & Hagood, 2012)

Continuous training

Training represents "*the process of learning knowledge and skills that enable employees to perform successfully in their jobs and also to meet changes in conditions and requirements of their jobs*"(Šikýř, 2011, p. 612). Continuous training is classified by authors in the IT and construction field as an alignment facilitating factor.

In the IT area, Luftman (2003) propose that organizations should continue to train their employees to acquire knowledge and keep them up to date specially in the IT area. Along the same line, in the construction project management field, authors such as Lee (2005) and Bingham et al. (2019), highlight the importance of relevant training of the team for continuous improvement. In the Lean context Grunden and Hagood (2012) argue that organizing training sessions is important not only to project team members but also to clients involved in the Lean activities.

Encouraging innovative ideas

As the name suggests, encouraging innovative ideas refers to motivating team members to provide their innovative propositions and to be creative. It represents an alignment facilitating factor in both IT and construction projects.

In the IT area, Luftman (2003) argues that managers should support innovative ideas in order to increase the chance of innovation and commitment of the employees in the organization. Similarly, in the context of project management, Griffith and Gibson (2001) propose that motivation of team members to successfully perform their job could be realized through verbal and actual compensations, with "verbal" referring to non-monetary compensations such as appreciation, benefits, vacations, and the "actual" referring to monetary compensations such as bonuses and increasing salaries.

3.4.5.2 Hindering factors

The following table presents the alignment hindering factor associated with the skills category.

Table 3.14 Alignment hindering factors: skills

Hindering factors	IT	Construction	
		Project management	Lean
Lack of training	[2]		[1]

[1] Whelton & Ballard, 2002) [2] (El-Mekawy et al., 2015)

Lack of training

Lack of staff training represents an alignment hindering factor in IT-business and construction areas. According to El-Mekawy et al. (2015), the lack of staff training has a negative impact on innovation of business organizations. Similarly, in the construction area, Whelton and Ballard (2002) argue that the lack of training has a negative impact on alignment during project definition.

3.4.5.3 Summary

The following Table (3.15) summarizes the alignment facilitating factors associated with the governance category identified in the reviewed studies.

Table 3.15 Facilitating factors vs hindering factors: skills

Skills			
Facilitating factors		**Hindering factors**	
Factor	**Definition**	**Factor**	**Definition**
Continuous training	"The process of learning knowledge and skills that enable employees to perform successfully in their jobs and also to meet changes in conditions and requirements of their jobs"(Šikýř, 2011, p. 612).	Lack of training	Lack of developing team members' skills
Encouraging innovative ideas	Motivating the team members to provide their innovative propositions and to be creative		

In this category, we have identified a total of 3 alignment factors: 2 as facilitating and 1 as hindering. Three factors are identified in both IT and construction fields. Furthermore, the only identified hindering factor represents the inverse of the facilitating counterpart which means that addressing the facilitating factor enables alignment and not addressing it could hinder it.

3.4.6 Technology and techniques

While technology is defined as "*a system created by humans that uses knowledge and organization to produce objects and techniques for the attainment of specific goals*" (Volti, 2009, p.9, as cited in Bailetti, 2012), techniques are defined as "*a particular method of doing an activity, usually a method that involves practical skills*" (Damayanti, 2020, p. 7).

In our research, we refer to "technology and techniques" to a category of factors related to technology and techniques used in a project that could support/facilitate or hinder IT-business, team, and/ or needs-solution alignment.

3.4.6.1 Facilitating factors

The following table summarizes the alignment facilitating factors associated with the technology and techniques category identified in the reviewed studies.

Table 3.16 Alignment facilitating factors: technology and techniques

Facilitating factors	IT	Construction	
		Project management	Lean
Participation methods			[3] [6]
Standardization			[2] [3] [4] [5]
Visualization			[3] [4] [5] [6] [8]
Flexibility	[1] [7]		[3]
Requirement management software		[8]	

[1](Luftman, 2004) ,[2] (Pennanen et al., 2005), [3] (Grunden & Hagood, 2012), [4] (Reijula et al., 2014), [5](Whelton, 2004), [6] (Hicks et al., 2015), [7] (Nurdiani, 2015), [8] Baldauf et al. (2020),

Participation methods

Participation is "*exercising voice and choice, and developing the human, organizational and management capacity to solve problems as they arise in order to sustain the improvements*"(Saxena, 1998, p. 1). The methods and techniques that are used to improve stakeholder participation represent an alignment facilitating factor in construction projects.

Authors adopting Lean approaches propose the use of methods/techniques such as "*kaizen*" and "3P" in order to improve the participation of client stakeholders in the process of project definition.

Kaizen is a Japanese expression which means continuous improvement. Landry and Beaulieu (2015, p.251) describe it as " *a workshop held for several consecutive days (often four or five), by a team of eight to twelve people representing the various stakeholders, including the supplier and customer, in order to solve a problem and propose a plan of action by the end of the workshop*". Grunden and Hagood (2012) point out that *kaizen* implies continuous

improvement and aims to analyze in detail the current problems and issues at hand, in order to propose the best solutions.

3P refers to product, process, and preparation. The idea in the 3P approach which is also applied in health institutes is to improve processes, systems, and activities in order to propose a better architectural solution according to Grunden and Hagood (2012). Hicks et al. (2015) add that during a 3P workshop, different stakeholders (designers, patients, clinicians, etc.) are involved in the project definition and decision-making process regarding the potential design solution.

These methods /techniques, adapted from or inspired by Lean production, should facilitate the alignment between stakeholders and the understanding of objectives and needs of all the parties. They are proposed to be used to implement the Lean-led Design approach. However, there is no definition of how they can be used simultaneously and what are the steps to implement them in hospitals.

Standardization

Standardization is defined as "*the process of setting generally uniform characteristics of a particular good or service. Standardization is used in order to help the management control, predict and minimize mistakes, and reduce deviation among employees. It also provides a means to maintain reliability and be free of defects*." (Kasiri et al., 2017, p. 92). This was identified as a facilitating factor only in construction area.

According to Grunden and Hagood (2012), developing a standard process represents a key factor of every improvement initiative and a lack of it creates a great deal of loss and it has in fact been widely used to control quality and costs in construction projects (Pennanen et al., 2010). In the Lean context, standardization is used during the early stages in order to facilitate the needs-design solution alignment. It involves the standardization of both project definition and design process, as well as the designed product.

Standardized project definition and the design process facilitate its management since each professional designer follow the same rules (Reijula et al., 2014; Whelton, 2004). Furthermore, standardization of the designed product makes the space much easier and flexible for architects to design by doing things the same way every time (Grunden & Hagood, 2012). In hospital projects, standardization of spaces and rooms should facilitate the development of safer spaces for patients for example by providing efficient and comfortable rooms in terms of size and configuration. An example of that is to always locate the space for family members to the left of the patient.

The reliability that results from a standardized space may sometimes make a life-or-death difference for patients. However, according to Grunden and Hagood (2012) even though standardization of hospital rooms took root in 2002 at St. Joseph Hospital in West Bend, Wisconsin, it still remains largely misunderstood and hard to sell when it comes to medical procedures. That is why, we will try to better understand how this factor is addressed in such projects based on our case study.

Visualization

Visualization refers to the act of representing data in "*a graphical or pictorial way in a clear and effective manner*" (Sadiku et al., 2016, p. 14). Visualization promotes the understanding and thus the communication between stakeholders. It includes the visualization of flows, requirements, designs, workspace, etc. This factor was only identified in construction projects by authors adopting the Lean approach as a facilitator of alignment for all project definition stages.

Hicks et al. (2015) emphasize the importance of visualizing the hospital flows (movements) before starting to calculate the square meters, during the planning stage. Here the objective is to collectively fix glitches, remove trajectories that do not add value, and move ever closer to ideal care by involving the users before coming up with the final design. To do so, several techniques/tools have been proposed such as the spaghetti diagram, value stream mapping (VSM), and mock-ups.

A spaghetti diagram consists of colored strings representing the different flows in a hospital (patients, staff, families and friends, equipment, medication, and information). This enables participants to visualize the flow and understand different design options and alternatives (Hicks et al., 2015). VSM is also a useful tool to visualize the flows and improve movements for instance back and forth inside the healthcare facility (Reijula et al., 2014). Mock-ups, also known as physical models, facilitate visualization and understanding of design solutions resulting in a fruitful discussion about various design options (Grunden & Hagood, 2012).

According to Reijula et al. (2014) and Grunden and Hagood (2012), designing visual workspace (e.g., space for each hospital equipment), during the programming and design stage, provides easy access to tools for the staff and thus saves significant time. Baldauf et al. (2020) highlight the importance of visualizing the information to manage client requirements better and facilitate the understanding of stakeholders. For that purpose, these authors propose the use of Building Information Modeling (BIM). BIM facilitates 3D visualization of sizes and shapes of spaces and their relationships, as well as layering every detail, tracking changes in real time, and making change suggestions by a simple click on a target they wish to alter. This results in improving stakeholder and client understanding of the design by reducing bias and intuition, since clients might not have the ability to read the drawings (architectural details and special arrangements) or understand the notion of scales (Whelton, 2004).

As a result, several tools/techniques have been proposed by the different authors to support visualization, understanding, and communication. Each tool/technique is proposed to be used for a specific purpose and during a specific stage of project definition. This has led us to ask the question about how these tools/techniques are implemented and interconnected during the project definition of a hospital project.

Flexibility

Flexibility is "*an important ability for an organization to restructure its organization constituents in a way that allow the organization to withstand a specific type of uncertainty*"

(Nurdiani, 2015, p. 18). We refer to flexibility in this context as the ability to adapt to the changing needs. It represents in fact, an enabler in IT and construction complex projects.

According to Nurdiani (2015), flexibility represents one of the most important keys for the success of IT-business organizations. Without it, organizations risk losing their competitive advantage. Thus, IT infrastructure should be flexible in order to deliver valuable customized solutions to clients (Luftman, 2004).

Similarly, in the hospital context, Grunden and Hagood (2012) emphasize the importance of designing flexible operation rooms and spaces in order to deal with the highly unpredictable healthcare environment. In fact, medical technology and demographic changes are affecting the number of patients and thus the amount of the hospital rooms. In summary, "*it is impossible to predict future patient activity with a reasonable degree of accuracy*" (de Neufville et al., 2008, p. 8) so designers should be aware of uncertainties about the future demand and prioritize a flexible design as a means of coping with potential changes and adding values in such a volatile environment to better align the needs with the solutions (Tzortzopoulos et al., 2008).

Requirement management software

As previously explained, managing client requirement priorities (see section 3.4.3.1) is recognized as an alignment enabler in definition processes of complex projects in which the objective is to sufficiently and reliably collect client requirements.

In construction projects, authors including Baldauf et al. (2020) propose the use of software platforms such as BIM, dRofus, Solibri in a complimentary manner, in order to facilitate this process. These platforms allow for connecting requirements and the product model by using IFC Open Standard. dRofus enables requirements to be tracked and reused in other projects and Solibri allows for the connection of the requirements to spaces and translating them into parametric rules in order to facilitate automated needs-solution alignment checks. So, this software is proposed to be used since the planning stage in order to manage the requirements well.

3.4.6.2 Hindering factors

The following table summarizes the alignment hindering factors associated with the technology and techniques category.

Table 3.17 Alignment hindering factors: technology and techniques

Hindering factors	IT	Construction	
		Project management	Lean
Lack of resources and time	[1] [2]	[4]	[3] [5]

[1] (Jobarteh et al., 2019), [2] (El-Mekawy et al., 2015), [3] (Whelton & Ballard, 2002), [4] Griffith and Gibson (2001), [5] (Hicks et al., 2015)

Lack of resources and time

Lack of resources involves both human and economical notions. Lack of time refers to the lack of team member availability to work within a targeted project objective and represents an alignment factor in IT and construction areas.

In the IT area, authors including El-Mekawy et al. (2015) and Jobarteh et al. (2019) hold that the lack of a budget and time has a negative impact on the adaptation and implementation of new technologies in an organization.

Similarly, in the project management field, according to Griffith and Gibson (2001) insufficient funding and time to realize the project and control different aspects of project definition, impacts the alignment between the needs and solutions. In fact, lack of time and resources leads to poor quality of work by team members. Whelton and Ballard (2002) add that allocating insufficient time to project definition results in a unreliable definition of client needs. Hicks et al. (2015) confirm this notion and point out that hospital projects are often subject to budgetary constraints that result in limited potential for innovation. This is what we will also investigate in our case study.

3.4.6.3 Summary

The following table (3.18) summarizes the alignment factors associated with the technology and techniques category. In this category, we have identified a total of 6 alignment factors: 5 factors are classified as facilitating and 1 as hindering. The majority of factors found in this category are only identified in construction area (e.g., standardization, participation, etc..).

Table 3.18 Facilitating factors vs. hindering factors: technology and techniques

Technology and techniques			
Facilitating factors		**Hindering factors**	
Factor	**Definition**	**Factor**	**Definition**
Participation methods	Methods used to improve the client 'involvement during the process of project definition	Lack of resources and time	Lack of resources refers to both human and economical ones. Lack of time refers to the lack of team members 'availability to work within a targeted project objective.
Standardization	"The process of setting generally uniform characteristics of a particular good or service" (Kasiri et al., 2017, p. 92)		
Visualization	"A graphical or pictorial way in a clear and effective manner" (Sadiku et al., 2016, p. 14).		
Flexibility	"An important ability for an organization to restructure its organization constituents in a way that allow the organization to withstand specific type of uncertainty" (Nurdiani, 2015, p. 18).		
Requirement management software	Software used to support a good management of the client requirement (clients 'needs in the language of the designers)		

3.4.7 External changes

External changes occur during a project due to its specificity and they increase when the project is complex. In our research, we refer to "external changes" to a category of factors related to external changes that negatively impacts the IT-business, team, and/ or needs-solution alignment. Unlike the other categories, this one only involves hindering factors.

3.4.7.1 Hindering factors

The table below presents the hindering alignment factor associated with the external changes category.

Table 3.19 Alignment hindering factors: external changes

Hindering factors	IT	Construction	
		Project management	Lean
Non-consideration of changing needs	[1]	[3]	
Changes in personnel and/or user		[2] [4]	

[1] (Zhang et al., 2019) [2] (Bingham et al., 2019) [3] (Larsen et al., 2020) [4] (Woods et al., 2017)

Non-consideration of changing needs

Changing needs represents one of the challenges in complex projects, as explained in chapter 1, which is a result of the dynamic market requirements and innovations such as technological changes. In the literature of both IT and construction areas, not considering the dynamic nature of needs represents a well-known hindering factor.

In the IT area, Zhang et al. (2019) point out that inattention to external changes impacts the internal organizational strategies of both IT and business. Along the same line, according to Larsen et al. (2020), rapid changes in hospital projects, due to technological and medical advances, have a significant impact on effective project definition management since innovation tends to happen more often in complex projects (Crotty, 2013). The challenge increases with project duration and size and with more stakeholders involved in the project,

which will make the management the changing needs even harder. As a result, dynamicity of needs represents a characteristic of complex projects. However, a failure of considering it could hinder the achievement of the project goals and thus the alignment.

Changes in personnel and/or user

Changes in personnel and/or user happens, especially in projects with a long duration (Woods et al., 2017). This represents an alignment hindering factor in construction projects. Bingham et al. (2019) argue that an excessive turnover lead to the loss of acquired knowledge and thus, affects project outcomes. This is particularly true when the management approach is participative, which is based on the involvement and engagement of different stakeholders. This means that this factor does not only hinder the alignment but also makes the implementation of participative approaches challenging. One of the solutions to deal with that is to provide a transparent and clear information flow between stakeholders during the process of project definition.

3.4.7.2 Summary

The following table (3.20) summarizes the alignment facilitating factors associated with external changes category. As explained previously, this category involves typically hindering needs-solution alignment factors that could be identified in complex projects such as changes of needs and personnel. Only 2 hindering factors were identified for this category.

Table 3.20 Hindering factors: external changes

External changes	
Hindering factors	
Factor	**Definition**
Non-consideration of changing needs	Non-taking into account the changes of needs related to the dynamic market requirement and component innovation such as changing technological
Changes in personnel and/or user	It refers to how long the personal stay in the project team and the leadership and how often they are replaced.

3.5 Toward a conceptual framework

As discussed earlier, it is widely accepted that needs-solution alignment can be considered a predictor of project success regardless of the area (IT or construction). Since the mechanism to achieve this alignment is important to help managers to take actions, authors in both IT and construction areas have identified key factors that potentially inhibit or facilitate it.

Within the construction area, there is not a big literature about alignment during hospital project definition, especially within the Lean context (9 papers in total). Furthermore, authors adopting the Lean approach do not clearly refer to the term "alignment factor" and most of the alignment inhibitors reviewed here are linked to the implementation of the traditional but not the Lean approach (e.g., Schouten et al. (2020), Smith et al. (2020)). Nevertheless, it seemed necessary for us to include these studies in the current research since authors of these studies adopt a non-traditional and participative approach.

Altogether, based on our systematic review of the literature in this chapter, the results point toward a number of factors that can facilitate or inhibit alignment between IT-business, teams, and needs-design solutions which were classified in seven major categories, as explained in the previous section (see 3.3). The results of this review showed that these different factors are interconnected. We can already identify some links between factors, and it will be interesting to confirm these results empirically. Findings showed also that many hindering factors are the inverse of the facilitating ones (e.g., trust and lack of trust). However, not every facilitator's inverse is a hindering factor (e.g., co-locating the team members) and this is precisely what leads us to create a new subcategory of factors called: influencing. The "Influencing" subcategory refers to the factors that could facilitate or hinder the alignment depending on their presence or absence in the process (influencing factor, e.g., trust). This means that this subcategory is always divided into two parts: facilitating and hindering. Thus, in order to include this new subcategory, we have modified the alignment framework previously presented in the section 3.4 (figure 3.3). Figure 3.4 presents the new conceptual framework developed based on these modifications that will be used as a reference for our case study.

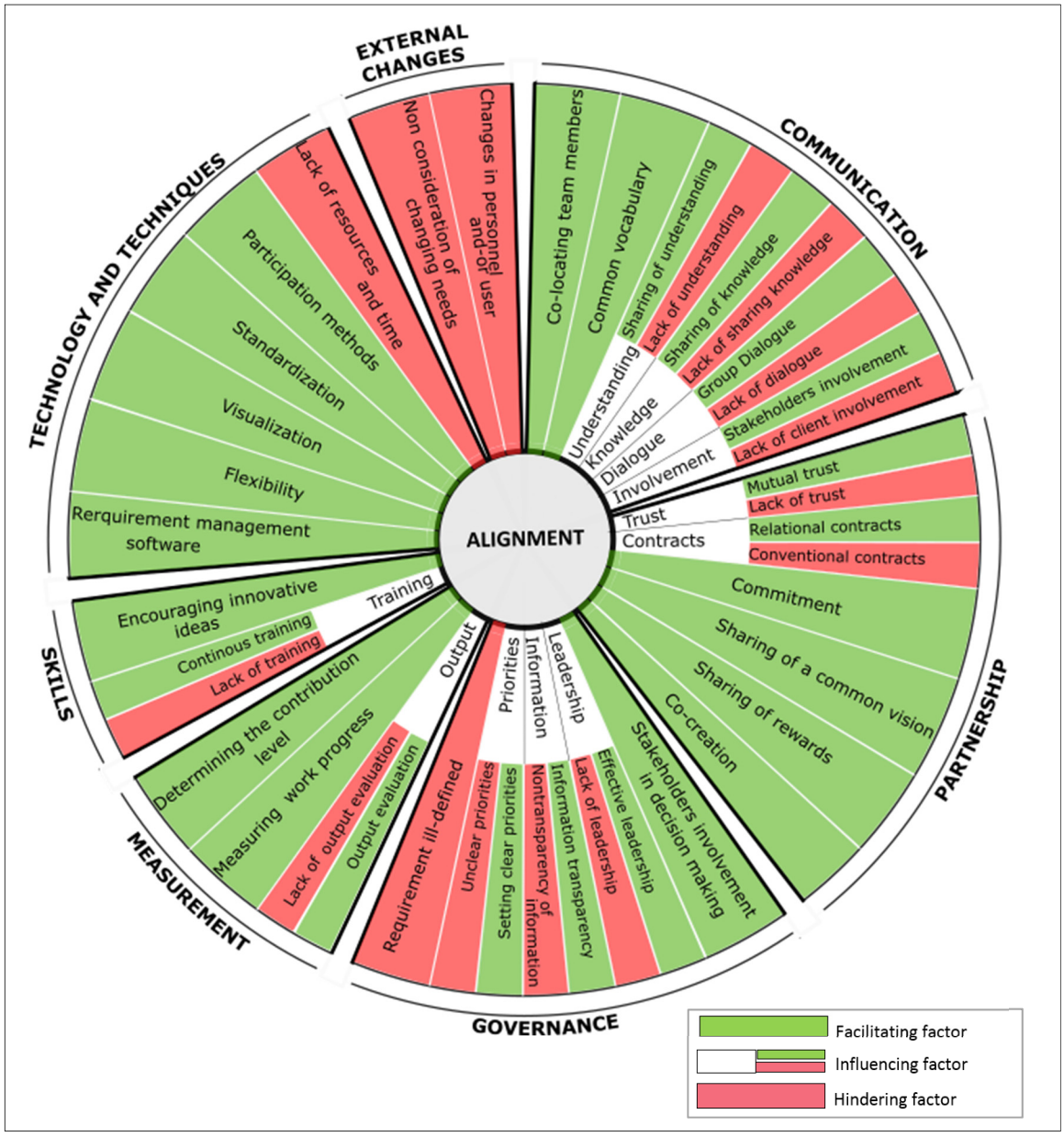


Figure 3.4 Alignment framework modified: 15 facilitating, 11 influencing and 4 hindering

Even though this literature review allowed us to develop a conceptual framework that summarizes the different alignment factors, we cannot assume that it can be generalized for hospital projects in the Lean context, since few papers were found and reviewed in that specific area. The validity of this alignment framework should therefore be investigated in the context of our research. Furthermore, there is a lack of essential details about how alignment factors

should be taken into account during the longitudinal dimension (between the project definition stages). This dimension is usually neglected, despite its importance as highlighted by Alm Lönnefjord and Johansson (2018); Griffith and Gibson (2001). As explained previously (section 3.1), the focus of IT has mostly been on the vertical and horizontal dimensions, namely strategical alignment (Luftman et al., 2017), whereas the focus in construction projects has been on the horizontal dimension, namely team alignment (Bingham et al., 2019). This gap in the literature has also been identified in the Lean context and most authors studying alignment have emphasized only one stage of the project definition (e.g., (Baldauf et al., 2020; Soliman-Junior et al., 2020)) .

Therefore, in order to firstly, evaluate the validity of our conceptual framework (Figure 3.4) in the case of hospitals; and to secondly understand how a longitudinal alignment, between the planning, programming and conceptual design stages, is achieved, we used a Canadian mega-hospital as a case study. In the next section, we present the finding of this empirical study.

CHAPTER 4

NEEDS-SOLUTION ALIGNMENT FACTORS: CASE STUDY

In the previous chapter, we have proposed a conceptual framework that facilitates the understanding of the categories of factors impacting alignment between needs and solutions in IT and construction projects. We felt it necessary to evaluate the validity of this conceptual framework in the context of Lean-led Design (our research context), in the form of a hospital case study, characterized by a complex and dynamic context.

More specifically, this chapter aims to falsify or confirm the validity of the proposed framework based on the qualitative results of our case study. To do so, we identify and analyze the specific factors that are addressed during each stage of the project definition of the mega-hospital project, namely planning, programming, and conceptual design. We will also identify how these factors evolve during the different stages of project definition and then compare these factors with the ones identified in the conceptual framework.

However, in order to be able to identify and analyze the factors addressed in our case study, we felt it was important to firstly present an overview of the project and the various Lean-led Design activities which were implemented.

4.1 Overview of the context of study

Our case study was a mega hospital called *Nouveau complexe hospitalier* (NCH), located in Quebec with an estimated cost of approximately 1,97 G$, announced in 2013 to be delivered in 2026. This hospital will be covering activities of two already existing hospitals in Quebec, namely *Hôpital de l'Enfant-Jésus* (HEJ) and *L'Hôtel-Dieu de Québec* (L'HDQ), on the site of the HEJ. The purpose of this voluntary consolidation is to simplify access to the already existing care management systems, align and reduce the distance between different hospital services, thereby improving the quality of patient care: *"Il est clair que si les deux hôpitaux se mettent ensemble nous allons doubler les avantages: avoir plusieurs spécialistes réunis et*

alignés" (It is clear that if the two hospitals are consolidated, we will double the advantages: having several specialists united and aligned) [project manager]. In fact, the *Nouveau complexe hospitalier* is a component of a larger health facility called *Centre hospitalier universitaire de Québec-Université Laval* (CHU de *Québec-Université Laval*) inaugurated in 2012 seeking to concentrate and align the region's hyper-specialized tertiary-level activities by merging five hospitals: 1) *Centre Hospitalier de l'Université Laval* (CHUL), 2) *Hôpital Saint-François d'Assise* (HSFA), 3) *Hôpital du Saint-Sacrement* (HSS), 4) *Hôpital de l'Enfant-Jésus, and* 5) *L'Hôtel-Dieu de Québec* (Figure 4.1). The merge made CHU *Québec-Université Laval* one of the biggest health facilities in Quebec, ranking among the top three largest in Canada since it provides care and services to over 2 million people in the territories covering eastern Quebec and the northeast of New Brunswick.

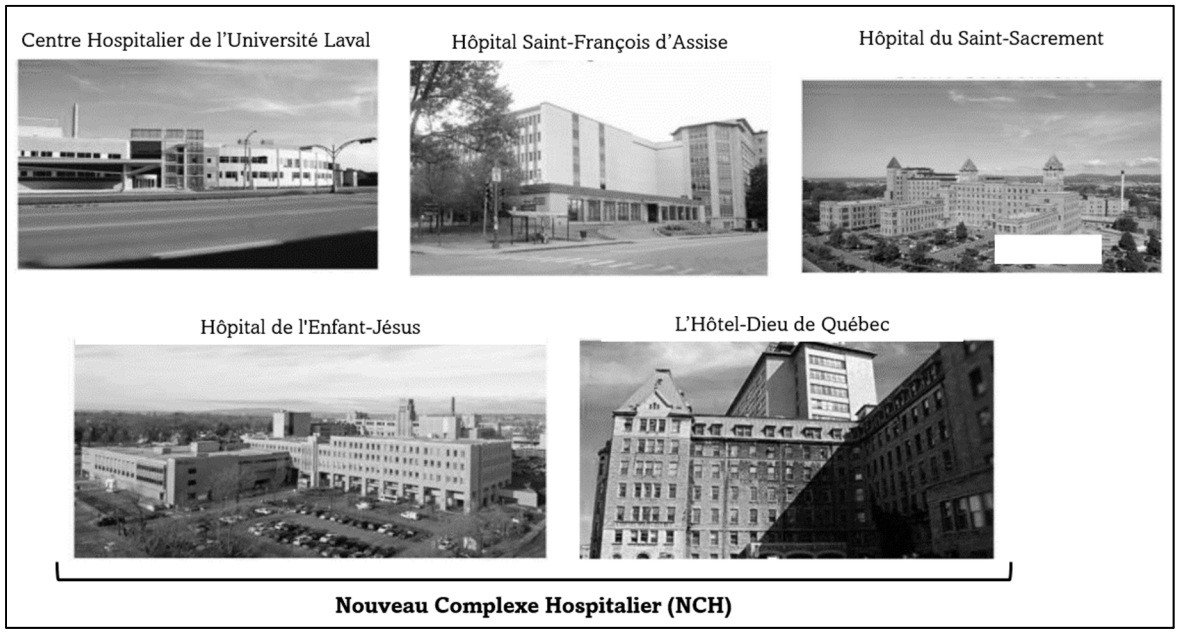


Figure 4.1 The five hospitals forming part of the *CHU de Québec-Université Laval*

Our case study, *Nouveau complexe hospitalier*, is the result of merging two out of five hospitals of CHU de *Québec-Université Laval*. The complexity of this project is not only due to the need for construction of new buildings (180,693 m^2) and the renovation of part of buildings (27 492 m^2), but also maintaining the regular operation of the two already functioning hospitals. Thus,

the project was realized in two different phases using the Construction Management Delivery Mode (Figure 4.2).

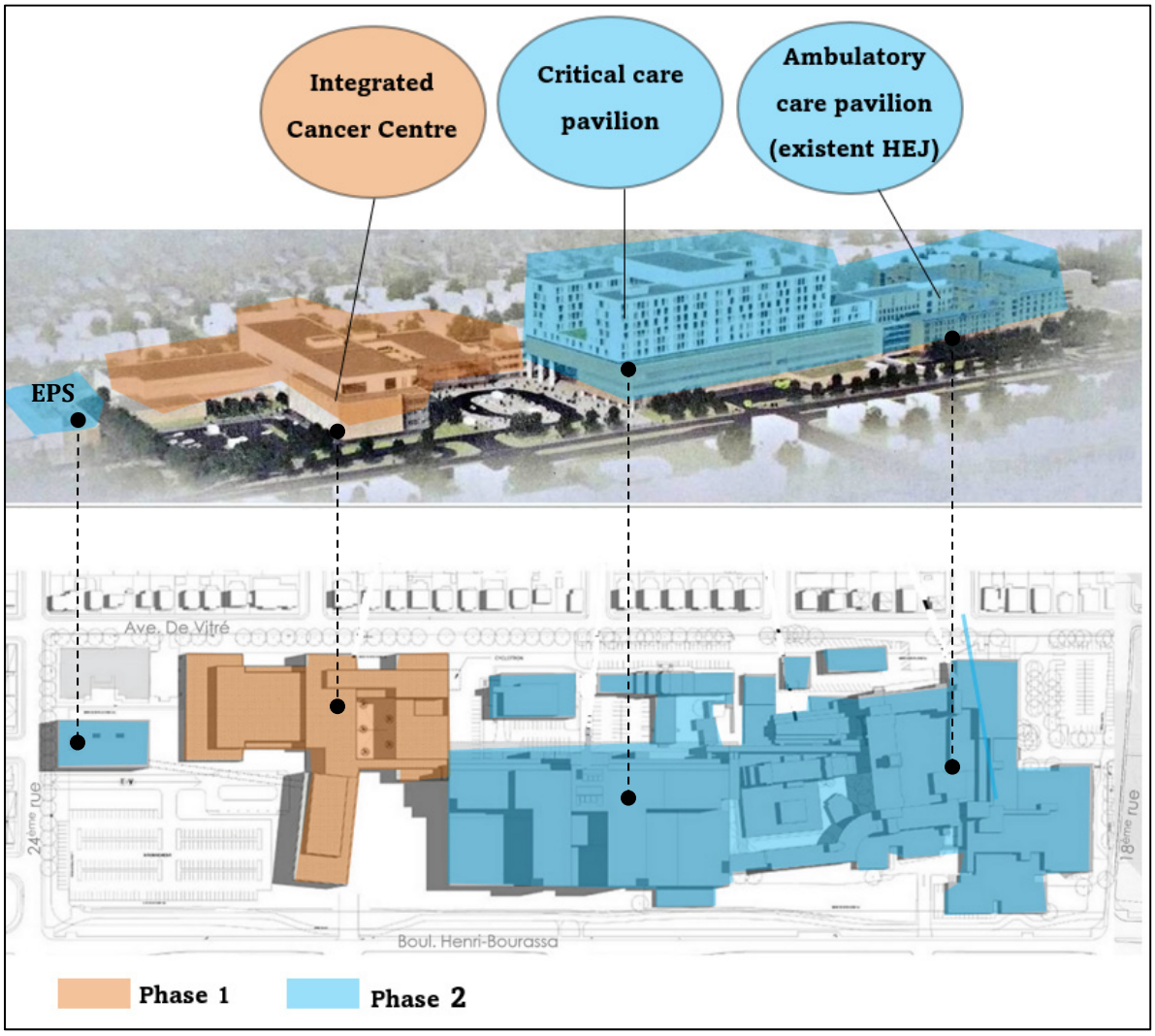


Figure 4.2 Phases of the nouveau complexe hospitalier
Taken from https://www.chudequebec.ca/a-propos-de-nous/nouveau-complexe-hospitalier-(1)/nouveau-complexe-hospitalier.aspx
(Consulted in July 2021)

Phase 1 consisted of construction of an Integrated Cancer Centre (CIC) that includes radiation oncology, cyclotron, and part of the parking area. Phase 2 included the construction of an energy power station (EPS), a critical care pavilion, and the renovation of the existing HEJ (ambulatory care). In fact, the healthcare system in Quebec City has been facing difficulties

regarding radiotherapy equipment reaching the end of their lifecycle. So, it was important to firstly start the Cancer Center as a priority: "*La première phase était faite en urgence. On avait un besoin urgent au Québec"* (The first phase was realized as an emergency. We had an urgent need in Quebec) [project manager]. This explains why the project has been divided into two phases and why the first phase just includes the new Integrated Cancer Centre and the second phase of the other buildings.

In order to compress the timeline and deliver the buildings of phase 1 quickly, the project was realized in a "Fast-tracking" manner. This means that the activities of design and construction were carried out simultaneously, instead of waiting for each task to be completed separately. To do so, the project was divided into components (for design purposes) and lots (for construction purposes) making a total of 13 components. A lot could be one or two components or also 50% of a component. For instance, the Integrated Cancer Centre represents one component and also one lot. The BIM technology was used in order to better manage the design of components and the construction processes. In fact, the total combined number of models used until spring 2020 was more than 400 for all disciplines, with 37 related to the design discipline.

Furthermore, more than 220 people were co-located near the project site for the purpose of better collaboration and communication. It is true that *project office* is a common practice for a major project, however, the particularity of this project required the addition of clinical managers (voice of the users) to the management organizational structure*:" Notre direction clinique est mixée avec les architectes et les ingénieurs, même le gestionnaire de projet est avec nous. On est un trio fort. Sans le bureau de projet, ça aurait été beaucoup plus difficile* " (Our clinical management is formed by architects and engineers, even the project manager is with us. We're a strong trio. Without the project office, it would have been much more difficult) [member of the NCH clinical management team]. Figure 4.3 represents information regarding stakeholders' co-location.

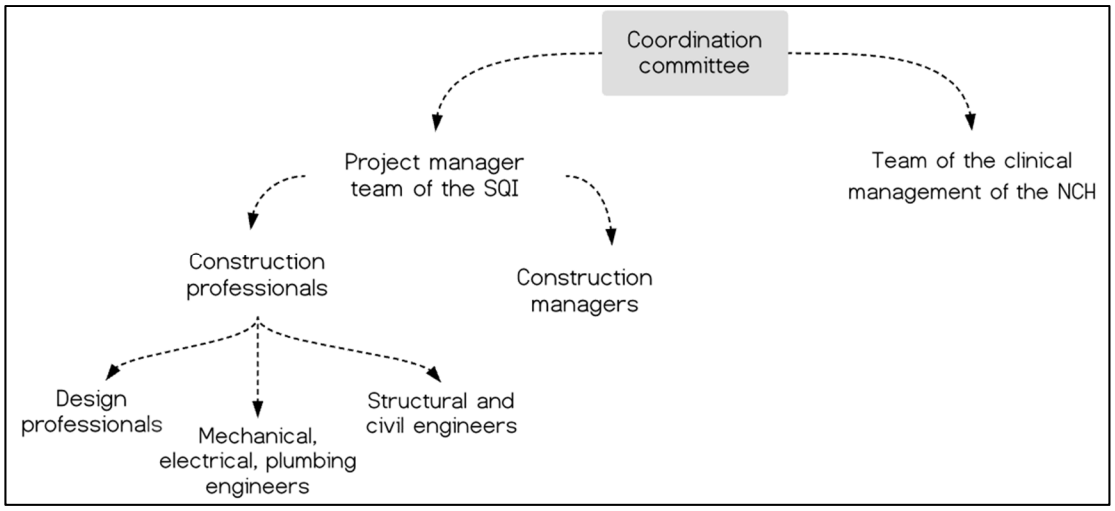


Figure 4.3 Co-located stakeholders: the project office of NCH

In this project, the project manager team, the construction professionals, and a team of the clinical management of NCH collaborated during the whole project in order to generate client value. The project manager team, who represents the *Société québécoise des infrastructures* (SQI), was assigned by the Minister of Health and Social Services of Quebec (MHSS) to manage the budget and schedules during the whole project. SQI is a public entity responsible for advising the government on public infrastructure projects as well as being responsible for subcontracting construction professionals. The clinical management team of NCH remains responsible for clinical and technical dimensions of the amalgamation of HEJ and L'HDQ hospitals. However, there were obvious issues regarding maintaining the already active healthcare services offered by both hospitals. To deal with these issues, the clinical management team members of NCH adopted the Lean-led Design Design approach during the project definition stages.

This approach was implemented in order to reduce the complexity of merging the two hospitals, since each had its own vision, culture, and operational approach to deliver healthcare services: "*Ce n'est pas évident, car même les médecins de la même spécialité ont de différents points de vue: côté clinique et technique. Chaque hôpital à une façon de travail différente"* (This is not easy, because even doctors in the same specialty have different points of view: clinical and technical side. Each hospital has a different way of working) [clinical manager of

the NCH]. The objective was to first align the visions of both hospitals by using an inclusive participative approach, before starting to design the new hospital.

However, before presenting how this approach meshes with the project definition process, it is worth presenting the conventional process of project definition in hospital projects of Quebec; the main output of each project definition stage and documents required by the Ministry of Health and Social Services of Quebec (MHSSQ).

4.2 Project definition in conventional practices: Outputs and deliverables

As shown in figure 4.4, there are three stages of project definition: 1) planning, 2) programming, and 3) preliminary (or conceptual) design. Each stage aims to produce an output with the planning stage aiming to produce the clinical plan, programming stage to produce the functional and technical program (FTP), and the preliminary design stage to produce the conceptual and schematic design. In addition to these outputs, there is an important deliverable required by the Council of Ministers, knows as "*dossier d'opportunité*." In the next sections, more details about the project definition stages and their outputs in the conventional practice will be presented.

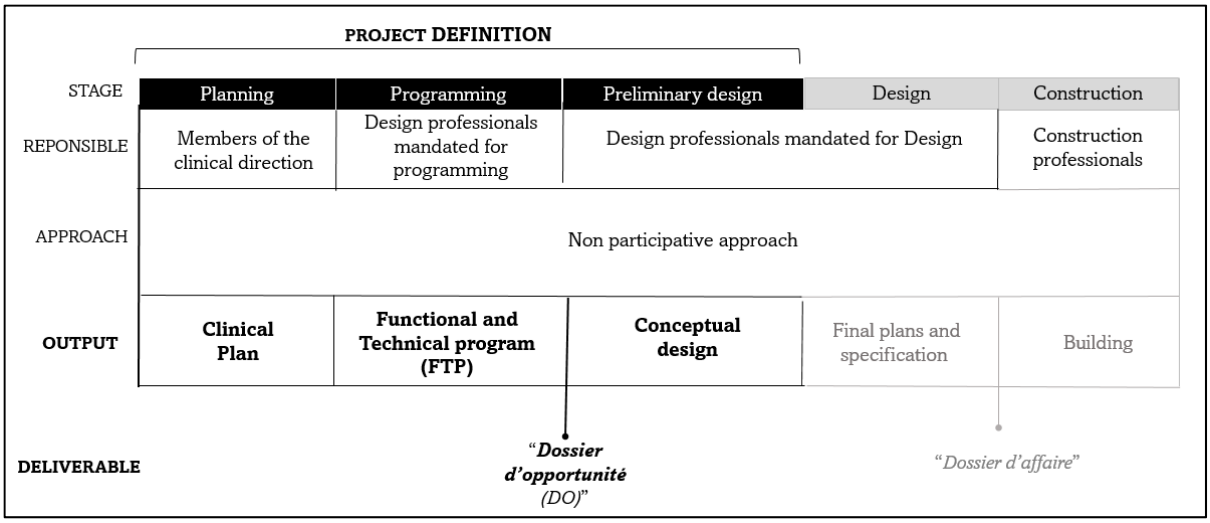


Figure 4.4 Project definition: stages, outputs and deliverable

4.2.1 Planning stage: clinical plan

The main objective of the planning stage is to produce the clinical plan. This document, required by the Ministry of Health and Social Services of Quebec (MHSSQ), provides a snapshot of the current state of care and services and gives an estimate of clinical activities in the next 15 or 20 years to determine the future potential needs of clients. This projection in conventional practices is made by the main clinical managers of the hospital, assisted by other expert consultants, using past statistics, estimates of the aging trend of the population. The projection of future needs aims to estimate the main medical requirements in a time point in the future for example, the number and type of rooms and beds.

Once this process is finished and the clinical plan is drafted and approved by the Ministry of Health and Social Services of Québec, the programming stage starts.

4.2.2 Programming stage: Functional and Technical Program (FTP)

The main input of this stage is the clinical plan. The conventional approach usually used by the SQI during the project definition consists of hiring design professionals to identify client needs and translate them into a set of requirements in a document, namely the Functional and Technical Program (FTP). The functional component defines the operating diagram (bubble diagrams), the required premises, and their surface area, while the technical component presents the costs, schedules, risks, and technical sheets. This document is indeed used as the main reference for designers to translate functional and technical requirements into a specific design. It is also used to produce the "*Dossier d'opportunité*", required by the Quebec Council of Ministers (Treasury Board Secretariat, 2014).

Dossier d'opportunité (DO)

This document provides the financial approvals required to move to the preliminary and then final design stages. The DO defines all the technical needs and requirements. However, unlike the FTP, it should allow the assessment of the relevance of the project while considering not

only the costs but also deadlines. The approval of this document by the Council of Ministers represents an important deliverable to move to the preliminary design stage.

4.2.3 Preliminary design stage: Concept

The conceptual design and final plans are usually realized by design professionals in a non-participative approach mandated by the SQI. After presenting the conventional process in hospital projects in Quebec, in the next section we will present how this process has been modified by members of the clinical management of the NCH.

4.3 Project definition in the NCH

In the NCH project, seven Lean activities, also called "*kaizen*" and "3P", were implemented, however, just five correspond to the project definition stage. As shown in the Figure 4.5, those five activities were organized during the planning and the programming stages, between 2014 and 2015, in order to develop the clinical plan and the Technical and functional program respectively. During the preliminary design stage, a non-participative approach was, however, adopted in order to develop the conceptual and schematic designs. Thus, following a chronological order, in next sections the process by which the output of each stage was developed will be presented, starting from developing the input of the planning stage: "*dossier d'orientation*".

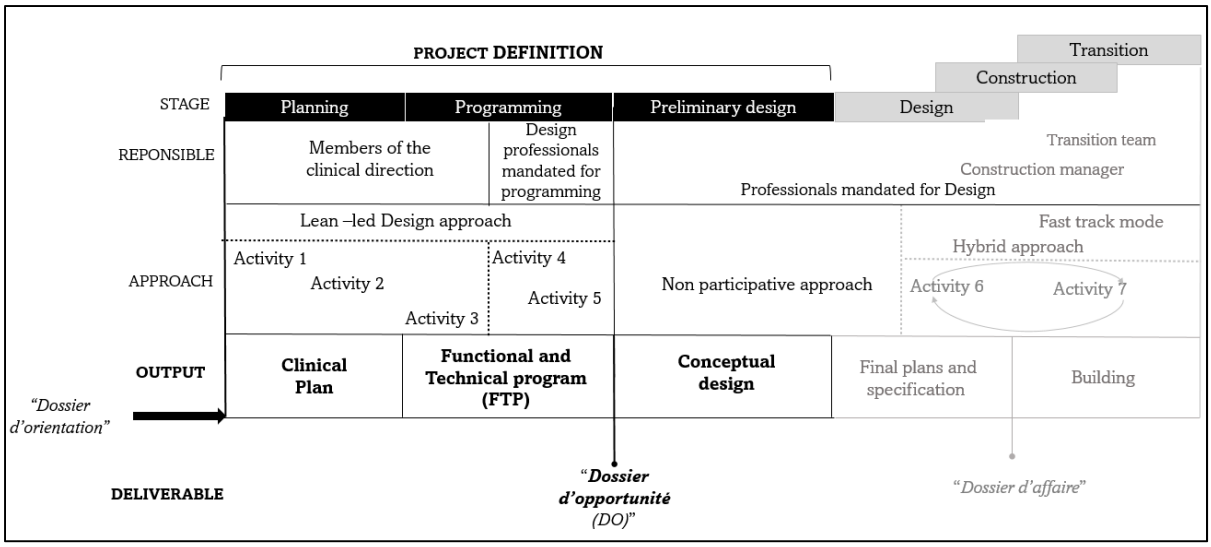


Figure 4.5 Project definition in NCH project

Dossier d'orientation

According to the new " Directive on the Management of Major Public Infrastructure Projects" (Directive) under Article 18 of « the Infrastructure Law», *Dossier d'orientation* is not required by the Council of Ministers. The objective of this document is to present the investigations that support the selection of the NCH site which aimed to align the activities of both L'HDQ and HEJ hospitals, thus evaluating the feasibility of the project. This process does not represent the programming stage, since it is providing a high-level but preliminary picture of the project.

More than 20 members of the NCH clinical management team, comprised of engineers, BIM resources, estimators, and architectural technicians, spent 8 weeks in 2013 to develop this document. Besides identifying the site's potential, interviews with users of HEJ and HDQ were conducted by the same team. The objective was to identify the advantages and disadvantages of the consolidation of clinical services of the two hospitals (HEJ, L'HDQ). Therefore, 10 different meetings with clinical service members were held to cover different topics. The duration of each meeting was between 2 to 3 hours and participants had to present their intentions and needs after 3 to 4 weeks.

Also in 2013, the SQI performed a comparative study, as well as developing technical guidance reports regarding hygiene of the HEJ site, trying to estimate the future needs of NCH.

The *dossier orientation* was developed based on these two investigations and was used as an important input for the elaboration of the clinical plan and starting the planning stage, thus the first Lean activities. As shown in figure 4.6, the first three Lean activities were organized by members of the clinical management team (approx. 12), the other three activities were mainly organized by 10 designers mandated for the programming stage along with Lean agents (approx. 10). Furthermore, each Lean activity could be one *kaizen* or more. For instance, activity 1 represents *kaizen* 1, Activity 2 represents *kaizen* 2a and *kaizen* 2b. Next section explains in detail the activities realized in each stage of the project definition.

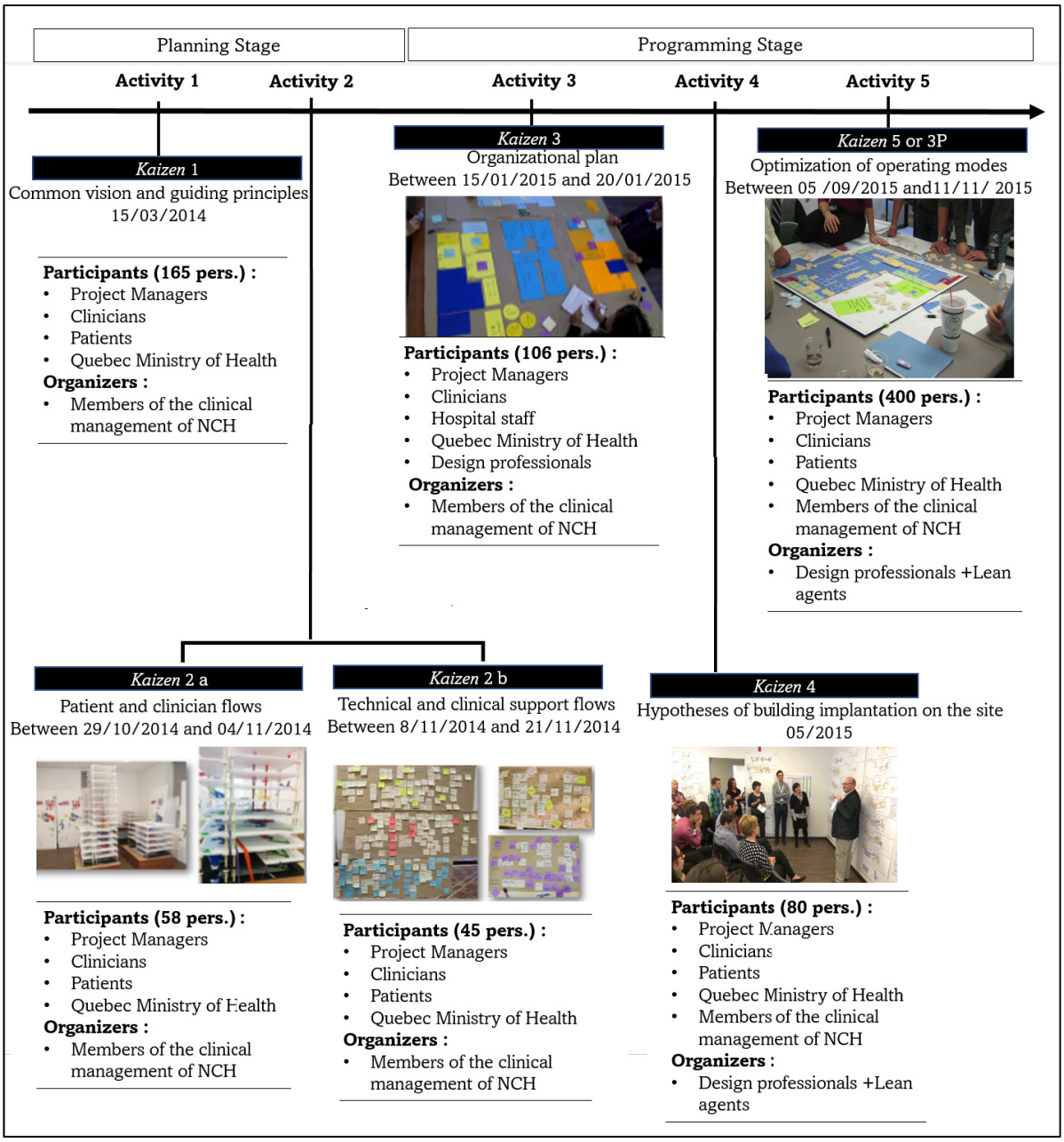


Figure 4.6 Different Lean activities implemented during the project definition of the NCH

4.3.1 Planning stage: Clinical Plan

In the NCH project, before estimating the needs of the new hospital, the focus was first on aligning the visions and different flows of both hospitals. To do so, two Lean activities were organized: *kaizen* 1 and *kaizen* 2 (a and b).

Activity 1: Developing a common vision

One of the first priorities of NCH clinical management members was to create a common vision of the project between teams from the two merging hospitals. Thus, the first Lean activity was *kaizen* 1, organized on 15th of March 2014. More than one hundred- and sixty people including external observers from Quebec Ministry of Health, project managers and clinicians along with patients, participated in the event. The selection of the patients who participated during this *kaizen* and the other ones was based on a database of volunteers, as explained by a member of the clinical management team: "*on a des bases de volontaires et on a un comité qu'on appelle repérage intuitif qui fait la sélection*" (we have volunteer bases, and we have a committee called intuitive tracking that makes the selection). Most of the patient participated suffers from chronic illness (e.g., kidney disease, mobility reduced, etc.). However, due to the difficulty of recruiting them, these patients do not represent all hospital departments.

Therefore, the participants were divided in seventeen round tables and were invited to discuss about six major themes proposed by the clinical management team members: 1) patient experience and access to services, 2) care and best practices, 3) teaching, research, and evaluation of health technologies, 4) environment and support services, 5) human resources, 6) Hospital as a Corporate Citizen.

Based on this perspective, several ideas were proposed in the brainstorming session and then transcribed, from which twenty-five guiding principles were derived: "*Ces principes représentent des éléments qui guideront les prises de décisions*" (These principles represent elements that will guide decision-making) [patient]. These guiding principles constitute the benchmarks to guide consistent decision-making not only in the project definition process but also in design and construction stages. Therefore, the first *kaizen* represents an important step as it provides a shared understanding and the widest possible consensus on project objectives*: "ceci nous a permis de débattre entre cliniciens afin d'avoir une vision plus claire et commune."* (this allowed us to debate between clinicians in order to have a clearer and common vision) [clinician]. The second activity was organized based on the output of the first.

Activity 2: Improving the flows

One of the particularities of Lean-led Design is the analysis of the seven flows in hospitals (patients, staff, visitors, supplies, equipment, medication, and information). The importance of this analysis is to align and improve the current flows of both hospitals before calculating the square meters or proposing a conceptual design of the new hospital. Activity 2 was composed of two parts: *kaizen* 2a and *kaizen* 2b. The first part focuses on patient and clinician flows and the second part focuses on the technical and clinical support flows.

- **Kaizen 2a: Patient and clinician' flows**

Kaizen 2a was organized for five successive days exactly during the days 29, 30, 31 October and the 3rd and 4th of November 2014 focusing on clinical aspects. In this kaizen more than fifty-eight persons participated including doctors, clinical staff, heads of both hospitals (HEJ and HDQ), responsible teams for the clinical plan elaboration, managers of SQI, MHSS representer as observers, and three patients who shared their experience. These participants were divided into four interdisciplinary groups with representants of each hospital. Figure 4.7 represents different objectives and steps followed during this *kaizen.*

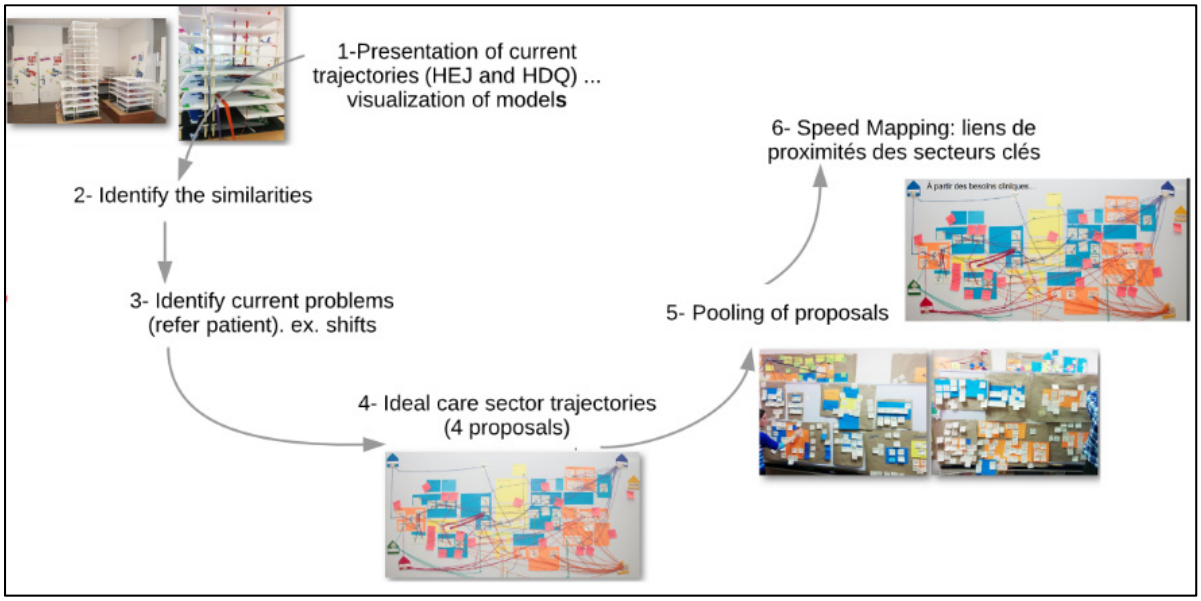


Figure 4.7 The followed steps during *kaizen* 2a: Patient and clinician 'flows

The first objective was to illustrate current care flow of five fictitious patients' representative of 80% of the sectors including one exclusive to each hospital. After that, the second step was to classify the identified problems based on the scenario. The objective was to understand the similarities and differences between HEJ and HDQ. In fact, several similarities were noted, in particular regarding bed management, access to hospital services, technical facilities, displacements, loss of time in the form of waiting for services, and lack of appointment synchronization.

Based on these classifications, participants were led to think about the best way to create unified trajectories and efficiently organize the care sectors. This reflection was based on the twenty-five guiding principles that had been identified during *kaizen* 1, such as putting the patient at the center of the care episode, making staff and technical equipment available to meet the needs of patients thus reducing the waiting time, optimizing, and creating secure trajectories, and promoting information and care continuity to facilitate patient trajectory.

All participants worked together, and the solutions were pooled and represented in two ways. The first one was a simplified visual mapping and the second one a scale model. These representations helped participants identify three large area activities: critical, hospital, and ambulatory. Therefore, the objective of this *kaizen* was to deliver a unified vision of the future hospital complex without considering the current physical and organizational constraints but in accordance with the project scope. During the next Lean activities, this vision will evolve towards a model that will be clarified at each stage.

- **Kaizen 2b: Technical and clinical support flows**

After aligning and improving the patient and clinician flows, the objective of the second part of activity 2 was to align the three other logistic processes and flows: medicines, material, and information. This activity was organized for four days, between 18th and 21st of November, 2014. More than forty-five people including SQI managers, MHSS representer as observers, and staffs of both hospitals from different services such as laboratory, technical and logistical services, IT, and food, participated in the event.

In order to achieve the objective of this kaizen, NCH clinical management organizers followed the same process of *kaizen* 2a, as shown in Figure 4.8.

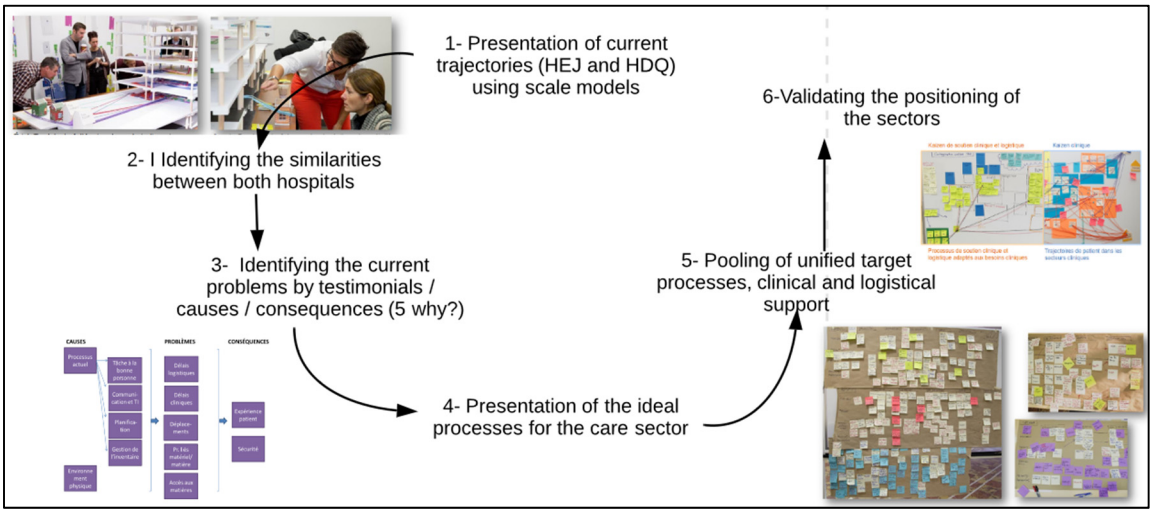


Figure 4.8 The followed steps during *kaizen* 2b: Technical and clinical support flows

They started by evaluating current logistical flows of both hospitals and then identifying the similarities and current problems of each situation before unifying and improving the logistical processes thus making them invisible for clinicians, enabling the opportunity to deliver the best health services to patients. By making the providers of services working together, a shared understanding and common vision were created. This exercise also helped to reduce the distances between the different hospital services: "*on a réussi à concentrer les secteurs. Par exemple, pour le secteur ambulatoire le personnel va se déplacer beaucoup moins puisque le stationnement est tout près du service."* (we managed to concentrate the sectors. For example, for the outpatient sector, the staff will travel much less since the parking lot is very close to the service) [Member of the NCH clinical management team].

Therefore, at the end of activity 2 (22 December 2014), a clinical plan was co-created by users, members of clinical management of NCH, and designers. In fact, at the beginning the clinical plan was written only by external persons, however, "*ils ne l'ont pas bien rédigé parce qu'il n'ont pas compris très bien les secteurs cliniques "*(they didn't write it well because they didn't understand the clinical areas very well) [member of the NCH clinical management team].

That's why it was written again by involving users. Further, another complexity when drafting this document was related to the fact that *"le guide de développement du plan clinique du ministère de la Santé est nouveau. On était les premiers à l'utiliser. On n'avait pas de référence à suivre" (*the Ministry of Health's clinical plan development guide is new. We were the first to use it. We had no reference to follow) [member of the NCH clinical management team]. This means that the clinical management team members did not have any reference, in order to produce such document. In February 2015, experts of the Ministry of Health and Social Services of Québec based their decisions on this draft. The next document was consequently developed by FTP based on this decision.

4.3.2 Programming stage: Functional and Technical program

In order to realize the functional and technical program, three Lean activities (i.e., activity 3,4, and 5) were organized.

Activity 3: Organizational plan

This activity refers to *kaizen* 3 involving eighty participants including clinicians, patient representatives, project managers, and members of NCH clinical management team.

After aligning the flows of both hospitals, this *kaizen* aimed to identify the needs of proximity and prioritize them:*" on priorisait les types de clientèle et non pas des secteurs. Par exemple: la clientèle est accordée à la clientèle qui a besoin des soins critiques puis à l'hospitalisation et en fin aux soins ambulatoires"* (we prioritized the types of clientele and not sectors. For example: clientele is given to clients who need critical care, followed by hospitalization and, finally, outpatient care) [member of the NCH clinical management team]. The objective is to reduce the distances between different sectors by putting the patient at the center of the reflection. The first step was to analyze, document, and prioritize according to the proximity needs of the areas in the clinical plan and their importance according to the patient flow, already identified in *kaizen* 2, while taking into account the clinical and technical constraints.

The second and third steps aim to illustrate and improve the different existing scenarios of each sector (Figure 4.9).

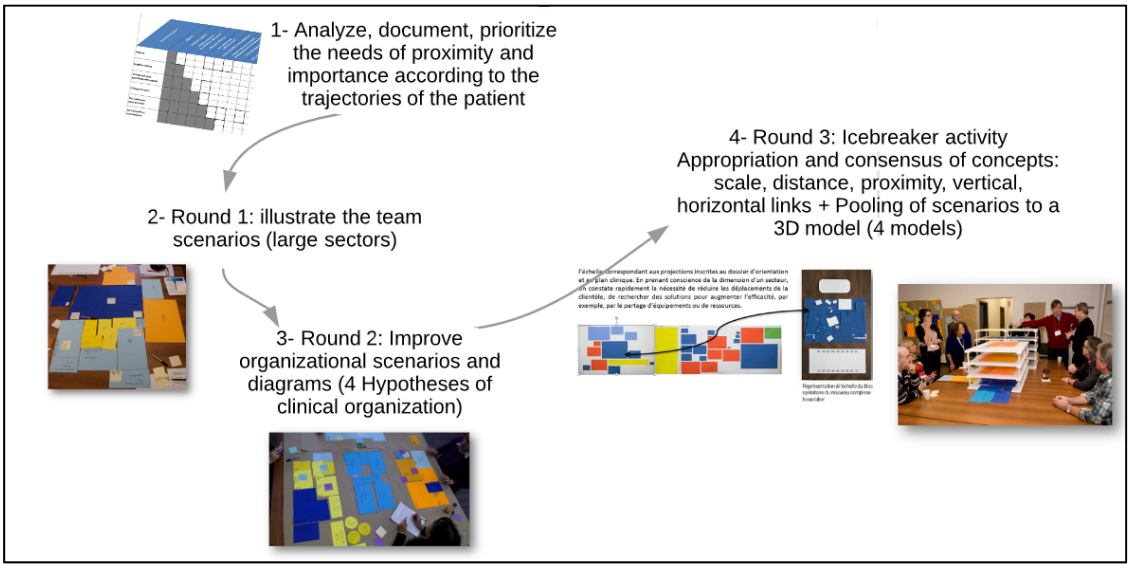


Figure 4.9 Steps followed during the *kaizen* 3: organizational plan

Moreover, at this stage the vocabulary regarding scale (area, square meters, etc.) was introduced to facilitate a mutual understanding and perception of user spaces. To this end, the organizers of *kaizen* 3 used reference points such as a football field, an ice rink, etc. Thanks to a better comprehension of the dimensions of each area, participants were able to quickly see the need to reduce patient movement and organize the essential activities and services in a more efficient manner. On this organizational basis, three types of links were identified between different sectors: critical, essential, important, or desirable. These links were assessed using a weighted and objective grid to develop an organizational plan. Subsequently, this pattern was improved during the complementary workshops by the clinical management team in collaboration with logistical support team. The aim was to achieve the best possible organizational plan, so all of this work served as the basis for the development of hypotheses regarding the implementation of a functional and technical program.

Activity 4: Hypotheses of building implantation on the site

At this stage, architects had integrated the project definition process through the last two activities (4 and 5), although the clinical management team continued to attend and supervise the process: "*les professionnels étaient les animateurs"* (The professionals were the animators) [member of the NCH clinical management team]. Before *kaizen* 4, designers had translated the organizational plan which was delivered during *kaizen* 3, into five hypotheses regarding the location of the different sectors of the site. These were developed from dozens of studies by testing different ways of locating the sectors and taking into account the constraints of the land as well as the existing buildings on the site. Figure 4.10 presents one of those hypotheses.

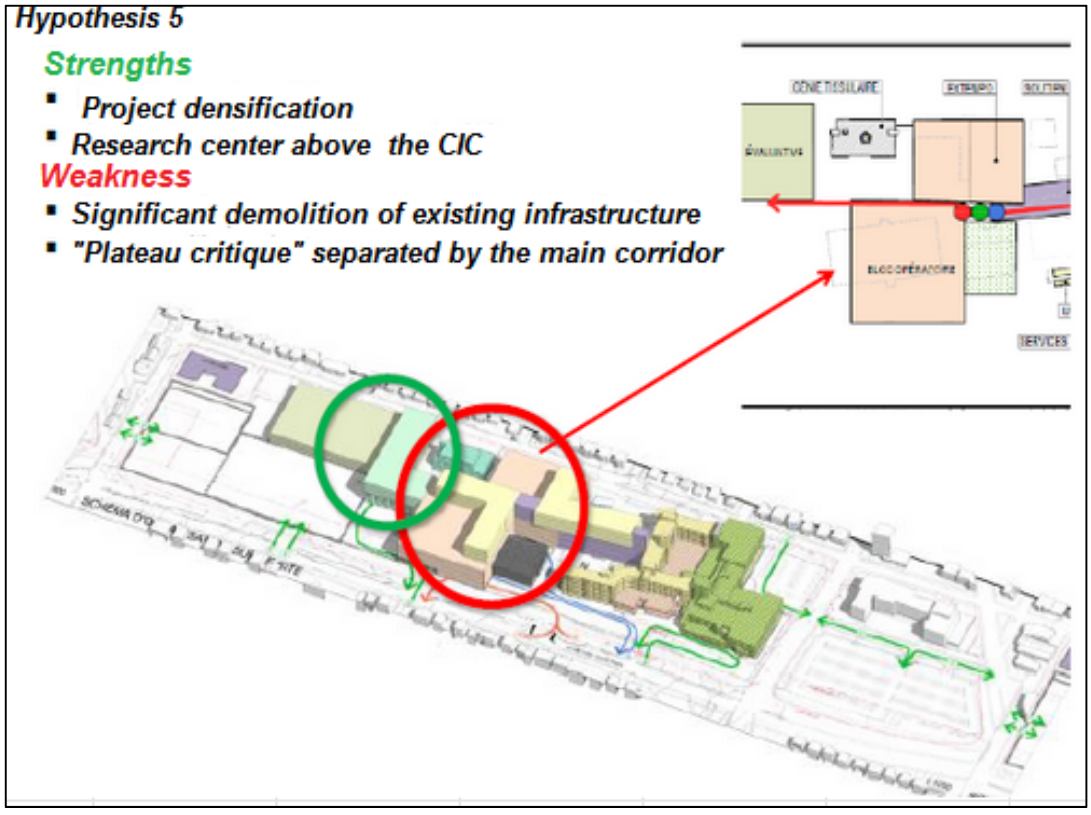


Figure 4.10 One of the five hypothesis proposed for the NCH project

Activity 4 represents *kaizen* 4 which took place in May 2015 and included architects, clinicians, managers, and clinical management team members. The purpose of this *kaizen* was to evaluate the five implantation hypotheses and identify the one to retain for the rest of the

project. This *kaizen* empowered users by involving them in the process of decision-making. To facilitate these decisions, an evaluation grid was proposed based on clinical and technical criteria. These criteria were in fact the twenty-five guiding principles which were developed during *kaizen* 1 plus the links between sectors which were developed in the previous *kaizen*. Based on this initial evaluation, designers reviewed the implantation hypotheses and after two days of work, proposed two more. The latter two were re-evaluated and commented on, which allowed for the development of a single reference hypothesis for the implantation of the different sectors of the hospital.

Several complementary workshops were organized among the designers after *kaizen* 4. Here the objective was to continue to improve and adjust baseline implementation hypotheses by exploring the operating methods of about 20 hospital sectors. In fact, this step aimed at comparing and aligning current operational clinical methods with the implementation hypotheses developed during *kaizen* 4. This allowed professionals to propose physical planning standards, confirm the revised operating model, and establish a list of validated and optimized needs (spaces, resources, and main required equipment).

Activity 5: Optimization of operating modes

Following all this pre-work, designers organized activity 5 also called "kaizen 5" and "3P workshop (patient, process, preparation)", in five consecutive phases between September and November 2015 to continue the validation and the alignment of the business models regarding each sector. More than four hundred participants including clinicians, managers, patients, and members of the clinical management team were involved. The objective was to continue the validation and the alignment of the business models of the sectors: " *l'objectif est de valider le positionnement des secteurs et des locaux les uns par rapport aux autres. Ce positionnement a été la base pour réaliser les plans*" (The objective is to validate the positioning of sectors and premises in relation to each other. This positioning was the basis for carrying out the plans) [Design professional mandated for programming stage].

To do so, the first part was based on optimizing patient experience and use of space, which aligned and validated the whole [or part of] the operation model of different sectors. This exercise was realized by using 10 full-scale mock-up (Figure 4.11). The idea is to reproduce

standardized rooms in an environment mock-up on a small scale to facilitate the understanding of spaces for participants, using removable walls. The rooms presented in the full-scale mock-up were often "standard rooms" or particular rooms, for instance, rooms in a care unit, intensive care units, examination rooms, etc. The second part of the 3P was intended to allow the participants from the previous kaizen to appreciate the evolution of the improved organizational plan of the new hospital and to provide feedback. In addition, it ensured that the implementation hypotheses regarding the site are aligned with the user needs (developed during kaizen 4). At the end of 3P, an open house event was organized to let a wider range of audience visit the full-scale models and become familiar with the Lean approach.

Figure 4.11 An example of a full-scale model used during the project definition stage of NCH

As a result of this iterative and progressive work, the Functional and Technical program (FTP) was drafted by the designers mandated for the programming stage and submitted to the MHSS. However, this document was written a second time, after its analysis by experts of the Ministry of Health and Social Services of Québec.In fact, the reason of this rework was not really identified. While project managers claim that the problem was related to the lack of knowing how to develop such document (see. 4.4.6.3), members of the NCH clinical management team

explain that the problem was more related to the confusion between the traditional and Lean approach: "*il y avait une confusion entre nos deux façons de livrer nos réflexions: traditionnelle vs Lean. Au début on avait rédigé un document Lean mais le ministère n'était pas satisfait. On l'a donc bonifié pour aller chercher le côté traditionnel"* (There was a confusion between our two ways of delivering our thoughts: traditional vs Lean. At the beginning we had drafted a Lean document, but the department was not satisfied. We therefore improved it to go for the traditional side) [member of the NCH clinical management team]. After this modification, the FTP was approved. However, this document is not static*: "On a changé des parties du PFT pour s'assurer justement de l'évolution dans le temps: de la technologie et les méthodes que les médecins peuvent avoir.* C'est *un document évolutif et non pas statique" (*We changed parts of the PFT to ensure precisely the evolution over time: of the technology and the methods that doctors may have. It is a living document and not a static one) [mechanical engineer]. On the basis of the FTP, the *dossier d'opportunité* (DO) was developed.

Dossier d'opportunité (DO) in the NCH

This document was developed by SQI in collaboration with design professionals and members of the NCH clinical management team, and then submitted to the Secretariat of the Treasury Board in December 2015. After the approval of the DO, a tender was launched to select new designers to continue the conceptual and design stages. This means that the majority of the design professionals mandated to carry out the functional and technical programs were different from those mandated to carry out the architectural propositions: "*ce n'est pas les mêmes concepteurs que ceux de la phase de la programmation, mais on était chanceux, car il y avait des personnes qui ont vécu avec nous les activités Lean"*(it's not the same designers as during the programming phase, but we were lucky, because some of them have participated in Lean activities) [member of the NCH clinical management team].

4.3.3 Conceptual design stage: schematic design solution

The conceptual design stage started at the beginning of 2016. Unlike the previous stages, in the conceptual design stage as well as the design stage, a non-participatory approach was used, so users were not involved: "*On revient au traditionnel, car les concepteurs sont plus à l'aise*

avec ce mode de travail" (We are going back to the traditional, because designers are more comfortable with this way of working) [member of the NCH clinical management team]. By the end of these two stages, the established departments are no longer movable, and the design is frozen.

As this project was realized in a fast-track mode and divided into different components, once the architectural plan of the first component, namely the CIC building was finished, new Lean activities, *kaizen* 6 and *kaizen* 7, started in parallel to the design stage. They started exactly at the end of 2016 and are expected to continue until full delivery of the project in 2026. However, unlike the previous *kaizen*, they are not very often organized since they are based on an iterative process depending on the progress of the project and specific expressed needs.

In such mega-hospital, preparing for moving to the new building is a complex process that takes years since the different department existing are interconnected. A lack of preparation may lead to several problems: *"par exemple le fait que les hôpitaux CHUM et le CUZUM n'avaient pas fait de transformation de leurs pratiques, ceci a créé beaucoup de problématique lors des transferts des activités (les médicaments ne sont pas unifiés, les feuilles non plus, etc.)"* (for example, the fact that the CHUM hospitals and CUZUM had not transformed their practices created a lot of problems during the transfer of activities (the drugs are not unified, the sheets either, etc.) [member of the NCH clinical management team]. The objective of these Lean activities was thus to prepare both the transformation (*kaizen* 6) and the transition (*kaizen* 7) of the hospital staff. In such a mega-hospital, the transformation and the transition are complex processes and can take years of preparation since the different existing departments are interconnected. While in the transformation process, we are interested to understand how to transform the activities of both hospitals and align them with the new designs so that after moving to the new setting, there will be no major hardships, the main question in the transition process is: What are the steps to follow in order to move out to the new setting while keeping the continuity of care for patients?

Therefore, to achieve the objectives of those Lean activities, a clinical management team, namely "transition team" took up the leading position along with some designers and agents for the transformation: "*cette équipe était formée pour préparer la transition vers les bâtiments du NCH* " (This team was formed to prepare for the transition to the NCH buildings) [member of the NCH clinical management team]. This team mobilized different hospital staff during the years to help them develop the required skills for changes in the workspace and innovations.

However, according to a clinical manager, it was sometimes challenging to realize this exercise since "*par exemple pour le centre de cancérologie, on voulait commencer tôt, les projets pilotes avec l'équipe clinique afin de revoir le mode de fonctionnement. Cependant, les espaces physiques des bâtiments existants ne permettaient pas de revoir tous les modes de fonctionnement. On était donc obligé d'attendre que certains bâtiments du NCH finissent d'être construits pour le faire*"*(*for example, for the cancer center, we wanted to start early pilot projects with the clinical team in order to review the way it works. However, the physical spaces of the existing buildings did not make it possible to review all the modes of operation. We therefore had to wait until some NCH buildings were finished to do so) [member of the transition team].

At the time of writing, the design stage is completed, phase 1 (CIC) has been delivered, and phase 2 is still in the construction stage.

To sum up, *Nouveau Complexe Hospitalier* represents the amalgamation of two existing hospitals and represents one of the biggest and most complex projects in Canada, involving a wide range of stakeholders that change over the different stages of the project definition. The complexity of this project pushed the members of the clinical management team to innovate and implement the Lean-led Design approach when defining the client needs. The main intention of implementing such an approach was firstly aligning the needs of both HEJ and L'HDQ and secondly aligning these needs with the designer's proposal by involving the users in the whole process of project definition. To do so, five Lean activities were implemented

between the planning and programming stages in order to develop an FTP. The preliminary design, the design, and the construction stages were implemented in a conventional mode.

During Lean-led Design the balance of power between users and designers have changes since they have acquired an understanding of the working scenario and they were seen as co-designers during both planning and programming stages. An example of that is during the Lean activity 5, users participants rejected all first scenarios proposed by the architects, which is a quite unusual situation in the conventional practices.

However, implementing such a participative approach is quite challenging in a context with different regulations and departmental requirements. As explained previously there is a contradiction and a "clash" between two ways of working traditional and required by the MHSS vs. Lean. This clash can sometimes make the process effortful and challenging. As an example, the FTP was rejected for the first time by the MSSS because it was written as a Lean FTP and not in a traditional way.

Furthermore, Lean-led Design did not end at the project definition phase. When the final architectural plans of the first components (CIC building) were developed, Lean-led Design started to be implemented again, in parallel with the design and the construction stages in order to prepare the transition and transformation of the hospital staff. Having said that, in the NCH project, the Lean-led Design approach is a continuous and iterative process that aims to align user needs with the final product which started with the beginning of the project (2014) and should be ended with the delivery of the building (2026). But how did this approach impact alignment between the needs and the design solution in NCH project definition?

After presenting the particularities of this project and the different Lean activities in the definition stages of planning, programming, and conceptual design, in the next section we analyze different alignment factors that facilitate or inhibit alignment between user needs and design solutions when using Lean-led Design in this complex project.

4.4 Alignment factors

Figure 4.12 presents the final framework that summarizes all the alignment factors identified in this research study. It represents in fact, a revised version of the conceptual framework developed in the literature based on the findings of the case study. This framework represents not only factors similar to those found in the conceptual framework (e.g., commitment), but also, in dashed lines, newly identified ones based on the case study (presented, e.g., loss of acquired knowledge). We have identified the same seven categories of factors in the theory, 13 being facilitating (green colour), 12 influencing (white colour), and 5 hindering (red colour). As a reminder, these terms are once again defined below:

- Facilitating factors: factors that positively impact alignment. When addressed, they facilitate alignment and when not addressed they do not hinder it;
- Influencing factors: factors that can both positively and negatively impact alignment, which means when they are addressed, they facilitate it and when not addressed, they hinder it;
- Hindering factors: factors that negatively impact alignment.

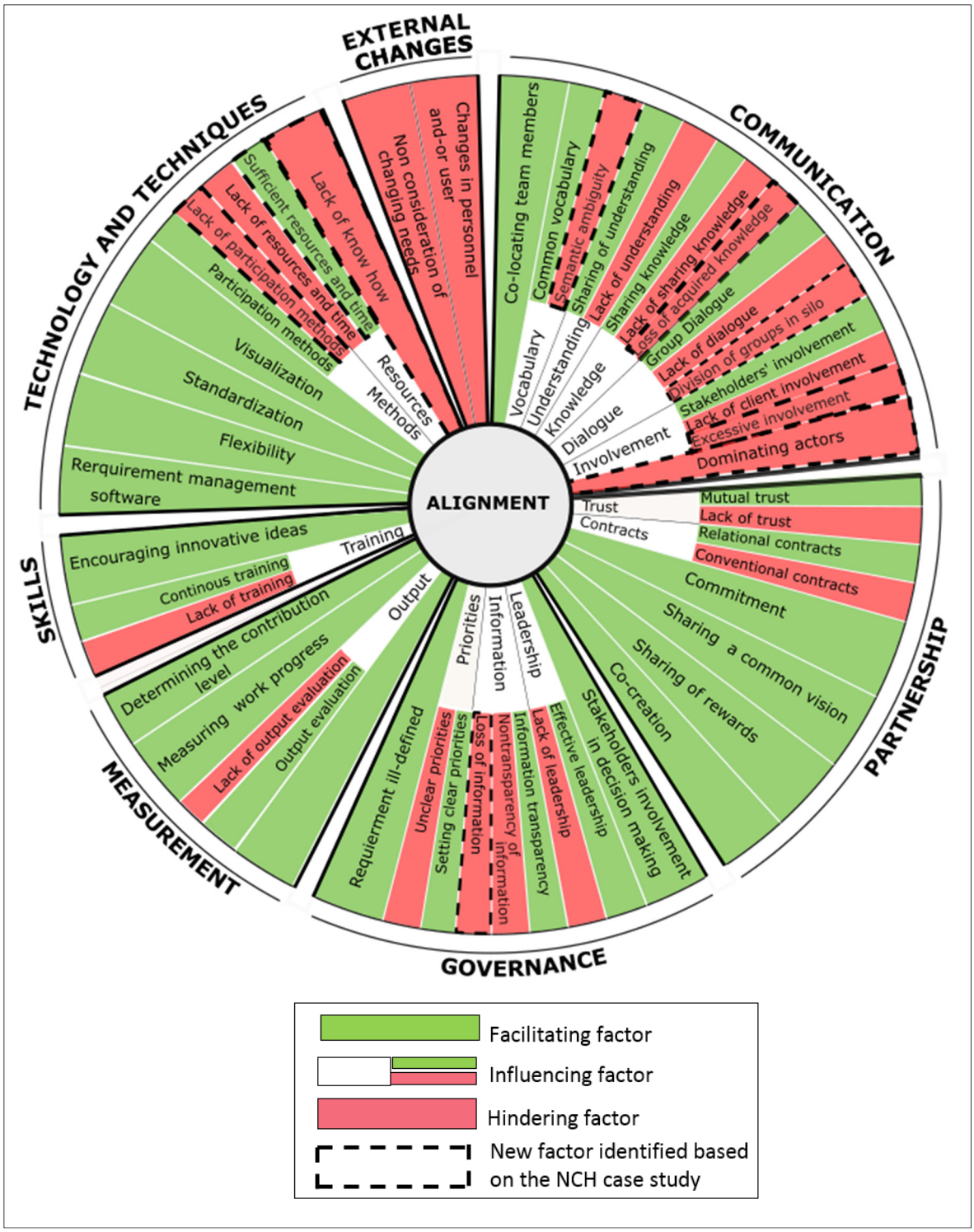


Figure 4.12 Final alignment framework (both theory and practice):13 facilitating factors, 14 influencing factors and 5 hindering factors

The following sections present in detail how we achieved the results. In order to facilitate the reader's understanding, one section is dedicated to each one of the seven categories plus the three categories previously presented. It is important to mention that the order to present the factors in each division is not related to their importance or their order of the appearance in the process. However, we first present the factors that are similar to those identified in the literature investigation and then the new ones in the context of our case study. In addition, for each alignment factor we report in which stage of the project definition it was identified and how it evolved in time.

Although each factor seems to be dissociated from the others when reading the document, the analysis is in fact much more complex because it is clear that some factors influence each other during the process or co-evolve simultaneously. This phenomenon will be explained directly during the discussion of each factor.

At the end of each category, a summary is presented in order to facilitate the reading and allow interested parties to grasp the work with different reading speeds depending on the needs and expectations of each. In this section, we used the conceptual framework developed previously (see chapter 3 section 3.5) as a reference in order to confirm or disconfirm the validity of each factor category in each project definition stage.

4.4.1 Communication

In the communication category, three subcategories of alignment factors were identified: facilitating, influencing, and hindering. The following sections provide more details about these results.

4.4.1.1 Facilitating Factors

The table below presents the two alignment facilitating factors that were identified in the project definition stage. Both of them are similar to those found in the literature. In addition, a

black line has been used to show when exactly the factor is or is not addressed (beginning, middle, end). As shown in the table (4.1), it can be seen that common vocabulary was addressed in the planning and programming while co-locating team members in all of the stages. The following sections explain each of these factors in more details and evaluate their influence on aligning the needs and solutions during the project definition phase.

Table 4.1 Alignment facilitating factors identified in the NCH project: communication

Facilitating factors	**Planning stage**	**Programming stage**	**Conceptual Design stage**
Common vocabulary	●	●	
Co-locating team members	●	●	●

Common vocabulary

One of the most important facilitating factors of alignment that was identified based on the literature investigation was common vocabulary, which was also identified in the NCH project. According to the NCH clinical management team, developing a common vocabulary between professionals and clients before and during *kaizen*, is necessary for their mental alignment: "*Le secret de notre succès était vraiment le développement d'un vocabulaire commun. On a amené les usagers et les architectes à utiliser le même vocabulaire afin d'avoir une base commune. Par exemple on a défini c'est quoi une cuisinette, une salle de repos, etc., pour le patient pour les cliniciens et pour les architectes"* (The secret to our success really was the development of a common vocabulary. Users and architects were encouraged to use the same vocabulary in order to have a common basis. For example, we have defined what is a kitchenette, a rest room, etc., for the patient, for the clinicians and for the architects) [member of the NCH clinical management team]. Taking the example of a hospital, since users generally do not understand the technical words used by architects and architects do not exactly know the expert medical vocabulary used by users to express their needs, it would be difficult to reliably identify their needs and translate them properly.

The concept of scale (area, square meters) is as an example of a vocabulary that was introduced to the users which represents a routine vocabulary only in the architectural field. Therefore, to help users' perception of the concept of scale, as explained in section 4.3, the architects used references such as a football field, an ice rink, etc., during *kaizen* 3. These references helped them make distance comparisons to understand and be aware of room sizes : "*On essayait de leur expliquer la notion d'échelle et les géométries spatiales pour bien identifier leurs besoins"* (We tried to explain to them the notion of scale and spatial geometries to properly identify their needs*)* [Design professionals mandated for the programming stage]. These exercises not only help introduce new vocabularies to facilitate mental alignment between users and the architects to promote a shared understanding (see. 4.4.1.2), but also help reduce semantic ambiguity which was identified as a hindering factor in programming and preliminary design stages (see section 4.4.1.3).

Clinicians and architects use different vocabularies, namely medical and spatial, respectively. Therefore, common vocabulary is important for effective communication and common understanding, especially in a dynamic context. In conclusion, this factor in fact helps reduce the interpretation gaps and ensure that needs are translated in a uniform way thus having a significant impact on a sharing of understanding between parties. However, this factor was only identified during the first two but not the third stage of project definition.

Co-Locating Team Members

The respondents referred to Co-locating team members as one of the biggest advantages of the NCH project. In fact, as found in the documentation reviewed and explained in the section (4.1), more than 220 people, including construction professionals, members of Quebec society of infrastructure, and members of the clinical management team were co-located in a project office near the building site, since the planning stage.

According to some interviewees, co-locating different identities improves communication and rapid diffusion of information to some extent due to informal meetings**:** "*On est plus présent que le mode traditionnel. Notre direction clinique est mixée avec les architectes et ingénieurs*

mêmes le gestionnaire de projet est avec nous. Sans ce bureau de projet, la communication aurait été plus difficile. On est un trio fort. " (We are more present than the traditional mode. Our clinical management is mixed with the architects and engineers even the project manager is with us. Without this project office, communication would have been more difficult. We're a strong trio) [member of the NCH clinical management team]. However, while some interviewees hold that co-locating the stakeholders helps improve the communication among them, others believe that sharing the same workspace does not necessarily lead to a better communication. One designer mandated for both the programing and design stages said: " *être dans un bureau de projet ne veut pas dire que la qualité de communication est meilleure. Certes, tout le monde est ensemble, mais chacun travaille dans sa bulle. On envoie toujours des courriels au lieu de se lever." (*being in a project office does not mean that the quality of communication is better. Of course, everyone is together, but everyone works in their own bubble. We always send emails instead of getting up). This means that each person works in their own space even if they are all in the same room or location.

To sum up, the project office certainly facilitates the rapid diffusion of information and interactions between different players, but in this project, it was still challenging to make collaborative conversations since people still tend to communicate in the traditional manner, for example by email instead of face-to-face even if they are co-located. In light of this, it is possible to make some observations such as the difficulty of changing people's habits, especially if there is a significant number of participants that do not engage in face-to-face dialogues even if stakeholders are co-located.

4.4.1.2 Influencing Factors

The table below summarizes the factors influencing alignment which were identified in each stage of the project definition of NCH. In this table we used the same nomenclature of table 4.2. This means that black line signifies when the factor started and stopped being addressed during the stages. We also used a discrete black line to show the discontinuity in addressing the factors in the process. As can be seen in the table, both the factor and its opposite were

identified in the project definition stage. The facilitating factors which were addressed during the planning and programming stages, did not continue to be considered during the conceptual design stage. The following sections explain these changes in more details.

Table 4.2 Alignment influencing factors identified in the NCH project: communication
Taken from Chbaly et al., 2021

Influencing factors		**Planning stage**	**Programming stage**	**Conceptual design stage**
Knowledge	Sharing of knowledge	●	●	
	Lack of sharing knowledge		●	●
Understanding	Sharing of understanding	●	●	
	Lack of understanding		●	●
Dialogue	Group dialogue	●	●	● - - ●
	Lack of dialogue			
Involvement	Stakeholders (user) early involvement	●	●	
	Lack of client (user) involvement		●	●

Knowledge: sharing of knowledge / lack of sharing knowledge

The factor *sharing of knowledge* has been identified principally during the planning and programming stages. In fact, during both stages of planning and programming, the 5 levels of that have been implemented in the form of *kaizen,* facilitated a bidirectional sharing of knowledge among project managers, members of the clinical management team, construction professionals mandated for FTP, and users. "*C'est une démarche qui permet d'un côté aux professionnels d'apprendre des nouvelles pratiques et ça permet aussi au personnel clinique (médecins, infirmiers, etc.) de connaitre les différentes limites du bâtiment "* (This is an approach that allows professionals on the one hand to learn new practices and also allows clinical staff (doctors, nurses, etc.) to know the different limits of the building) [member of the NCH clinical management team]. This means that the project team is not the only party that shares information with users for example regarding constraints of the project, but users also

shared information about the general operation of hospitals, patient flow and different types of clienteles. In this manner, users learn about the reality of architecture; architects learn about the details that are of importance to hospital users. This helps clarify any unclear points about the project that can potentially impede achievement of client requirements. Also, when sharing of knowledge is realized, sharing of understanding could follow.

At the end of the programming stage (FTP drafting) and during the conceptual design stage, information was not shared as much as in the first two stages, despite its importance in the process. On the one side, there was no knowledge sharing across programming and conceptual design stages, namely between designers mandated for FTP and those mandated for the design stage. On the other hand, sharing of information between project members and users only occasionally happened and was often unidirectional from users to construction professionals or from the construction professionals to the users. This could be explained by two reasons. Firstly, the designers mandated for the conceptual design were different from those mandated for the FTP development. Secondly, a non-participative approach was used in the design stage, which means that users were not involved in the process.

Furthermore, the conceptual design stage was not only characterized by discontinuity in sharing knowledge but also by a loss of the previously acquired knowledge (see section 4.4.1.3). This means that the switch from a participative to a less participative approach can potentially undo what was achieved before.

In conclusion, a considerable work was realized in order to share understanding and knowledge among stakeholders during planning and programming stages when using the Lean-led Design approach. However, a loss of the previously acquired knowledge was identified was a bit lost in time: between the programming and conceptual design stages and during the conceptual design stage, since the approach was less participative, and the professionals mandated for this stage were different from those of the other stages. Also, the factor regarding sharing of knowledge seems to co-evolve with sharing of understanding, presented next.

Understanding: sharing of understanding/ lack of understanding

Sharing of understanding represents an important factor in aligning the needs and the design solution. Based on the literature (see 3.4.5.1), implementation of the Lean-led Design approach should facilitate the sharing of understanding since users are involved in the process, but in the NCH project, answers in the interviews on the subject were sometimes confusing and contradicting.

Based on the perspectives of clinical management team members and the project manager, there is a positive link between the implementation of *kaizen* and level of the user understanding: " *Grâce aux kaizen, les cliniciens comprennent mieux le développement du projet et les choix conceptuels*" (Thanks to *kaizen*, clinicians better understand the development of the project and the conceptual choices) [Project Manager, SQI]. According to these respondents, when a user is involved in the process they actively participate and ask questions that increase their understanding and awareness. However, designers in the programming stage responded differently: " *les cliniciens pensent que l'architecture c'est juste déplacer les pièces. Ils ne nous font pas confiance même si on leur explique qu'on a d'autres considérations à prendre en compte telles que les contraintes structurelles et mécaniques* " (clinicians think architecture is just moving the pieces. They don't trust us even if we explain to them that we have other considerations to take into account such as structural and mechanical constraints) [Design Professional]. According to them, the users still did not understand the design choices despite the fact they were involved in the process from the beginning. This problem could be due to semantic ambiguity (see section 4.4.1.3) or change in users throughout the project definition stage, since those who participated in the beginning of the process are not necessarily those in the middle or the end of the process (see section 4.4.7.1).

To sum up, even though Lean-led Design was implemented during both the planning and programming stages, we cannot assume that a shared understanding necessarily existed between the participants during these stages, and least of all during the conceptual design stage where the users were less involved. Nevertheless, we have found that this factor remains linked

to the need to share knowledge and to create a common vocabulary. These three factors that evolve together are discussed by several researchers (as presented in chapter 3), as the three main pillars of communication.

Dialogue: group dialogue / lack of dialogue

This factor was addressed during all project definition stages of NCH to make decisions collectively and thus achieve a horizontal alignment. However, group members involved in the dialogue were different in each stage.

During the planning stage, the dialogues included members of the Clinical Department, project managers from SQI (Quebec infrastructure society), members of the Ministry of Health, and users of different hospital departments including patient representatives. All of these participants were involved in order to gather the necessary information to develop the clinical plan.

During the programming stage, the group dialogues involved the professionals mandated for the FTP along with the same participants during the planning stage. The objective was to define hospital needs and think about the organization of the premises.

During these first two stages, the dialogue groups included a large number of participants (100 to 400), frequently gathered together during the different *kaizen* activities (see chapter 4, section 4.3), while during the preliminary design stage, the dialogue groups involved fewer participants.

In fact, during the third stage of project definition, dialogue groups did not involve all stakeholders at the same time and different small groups were created (between 6 and 10). For instance, a dialogue group could involve members of the clinical management team, project managers from SQI (Quebec infrastructure society), and the design and construction professionals, to discuss the project problems or to find solutions. These meetings were usually informal and were held in the project office. Other dialogue groups could involve only the

architects with clinicians of a specific hospital department with the objective to discuss the needs of different departments or the proposed design solution. These meetings were usually informal and occasional.

To conclude, contrary to the dialogue groups developed during the planning and programming stages, in the preliminary design stage the dialogue groups were informal and less frequents with fewer participants. This impacts the understanding and satisfaction of different users and creates a gap between the first two stages and the third one.

Involvement: Stakeholders (user) early involvement / lack of client involvement

One of the factors to align client needs with design solutions and to better manage the hospital complexity is to involve the users starting from the beginning of the project definition process. According to the interviewees, it proved extremely important to get a wide and representative user involvement of the two hospitals during both planning and programming stages. For this purpose, the expertise of all sectors was mobilized to generate an integrated vision. Clinicians and support service staff were brought together to help define the best possible hospital. According to some of the respondents, this project has been a great opportunity and a privilege for them to work together and develop a collaboration: “I really believe in grouping teams, it creates synergies; it creates the setting of common expertise.” [Patient].

In the NCH project, the particularity was not only the early involvement of clinicians and support service staff but also the involvement of real patients. As the basic premise of the planning stage was to provide efficient healthcare services to patients, during the different levels of *Kaizen* they were encouraged to participate and give their testimonies: «In fact, what we want is to improve the care and services for the patient and then put the walls around» [Clinician]. In fact, the involved patients usually represent those with chronic diseases that require long hospitalization periods. By putting them at the center of the discussions, it was acknowledged that they helped raise awareness about certain issues that were not obvious at first to clinical and professional teams.

However, unlike the first stages, users were no longer part of the process during the conceptual design stage since the adopted approach in that stage was non-participative. This change in the approach is believed to impact the understanding and engagement of users.

To sum up, involving the users and patients and working together with the clinical management team to solve problems is a crucial factor to improve understanding of user needs. It also helps reduce conflicts between users and improve their engagement (see section 4.4.2.1). Despite its significance to the project definition process, the continuous involvement of different stakeholders ended with the beginning of the design stage, having consequences like the disappearance of factors such as "sharing of understanding" and the appearance of new hindering factors such as "loss of acquired knowledge", which will be presented in the next sections.

4.4.1.3 Hindering factors

The table below presents the five alignment hindering factors in each stage of the project definition of the new hospital, all of them representing new factors, identified based on the NCH case study, which were identified in different stages of the project definition.

Table 4.3 Alignment hindering factors identified in the NCH project: communication

Hindering factors	Planning stage	Programming stage	Conceptual design stage
Excessive involvement of users	●	●	
Division of dialogue groups in silos	●	●	●
Loss of acquired knowledge		●	●
Semantic ambiguity		●	●
Dominating actors			●

Excessive involvement of users

As explained previously, involvement of clients from the beginning of the project definition process should facilitate the alignment (see section 4.4.1.2). However, excessive involvement of users during *kaizen* is seen by some respondents as an alignment hindering factor.

According to a member of the clinical management team, involvement of more than 200 participants at the same time in each *kaizen* during planning and programming stages may lead to their excessive mobilization: *"Un des risques à éviter est la surmobilisation et la fatigue organisationnelle autour du projet immobilier "* (One of the risks to be avoided is excessive mobilization during the project) [member of the clinical management of NCH]. Management of this mobilization was not always easy, despite the organizers' efforts to remind the participants about the project vision in each step, to maintain a harmony between them. According to the interviewees, each party sometimes tried to use *kaizen* to defend their own interests and objectives. For instance, the objective of the project manager is to reduce budget, construction professionals to verify the technical issues of the building.

To conclude, participation is certainly necessary for alignment between stakeholders. However, it is a double-edged sword since excessive involvement of users could hinder alignment. Thus, it seems important to involve the participants in a relevant and timely manner.

Division of Dialogue Groups in Silos

An inadequate distribution of participant profiles in dialogue groups that leads to a disconnected discussion between different specialties is what we mean by *division of dialogue groups in silos*. This factor was identified by some respondents as an inhibitor to align needs-solutions. It was identified not only in the preliminary design stage, where a non-participative approach was adopted but also during the planning and programming stages even though an inclusive Lean-led Design was implemented.

In fact, one of the objectives of implementing Lean-led Design is to minimize the "silo work" since different stakeholders are involved from the beginning. However, looking back on these

activities realized in the NCH, the division of discussion groups during the planning and programming of the NCH project led to a silo work, according to some members of the clinical management team: "*On a regroupé plusieurs participants en même temps, lors des activités Lean pour éviter le travail en silo. Cependant, je pense qu'au contraire, on a créé des silos.* On *est quasiment passé à côté de ce qu'on voulait aller chercher lors du kaizen* " (We grouped together several participants at the same time, during Lean activities to avoid working in silos. However, I think on the contrary, we created silos. We almost missed out on what we wanted to get during the *kaizen*) [member of the clinical management of NCH]. According to them, although each *kaizen* involved different stakeholders, the composition of small discussion groups (roundtables) was based on a specialty and thus was inadequate. These groups were made up of only the people working in the same department which creates a disconnection from other hospital departments that should also be involved. For instance, when the group objective was to discuss the emergency department, participants were only the emergency doctors and nurses. By contrast, the doctors who made consultations in the emergency department such as paramedics, cardiologists, and neurologists were not consulted which in general means that different clinicians that have a functional contribution to the service were not integrated in the discussion.

In simple terms, too many users were involved in the *kaizen,* but the manner of their involvement was not the most efficient, not only because of their excessive involvement as explained previously but also because each discussion group was composed of representants of the same hospital specialty, which led to a "silo" work. This situation does not favor interdisciplinary dialogue and thus mental alignment, which is precisely sought by participatory approaches such the Lean-led Design.

Loss of Acquired Knowledge

Another important factor that has been addressed by respondents is the loss of the acquired knowledge by users. This factor was identified at the beginning of the preliminary design stage.

In fact, unlike the first two stages of the project definition, at the beginning of the preliminary design stage, different clinicians were not satisfied and did not understand the decisions made by the architects. For instance, the reason why their list of needs including the square meters of their department defined during the *kaizen* was reduced (see. Section 4.4.3.2). This means that all the shared knowledge during the different *kaizen* practices was lost at the beginning of the preliminary design stage.

Different interviewees thought that the main problem was related to the lack of involvement of users during an important part of the project definition process. Clinical managers thought that users were not involved during the FTP drafting: "l*e PFT lui-même c'est un résultat. Il fallait quand même montrer aux cliniciens comment on a réfléchi pour réduire les besoins afin de répondre à la demande ministérielle"* (The PFT itself is a result. We still had to show the clinicians how we thought about reducing the needs in order to meet the ministerial demand) [member of the NCH clinical management team]. Inclusion of participants in all the project definition processes becomes even more important in complex projects that take lots of years such as NCH, where: "*Les gens ont tendance à oublier un peu les discussions qui ont eu lieu lors de la démarche Lean*" (People tend to forget a little about the discussions that took place during the Lean process) [Lean agent].

To sum up, user knowledge about the process and decisions was lost between the programming and the preliminary design stage since they were not involved in this process. This represents a real barrier to alignment and gives the impression that much of *kaizen* outputs in the planning and programming stages have been lost in the design stage. This is against the first intention of implementing the Lean-led Design approach during the project definition phase. Furthermore, a shared knowledge was also lost since the duration between their last involvement in the programming stage and their first meeting during the design stage was long. This leads to a gap between the user expectations and the architectural plans.

Semantic Ambiguity

Semantic ambiguity was identified as an alignment hindering factor during the project definition. Semantic ambiguity exists when a vocabulary has multiple meanings depending on the context or the field. For instance, the term "PCI" in the medical field signifies infection prevention and control measures, while in the construction field means integrated design process. This factor was identified during programming and preliminary design stages. It basically appeared when design professionals mandated for programming and design stages started to be involved in the process.

In spite of the efforts from the beginning to share a common understanding and vocabulary between different stakeholders, there still seems to be a semantic ambiguity between them. The actors did not use the same vocabulary to refer to the same information or tasks: "Les usagers *mélangent souvent les cartographies de processus (comment ils vont travailler) versus nos plans architecturaux*" (Users often mix up process maps (how they are going to work) versus our architectural plans) [Design professional mandated for programming stage]. This hindering factor was identified during and across different stages, especially when new data and/or actors were present. For instance, while "plan" in architectural field refers to the "design plan," the users who participated in the *kaizen* use this vocabulary to refer to both the process mapping and the design plan.

In conclusion, semantic ambiguity between stakeholders represents a hindering factor that negatively impacts not only sharing of knowledge and understanding as shown in the previous section (see section 4.4.1.2), but also its transfer to others across stages.

Dominating Actors

Dominating actors refers to the actors who have more power than others in the process. Several studies including Carlile (2002) recognize the close relationship between the power of actors and the transfer of knowledge. This was identified as an alignment hindering factor between the programming and the conceptual design stages.

In the NCH project, the architects mandated for the design stage used the power provided by their ownership of the design knowledge to take control of the process. They did not recognize some works previously realized by the *kaizen* participants during both the planning and programming stages, which represents an important output of the design solution: "*Mais à chaque fois, les architectes veulent créer quelque chose de nouveau. Ils ne prennent pas en compte ce qu'on fait* " (But every time the architects want to create something new. They don't take into account what we're doing) [member of the NCH clinical management team]. An example of that is the different mock-ups that were developed by users, clinical managers, and design professionals mandated for the FTP. The objective of these mock-ups was to define the exact square meters required for each representative hospital room.

However, the architects mandated for the design stage modify the decisions concerning the square meters of the rooms previously taken by consensus during the *kaizen*, using their power in the process. According to them, the reason of these modifications was that the mock-ups were developed in a theoretical way: "*Le CHU avec les architectes mandate pour le PFT ont développé les mock-ups, mais ils les ont développés dans un monde idéal lorsqu'on vient avec les contraintes architecturales, les modèles types doivent être modifiés* " (The CHU with the architects mandated for the PFT developed the mock-ups, but they developed them in an ideal world. We had to modify them and add architectural constraints) [Design professional mandated for the design stage]. Therefore, the architects demanded separate meetings with the different hospital departments representants that previously participated in the *kaizen,* in order to confirm user needs by themselves.

To sum up, in the traditional approach such as the one adopted during the design stage, the architect is the most powerful actor in the process. This dominance could hinder the alignment between stakeholders since they do not consider the work realized by other specialties. In fact, in this approach, the architect is deeply embedded in his practice, knowledge, and tools, and the involvement of other actors including users in the process of design, jeopardizes his position and dominance. Implementing a participative approach during preliminary and design stages with an integrated project delivery method (see. chapter 3 sections. 3.4.2.1) could reduce

the architect's dominance and balance both voices: "users" and "designers". By choosing such an approach, the user is part of the process and is a member of the design team, as explained in chapter 1 (section 1.6).

Summary

Figure 4.13 summarizes all the alignment factors associated with the communication category, identified based on both the literature work and the case study.

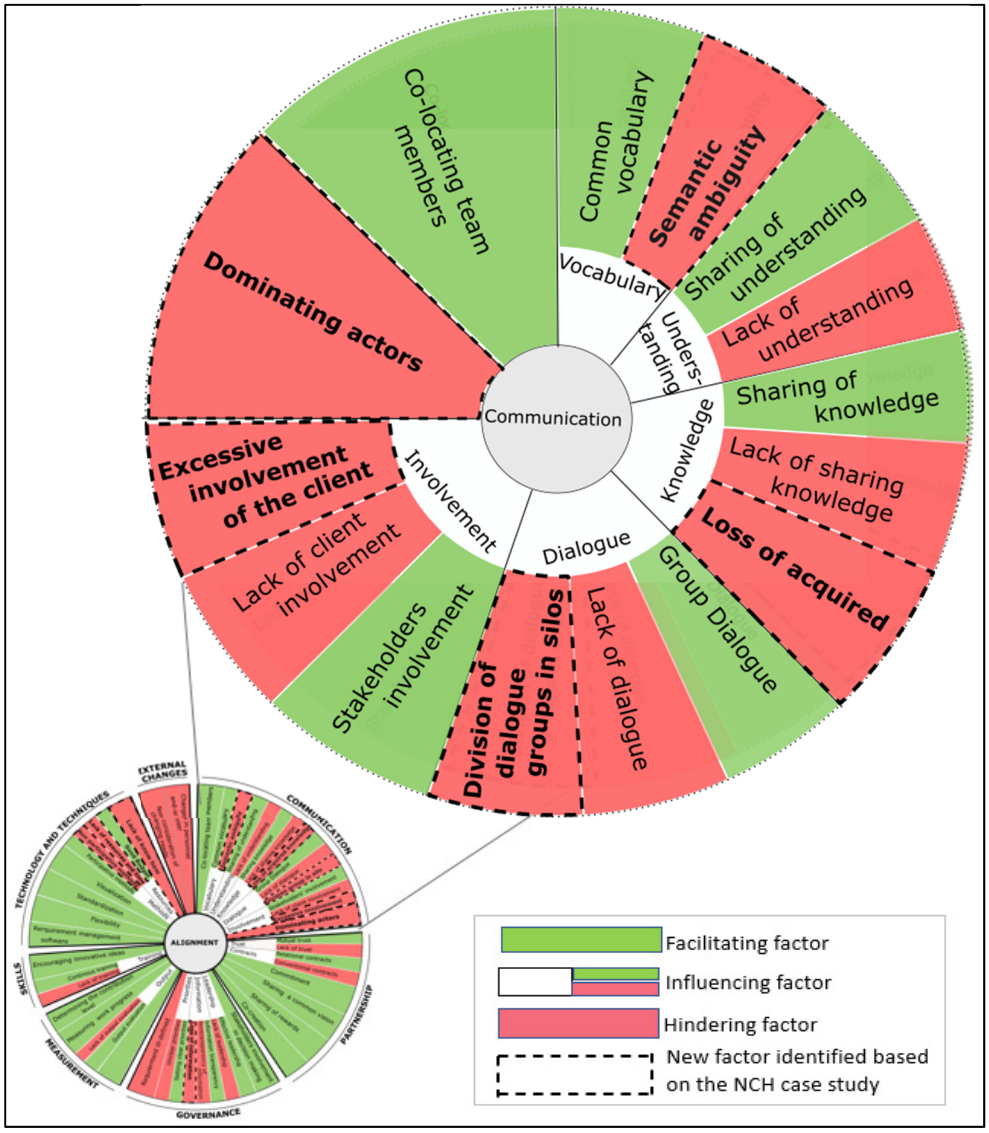


Figure 4.13 Total of factors identified based on both the literature and the case study: communication

In fact, all of the identified factors in the literature were also identified in this case study, in addition to that, new factors were also identified. More precisely, 6 factors were similar to those identified in the literature (2 facilitating and 4 influencing) and 5 newly identified were classified as hindering factors: semantic ambiguity, loss of acquired knowledge, division group in silos, excessive involvement of the client, and dominating actors. However, we noticed that 4 out of 5 of the newly identified factors represent the opposite of the others found in the literature. For instance, *semantic ambiguity* (newly identified), classified in the hindering subcategory, is the opposite of *common vocabulary* classified in the facilitating subcategory. For this reason, we decided to classify both of them in the influencing subcategory (Figure 4.13), since one represents the opposite of the other and they could be seen as only one factor that positively influences alignment when it exists and hinders it when it does not exist.

Furthermore, as shown in figure 4.14, not all factors are addressed during all project definition stages. While some factors are only identified during one specific stage (e.g., dominating actors), others evolve during the project definition process (e.g., sharing of knowledge). Also, within the same stage of project definition, factor could be identified only at the beginning or end of it (e.g., lack of understanding during the programming stage).

As shown in figure 4.14, most of alignment facilitating factors (green colour) which were addressed during the planning and programming stages, disappeared or were less addressed during the conceptual design stage (e.g., sharing knowledge, sharing of understanding, group dialogue). Not only that, but also when these facilitating factors disappeared, hindering factors (red colour) appeared. According to our analysis, this disappearance could be explained by abandoning the participative approach and adopting the traditional non-participative approach. The facilitating factors were addressed when the participative Lean-led Design approach was implemented. By contrast, the majority of hindering alignment factors were linked to the implementation of a traditional (non-participative) project definition approach.

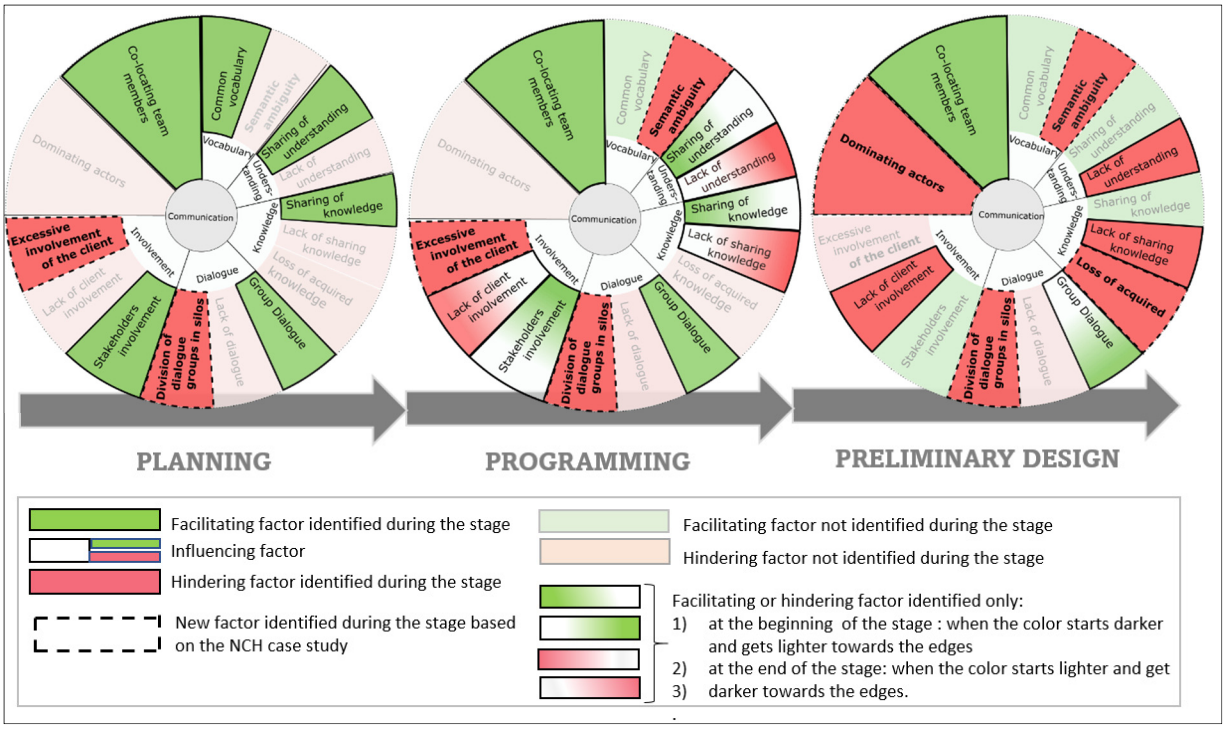


Figure 4.14 Factors related to communication identified during each stage of the project definition of the NCH
Taken from Chbaly et al., 2021

In addition, we noticed that different factors influence each other and evolve together. For instance, sharing of knowledge and common vocabulary positively influenced stakeholder understanding, while a lack of knowledge sharing, and semantic ambiguity negatively influenced understanding. In addition, we observed that the factors linked to the influencing subcategory are very important in the process of project definition, because when the factors that positively influence alignment disappear from the process, their opposites that hinder it appears instead.

Having said that, implementing a Lean-led Design seem to promote a continuous alignment between the planning and the programming stages while an alignment gap between the programming stage and conceptual design during the conceptual design stage seem to emerge when a non-participative approach is adopted.

4.4.2 Partnership

In this category, we have identified two subcategories: facilitating and influencing. Although many factors are similar to those already found in the theory, new ones are also found. The following sections provide more details about these results.

4.4.2.1 Facilitating factors

The table below summarizes the alignment facilitating factors found in each stage of the project definition of the NCH. Only three out of four factors (found in the literature) were identified in the case of the NCH during both planning and programming stages: commitment, sharing of a common vision and co-creation. None was identified at the end of the programming and during the conceptual design stage.

Table 4.4 Alignment facilitating factors identified in the NCH: partnership

Facilitating factors	Planning stage	Programming stage	Conceptual design stage
Commitment	●	●	
Sharing of a common vision	●	●	
Sharing of rewards			
Co-creation	●	●	

Commitment

As explained in chapter 3, in the context of the current research, commitment is meant to refer to both user and client commitment. It was noticed that during planning and programming stages where Lean-led Design was implemented, the users gradually developed a sense of ownership and a commitment: " *L'exercice de vision doit faire en sorte que le projet soit « leur projet », soit « notre projet». Ça aide à développer un sentiment d'appartenance* et d'engagement " (The vision exercise ensures that the project changes from "their project" to

"our project". It helps to develop a feeling of belonging and commitment) [member of the clinical management of NCH]. Participants develop their new collective identity through the course of the *kaizen* activities, starting from a sectoral/hospital perspective and gradually moving towards a united “us”. The concept of *Evolution* has been noted by several participants during these activities. At first, participants referred to their respective hospital (HEJ or L’HDQ), but gradually developed a collective identity; an “us” for the new hospital. This happened after putting together the strengths of both hospitals and helping the users to gradually create their new hospital. As time passed and activities unfolded, the overall synergy of participants improved, as each got a deeper understanding of the reality of others. It is noteworthy that at the beginning of the planning stage, all users were rewarded for their participation in *kaizen*. However, starting form *kaizen* 3, many of them participated as volunteers without any monetary compensation.

At the end of the programming and during the conceptual design stage, the commitment factor was no longer identified since users were not involved. This means that the existence of this factor is linked with other factors such as user involvement, presented in the previous section (4.4.1.2) or mutual trust presented next (see. 4.4.2.2).

In conclusion, it is possible to say that inclusive approaches such as Lean-led Design promotes users’ sense of belonging, commitment, and satisfaction by involving them during the early stages of project definition. But his could also lead to stakeholder disappointment, if their expectations are not met or if they were no longer involved. Furthermore, this factor could be impacted by user changes during the process (see. 4.4.7.1).

Sharing of a common vision

Sharing a common vision is identified as an alignment facilitating factor only during the planning and programming stage.

One of the first concerns of the NCH clinical managers was regarding sharing a common vision among different stakeholders since the first kaizen, organized in 2014: *"le kaizen nous a permis*

de débattre entre cliniciens afin de nous projeter de façon beaucoup plus optimale en groupe. L'objectif est d'avoir une vision commune, plus claire et plus complète des différents services. Le kaizen nous a permis aussi de mieux comprendre les choix et des décisions" (the *kaizen* allowed us to debate between clinicians in order to project ourselves in a much more optimal way as a group. The objective is to have a common, clearer and more complete vision of the different services. The *kaizen* also allowed us to do better. understand choices and decisions) [Clinician]. Both the users and the members of the clinical management team expressed that the Lean activities meaningfully helped them reach a consensus about the project objectives, choices, and decisions. By working together, every participant tried to share their views about the project and make sure that they were well understood by others. This gradually leads to the development of a shared understanding and mental alignment among them and thus motivate the users to be more committed to the project. However, it is noteworthy that this factor was only identified during the planning and programming stages where a participative approach was implemented. This results in, according to some members of the clinical management team, a loss of the previously reached consensus.

To conclude, the Lean-led Design approach facilitates the creation of a common vision between users and designers, co-evolving with the sharing of understanding factor. However, more important than sharing a vision, its continuity throughout the whole process of project definition is important since a lack of continuity can undo all the previous understanding and thus the consensus. Actually, changes in personnel and users can impact this continuity (see. 4.4.7.1 and 4.4.3.2).

Co-creation

Lean-led Design is strongly based on the concept of co-creation. The analysis of the results of the interviews revealed that co-creation stimulates engagement and positive attitude of users during the process.

In fact, the particularity of the NCH project was not only due to the involvement of users in co-creation of the output of each *kaizen* (flows cartography, the guiding principles, etc.) but

their involvement in co-creation of the draft of the clinical plan. *"Les chefs de chaque secteur hospitalier avaient élaborés eux-mêmes leurs porte-folios. Ils étaient propriétaires de leur rédaction. Par la suite, nous avons repris l'information retrouvée dans les porte-folios (les verbatims) pour rédiger le plan clinique"* (The heads of each hospital sector had developed their own folio cases. They owned their editorial staff. Subsequently, we used the information found in the folio cases (verbatims) to draft the clinical plan) [Project manager of SQI]. This means that the heads of the clinical sectors of both hospitals (HEJ, HDQ), for instance outpatient or emergency care unit, have themselves written their needs in separate portfolios to draft the clinical plan. However, the chosen method in the process of co-creation was not the best: "*On avait beaucoup de documentation, c'était très fastidieux pour rédiger le plan clinique. De chaque 50 pages de porte-folios qu'on avait par secteur, on a fait ressortis, que 4 pages, de plan clinique. C'était très énergivore* " (We had a lot of documentation; it was very tedious to write the clinical plan. Of every 50 pages of portfolio that we had by sector, we brought out only 4 pages of clinical plan. It was a lot of effort) [member of clinical management of NCH]. All respondents who were involved in the drafting of the clinical plan mentioned that it was very effortful to summarize the information of several portfolios. According to the same respondents, the main reason for this perceived waste of time and effort is the lack of knowledge regarding how to do it efficiently (see. 4.4.6.3). The NCH project was the first that used the clinical plan guide provided by the healthcare ministry. This means that they did not have any experience in developing such a document.

By the end of the programming stage (during FTP drafting) and during the conceptual design stage, the co-creation factor was not in effect anymore since users were no longer involved in the process.

To conclude, the co-creation factor which was identified during the planning and programming stages was strongly connected with the implementation of the Lean-led Design participative approach. The existence of this factor positively impacts the commitment of users and both factors evolve together.

4.4.2.2 Influencing factors

As can be seen in the following Table, two factors (trust and relational contracts) were identified in the literature in this subcategory of factors. The following sections provide more details about the subject.

Table 4.5 Alignment influencing factors identified in the NCH project: partnership

Facilitating factors		Planning stage	Programming stage	Conceptual design stage
Trust	**Mutual trust**	●	●	
	Lack of trust		●	●
Contracts	**Relational contracts**	●	●	●
	Conventional contract			

Trust: trust / lack of trust

While mutual trust can facilitate alignment, lack of it could hinder it. In the NCH project, the interviewees' answers regarding trust were somewhat contradicting since both factors were identified.

According to SQI managers, a mutual trust was created between participants during the Lean-led Design activities: "*les kaizen ont aidé à renforcer la confiance mutuelle entre les usagers, et les professionnels*" (The *kaizen* has helped to strengthen mutual trust between users and professionals) [Project manager of SQI]. Project managers believed that during different *kaizen* sessions a trustful environment was created, which enhanced user commitment and helped solve any conflicting state among participants. By contrast, designers had another point of view: "*les cliniciens ne font pas totalement confiance au travail qu'on fait*" (clinicians don't have complete confidence in our work) [Professional designer 1]. According to them, users did not completely trust designer decisions and choices in spite of their involvement in the process of project definition through Lean activities.

This lack of trust could be explained by the semantic ambiguity between designers and users that have been previously identified (see. 4.4.1.3). It could also be explained by the complexity of building a trustworthy relationship in a dynamic and complex project involving heterogeneous groups with different experiences, domains, and languages.

To conclude this point, while mutual trust facilitates alignment between stakeholders and is believed to enhance user commitment, lack of it jeopardizes confidence in decision-making. Although the implementation of a participative approach such as Lean-led Design should have facilitated the development of a mutual trust, it is not possible to assume that it was completely achieved during the planning and programming stages, but especially during the preliminary design stage, where a non-participative approach was implemented. Furthermore, we found that trust is linked to the need to create a common vocabulary and understanding between both parties, namely users and professionals.

Contracts: relational contracts/ conventional contract

The project delivery method in NCH was the Construction Management–General Contractor (CMGC) delivery perspective. According to the respondents, this delivery mode facilitates alignment between team members, unlike the traditional mode. In the NCH project, the construction manager was engaged in the conceptual and design stages and was co-located with other experts and members of the clinical management team in the project office of the NCH which offers the possibility for them to collaborate better.

Although the CMGC delivery mode could facilitate an Integrated Design Process (IDP), the preliminary design and its respective stages were realized in a traditional non-participative manner: *"Ici, la conception est linéaire et traditionnelle. Le projet pourrait parfaitement s'asseoir avec une approche PCI, mais malheureusement le projet n'a pas été fait comme ça"* (Here the design is linear and traditional. The project could perfectly sit with a PCI approach, but unfortunately the project was not realized like that) [Mechanical engineer]. In this project and during the conceptual and design stages, the construction manager was only occasionally involved and the users were not involved at all.

To sum up, relational contracts such as CMGC delivery can facilitate an integrated design process and thus the alignment between the stakeholders since they are co-located. However, admittedly, the conceptual design and design stages were realized in a traditional mode in this project. This leads us to conclude that co-locating all stakeholders does not necessarily mean that all project processes are truly integrated.

4.4.2.3 Summary

Figure 4.15 summarizes the total of alignment factors associated with the partnership category identified based on both theory and case study combined: 4 facilitating and 2 hindering. In fact, all factors identified in the literature were also identified in this case study. We did not find any new factor, however.

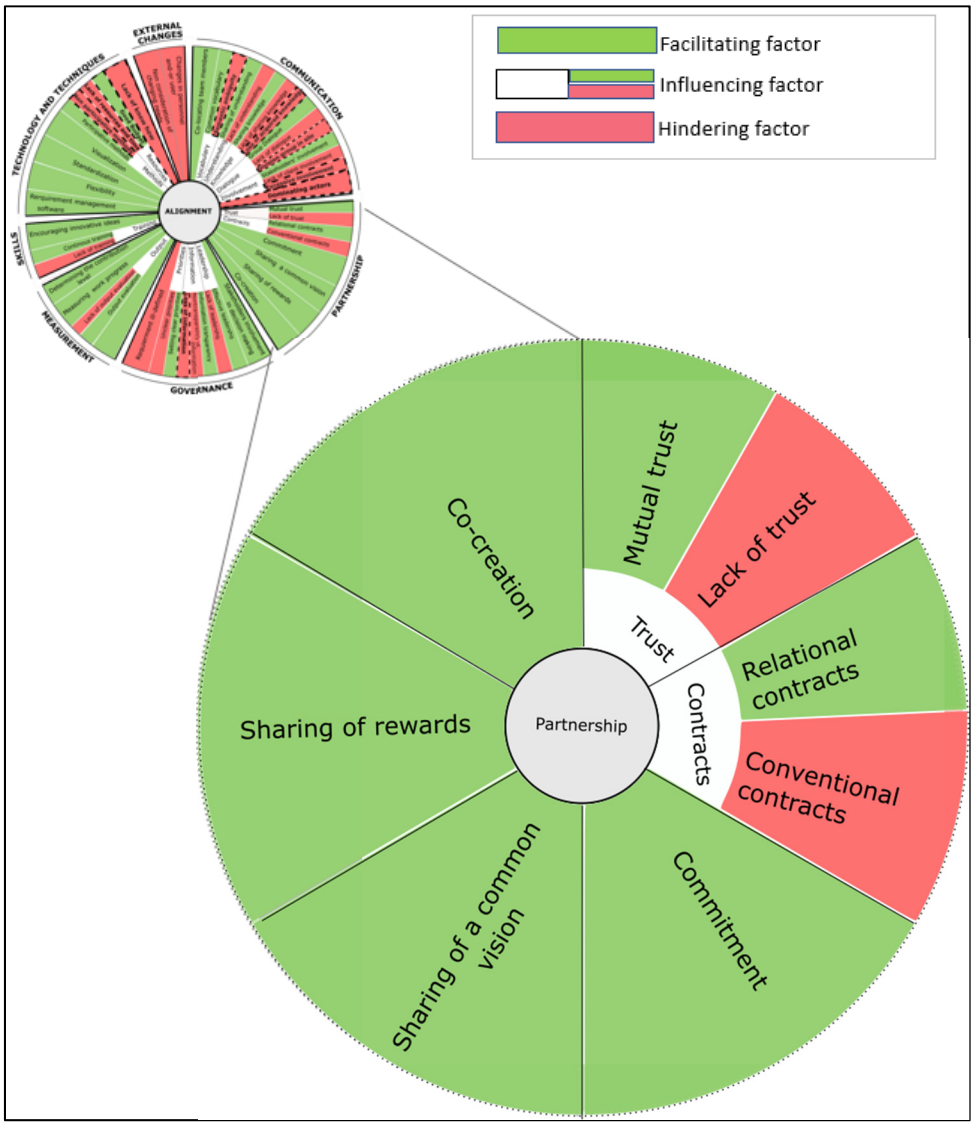


Figure 4.15 Total of factors identified based on both the literature and the case study: partnership

Furthermore, as found in the communication category, not all factors are addressed during all stages continuously. As shown in the Figure 4.16, the majority of facilitating factors are addressed only during the planning and programming stages. They disappeared by the end of the programming stage (e.g., co-creation, sharing vision). No partnership was identified during the preliminary design stage. Further, some factors and their opposite such as "trust" and "lack of trust" were both identified during the process of project definition, but each one during a stage. This could be explained by the different personal changes that characterize the dynamic projects.

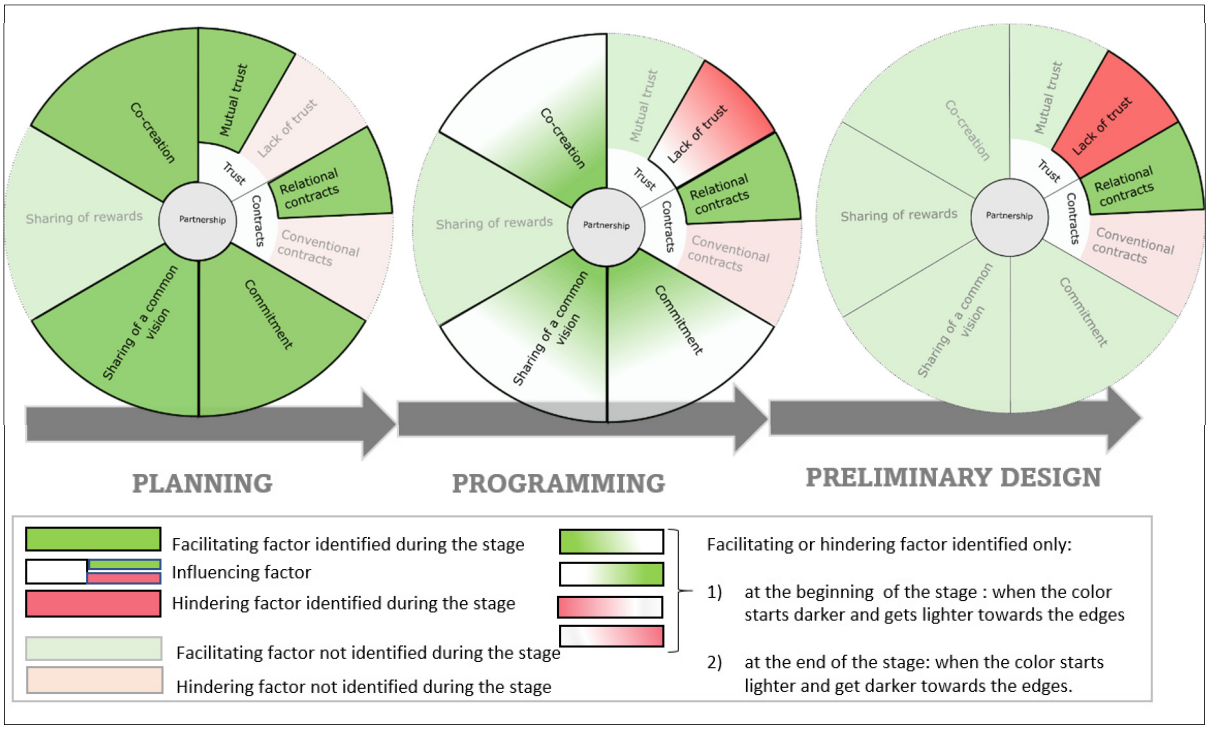


Figure 4.16 Factors related to partnership identified during each stage of the project definition of the NCH

In addition, some factors of the communication category have an important impact on the existence of some factors in the partnership category. For instance, the sharing of common vision co-evolves with the sharing of understanding, which is an important factor identified in communication category.

To sum up, all facilitating alignment factors, identified in the NCH project, and related to the partnership category, were addressed when the participative Lean-led Design approach was implemented. They disappeared with the end of the participation of the users in the process. Thus, based on this category of factors, it could be said that there is a partnership created between the professionals and the users during the planning stage and the programming stage and a lack of it at the end of the programming stage and during the conceptual design stage.

4.4.3 Governance

In the governance category, we have identified two subcategories of alignment factors: facilitating and influencing. The following sections provide more details of these results.

4.4.3.1 Facilitating factors

The table below presents the only alignment facilitating factor identified during the NCH project: Stakeholder (user) involvement in decision-making. This factor was identified in both planning and programming.

Table 4.6 Alignment facilitating factors identified in the NCH: governance

Facilitating factors	Planning stage	Programming stage	Conceptual design stage
Stakeholder (user) involvement in decision-making	●	●	

Stakeholder (user) involvement in decision-making

Different respondents agreed with the fact that user involvement in decision-making is an important alignment facilitating factor. It was addressed during both the planning and the programming stages, and it is linked to the user involvement during the project definition process (critical factor identified in the communication category).

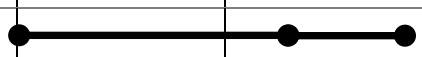
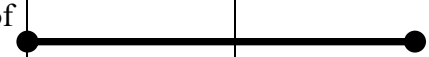
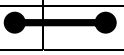
A clinician explains that Lean-led Design approach gives the user more power during the process: *“ Lors des exercices Kaizen on était plus que des observateurs. On a réfléchi et pris des décisions importantes à propos du nouvel hôpital. Par exemple on a pris des décisions par apport aux liens de proximité entre les différents services spécifiques de chaque spécialité*” (During the *Kaizen* exercises we were more than observers. We thought about and made some important decisions about the new hospital. For example, we took decisions based on the proximity links between the different services specific to each specialty) [clinician]. The participation of users in making decisions have a significant influence upon the form of design solution since they understand the functional issues better than the design professionals. This gives them more power during these stages and could explain their lack of involvement in the decision-making process at the end of the programming and during the conceptual design stages. At these stages, the process is more technical, and most users lack the background to participate in decision-making on equal terms with designers. They are therefore unable to exert symbolic power in response to that exerted by the design professionals.

In conclusion, user involvement in the project definition process is, itself, indicative of user power and influence over the decision-making process. It helps to bring an add value to the process. However, in this project this factor was addressed only during the planning and programming stages, which could be explained by the adoption of a non-participative approach.

4.4.3.2 Influencing factors

The following table summarizes the alignment facilitating factors identified in each stage of the project definition of the NCH. Almost all factors identified are similar to those found in the theory (e.g., effective leadership and transparency of information). However, a new factor was identified (loss of information).

Table 4.7 Alignment influencing factors identified in the NCH project: governance

Influencing factors		Planning stage	Programming stage	Conceptual design stage
Leadership	Effective leadership			
	Lack of leadership			
Priorities	Setting clear priorities			
	Unclear priorities			
Information	Transparency of information			
	Non-transparency of information			
	Loss of information			

Leadership: effective leadership/ lack of leadership

The analysis of the interview revealed that another factor influencing the alignment during the project definition is the leadership or more precisely the leadership consistency. During the project definition stages, changes in leadership occurred. As explained in section 4.3, these changes occurred during the middle of the programming stage (*kaizen* 3) and at the end of the programming stage (*kaizen* 5), which impacted strategies adopted during the project definition process.

According to the clinical managers, when the leader changes, the strategy changes with: *" Durant les 3 premiers kaizen, le responsable c'était la direction clinique du NCH et quand la phase de la programmation a commencé c'était plus les concepteurs qui avaient le lead de cette phase. Cependant, même s'ils ont bien organisé les activités 4,5,6, la démarche a été un peu dénaturée. Ils avaient suivi une autre stratégie. Si on était les responsables de toutes les activités Lean on aurait fait quelque chose de différent* " (During the first 3 *kaizen*, the lead was of the clinical direction of the NCH and when the programming phase started it was more the designers who had the lead in this phase. However, even though they organized the activities 4,5,6 well, the process was a bit distorted. They had followed a different strategy. If we were in charge of all Lean activities, we would have do it different) [member of the NCH

clinical management team]. Besides that, between the programming and the preliminary design stage, the approach and the strategy have changed again*: "il y avait une confusion entre deux façons de faire, Lean vs traditionnelle*." (There was a confusion between two ways of doing things, lean vs traditional) [project manager of SQI].

Having said that, maintaining the same strategy during the project definition process, in complex projects is a big challenge. Even though to mitigate this problem between the planning and the programming stages members of the clinical management were also involved in the whole stage of the programming, clinical managers still think that changing the organizational responsible could distort the project definition process. Furthermore, the leadership consistency and effectiveness factor influence different other factors such as the involvement of the users, the communication between the stakeholders, and it is also influenced by the personal turnover (see section 4.4.7). It could be said that in this project, the change of the leader between the stages impacted the continuity of the strategy followed and thus longitudinal alignment, especially between the programming and the schematic design stage. Adopting a participative approach during the whole process could significantly reduce the impact of this factor.

To conclude, during the planning and programming, the clinical management team members have been important catalysts and leaders in this undertaking, as they worked as change agents, first to involve the main users and second, to drive them through Lean activities. During the design stage, we cannot say that there has been a lack of leadership during the stages. However, there was a lack of leadership during the transition between the programming and conceptual design stages.

Priorities: Setting clear priorities/ unclear priorities

Setting clear priorities between users 'needs was identified by almost all interviewees as an important factor that impacts the alignment during the project definition. According to a member of the NCH project, setting clear priorities was one of the main objectives of the *kaizen* 2 and 3 in order to facilitate the decision-making: "*Pour les besoins c'est un casse-tête, il faut*

donc prioriser les besoins puisqu'on ne pourrait pas prendre en compte tout ce que les cliniciens veulent. On a budget restreint." (Needs are a major headache, so you have to prioritize the needs since you could not take into account everything that the clinicians want. We have a limited budget) [Design professional mandated for both programming and design stages]. It is in fact, challenging to set priorities specially in complex projects. Priorities are subjective and related to users 'perceptions. As an example for that, during Lean activities, all doctors wanted to have a proper office, however, it was not possible due to the limited budget: " *On était obligé de créer des bureaux partagés même si les médecins n'étaient pas satisfaits*" (We were forced to create shared offices even if the doctors were not satisfied) [Design professional mandated for both design stage]. Having individual office is not important as having individual patient room.

To sum up, defining what needs should be treated as more important was considered by the respondent as important, during the whole process of project definition. However, it is not always easy to prioritize the needs especially when the project is complex with a limited budget. The early involvement of users could reduce the complexity of the process and facilitate the decision-making.

Information: transparency of information/ non-transparency of information/ loss of information

The analysis of the results revealed that during the project definition, the information shared among stakeholders was transparent, since every member of the project office share his work progress in the SharePoint platform and had also access to others 'work. This information was also shared with users: "*On partage avec tous eux: les bilans, les plans et les conclusions*" (We share with all of them: reports, plans and conclusions) [member of the NCH clinical management team]. However, even though the information was shared in this collaborative platform, we have noticed a loss of information during the transition between the programming and the conceptual design stages and a lack of information transparency during the conceptual design stage.

As an example of that, the classification of the different proximity links between the hospital department into essential, desirable and strong. While a clinical manager explains that during the *kaizen* 4 "*on a illustré les liens de proximités devant tous les secteurs hospitaliers. On a créé aussi des liens de priorités entre eux. Ce travail était l'intrant principal qu'on a donné aux concepteurs*" (we have illustrated the proximity links in front of all the hospital sectors. We also created priority links between them. This work was the main input given to the designers), a design professional mandated for the design stage claims that " *On a reçu les liens entre les secteurs, mais ceci a été fait d'une façon assez générale sans donner des priorités. Nous avons donc rencontré secteur par secteur pour le faire*." (We received the links between the sectors, but this was done in a fairly general way without setting priorities. We therefore met sector by sector to do so). This means that, in spite of the effort realized during the *kaizen* 3 to develop this input to start the design stage, it was lost during the transition between the programming and schematic design stage. Thus, the design professionals repeated the same process, wasted time and effort. During the design stage, a lack of information transparency was identified, because at this stage users were no longer involved, and the existing information of the SharePoint was only shared with members of the project office.

To sum up, a loss of information was identified between programming and conceptual design stage when trying to move it across different domains. This loss created a gap between the stakeholders of each stage. This situation could be a result of changes in leadership and a lack sharing knowledge among the stakeholders of both stages (see section 4.4.7.1). It is also a result of adopting a traditional approach (sequential and fragmented). Having said that, sharing information in a collaborative platform is not enough to reach a horizontal alignment. The communication between the parties is a must.

4.4.3.3 Summary

Figure 4.17 summarizes the total of alignment factors associated with the governance category, identified based on both literature and case study combined: 1 facilitating, 1 hindering and 3 influencing. In fact, not all factors identified in the literature were identified in our case study.

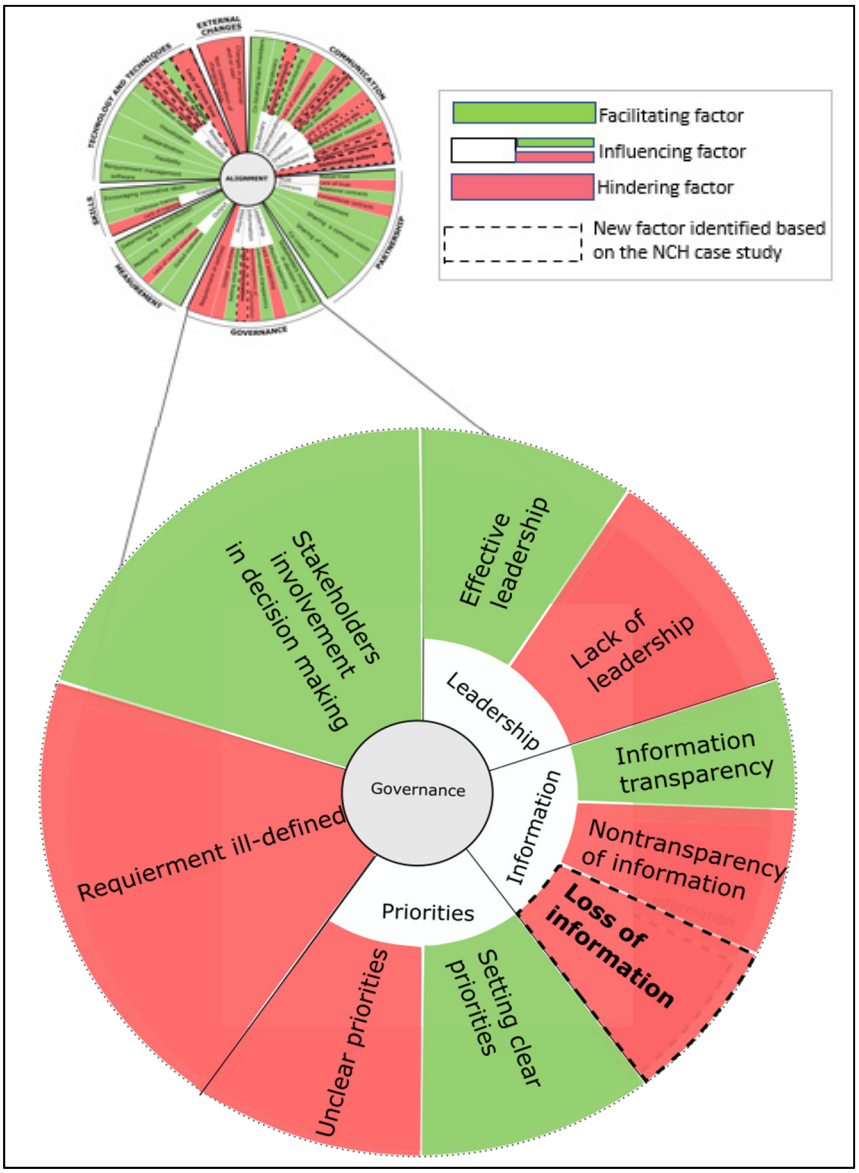


Figure 4.17 Total of factors identified based on both the literature and the case study: governance

The hindering factor, namely “requirement ill-defined”, was not identified during the three stages. Further, we have identified a new hindering factor, which is: loss of information. This factor was identified appeared between the end and the beginning of programming and conceptual design stages. Also, we noticed that this factor could be classified in the category of influencing with “information transparency” and “non-transparency of information”, since all three factors are about “information”. That’s why, we classified this new factor identified in the same subcategory of influencing, as shown in the Figure 4.17.

Further, as shown in the following figure (4.18), the factors identified change from a stage to another. The majority of alignment facilitating factors were addressed during the planning and programming stages, unlike the conceptual design stage where the majority of factors identified are hindering. This situation, related to leadership and approach changes, created a clear gap between the two final stages of the project definition.

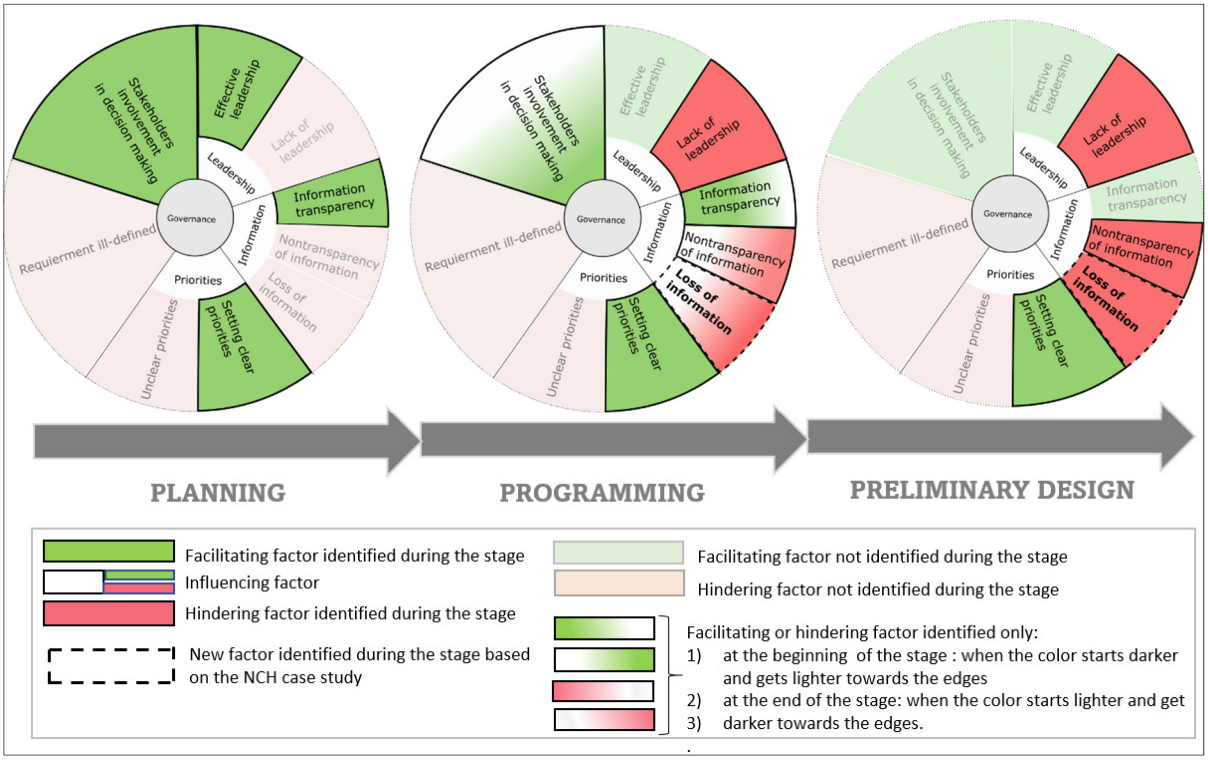


Figure 4.18 Factors related to governance identified during each stage of the project definition of the NCH

4.4.4 Measurement

In this category, we have only identified the influencing factors. The following section provides more details of this result.

4.4.4.1 Influencing factors

We have identified only one factor which is output (output evaluation/ lack of output evaluation) and it is similar to the one identified in the literature (Table 4.8).

Table 4.8 Alignment influencing factors identified in the NCH project: measurement

Influencing factors		**Planning stage**	**Programming stage**	**Conceptual design stage**
Output	Output evaluation	●	●	
	Lack of output evaluation			●

Output: output evaluation/ lack of output evaluation

Evaluate the output of each step of the project or also the solution was identified by the majority of the respondents (clinical manager, project manager and professionals) as a facilitating alignment factor. This evaluation based on a set of criteria and on an evaluation grid.

During the first Lean activity, the participants have developed 25 guiding principles or also named strategic orientation: *"on a développé, 25principes directeurs afin de nous aider à prendre de meilleures décisions par après"* (we have developed 25 guiding principles to help us make better decisions afterwards) [Clinician]. These principles represent the general project criteria of NCH and used in each *kaizen* in order to ensure that the solutions proposed are aligned with the project purpose. As an example of these criteria, we can find: 1) define spaces that bring together the patient, the patient's family, and the various stakeholders, 2) prevent and control infections, 3) standardize the processes, etc. During *kaizen* 3 and 4, these criteria have

been adjusted. The reason for that, as the design professional explains, was the fact that the criteria previously defined was not tangible or operational: "*les 25 principes n'étaient pas très opérationnels. On a donc traduit ses principes en terme plus technique de conception*" (the 25 principles were not very operational. We have therefore translated its principles into more technical design terms) [Design professional mandated for the programming stage]. Another technique used by the same professionals to evaluate the programming stage output was the evaluation grid: "*On avait des grilles d'évaluation des hypothèses d'implantation. Grâce à cette évaluation on a eu un 90% de dégrée de satisfaction des participants"* (We had assessment grids for the implementation assumptions. Thanks to this evaluation we had a 90% degree of satisfaction of the participants) [Design professional mandated for the programming stage]. This grid was used during the Lean activity 4 in order to evaluate the five hypotheses proposed of building implantation on the site (see. Section.4.3), and also it aims to evaluate the degree of the users' satisfaction regarding these solutions.

During the conceptual design stage, a lack of output evaluation was identified. The evaluation of the design solution was, however, realized at the end of the design stage, when the design plans were finished. The lack of evaluation at the conceptual design stage could be explained by the adoption of a non-participative approach. To sum up, in the NCH project, the output evaluation factor was addressed mainly during the planning and the programming stages. This evaluation, realized with the active participation of users, facilitate the decisions to make and the match between needs and solutions.

4.4.4.2 Summary

The following Figure summarizes the total of alignment factors associated with the measurement category, identified based on both theory and case study combined: 2 facilitating and 1 influencing. In fact, not all factors identified in the literature were identified in our case study.

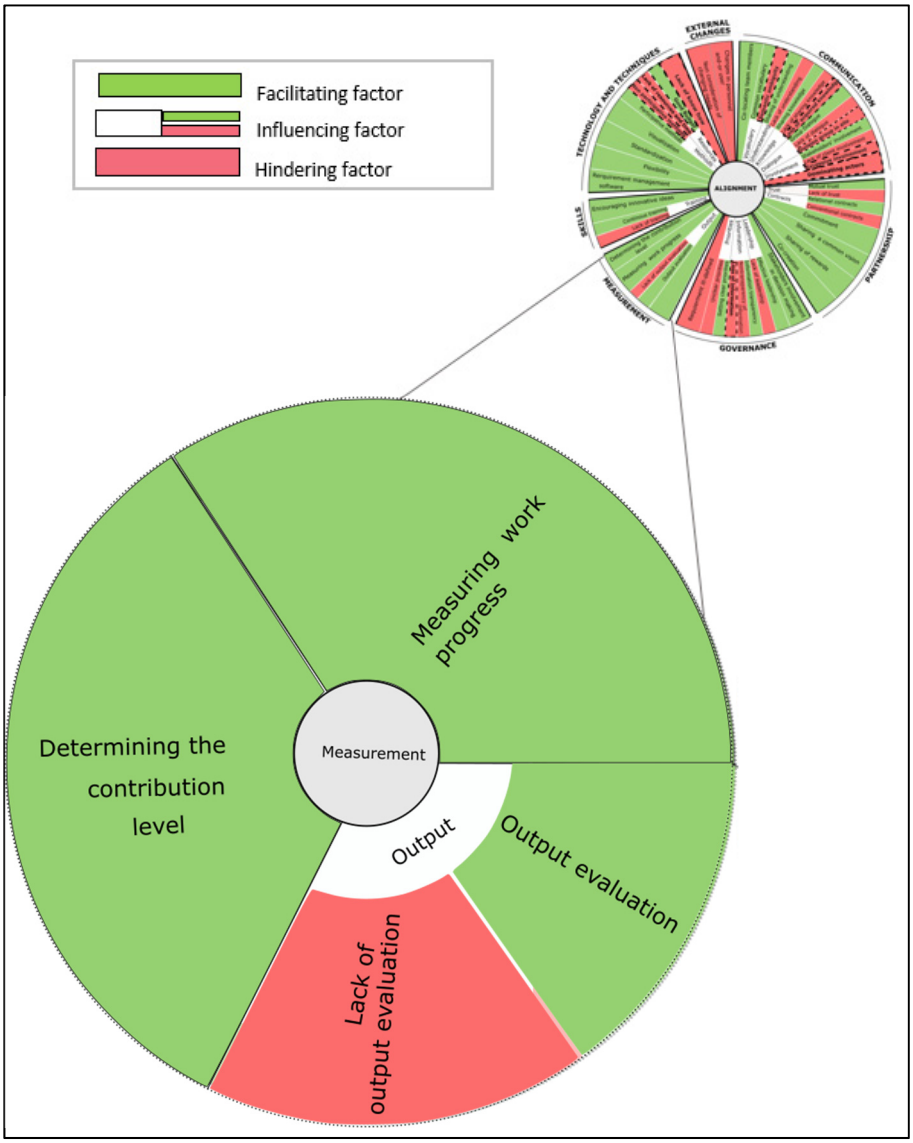


Figure 4.19 Total of factors identified based on both the literature and the case study: measurement

Two factors: 1 facilitating (measuring work progress) and 1 hindering (determining the contribution level) were not raised by interviewees as important to achieve an alignment between the needs and the design solution. As shown in the figure 4.20 these factors were not identified in any of the project definition stages. The only factor identified during the process is the influencing factor related to the "output ": output evaluation and lack of output evaluation. More precisely, there is an evaluation of the output during the planning and the programming, and a lack of it during the conceptual design stage.

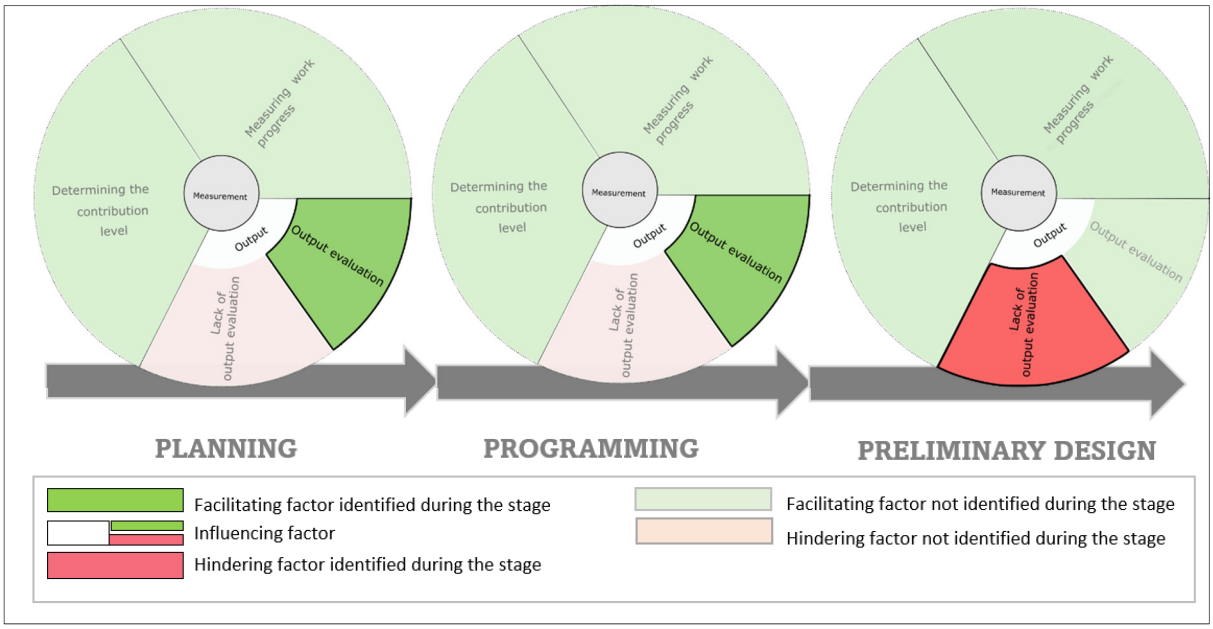


Figure 4.20 Factors related to measurement, identified during each stage of the project definition of the NCH

4.4.5 Skills

As in measurement category, in this one we have identified only one subcategory of factors which is "influencing". The following sections provide more details of this result.

4.4.5.1 Influencing factors

As presented in the following table, the Factor identified is training (continuous training /lack of training). This factor is similar to the one identified in the literature.

Table 4.9 Alignment influencing factors identified in the NCH project: skills

Influencing factor		**Planning stage**	**Programming stage**	**Conceptual design stage**
Training	Continuous training	●	●	
	Lack of training			●

Training: continuous training /lack of training

Almost all interviewed project managers and Lean agents, highlighted the importance of the training session in ensuring an alignment between the participants. In the NCH project, many users were not familiar with the project definition process and Lean method neither. It was thus, important according to the clinical managers to organize different training sessions, specifically before each Lean activity: "*On faisait des formations à 7h du matin*" (We organized training at 7 am) [member of the NCH clinical management team]. Six training sessions of 1h to 1h 30min were organized by the internal team of the clinical management of the NCH. The objective was to introduce or refresh some Lean concepts (value stream mapping) or architectural concepts (ex. scale): "*les formations nous aidé à mieux comprendre le vocabulaire utilisé par les architectes*" (the trainings helped us to better understand the vocabulary used by architects) [Patient]. The training sessions facilitate the creation of a common vocabulary and thus sharing understanding between the participants.

Thus, the continuous training factor was addressed during both planning and programming stages, unlike the conceptual design stage where a lack of training was identified. Addressing this factor positively influence the understanding of the stakeholders and reduce the impact of the changes in users during the project definition process (see section 4.4.7.1). A continuous training is an important learning process that aims not only to deliver specific knowledge in accordance with the objectives but also to create a team positive attitude.

4.4.5.2 Summary

Figure 4.21 summarizes the total of alignment factors associated with the skills category, identified based on literature and case study combined: 1 facilitating and 1 influencing.

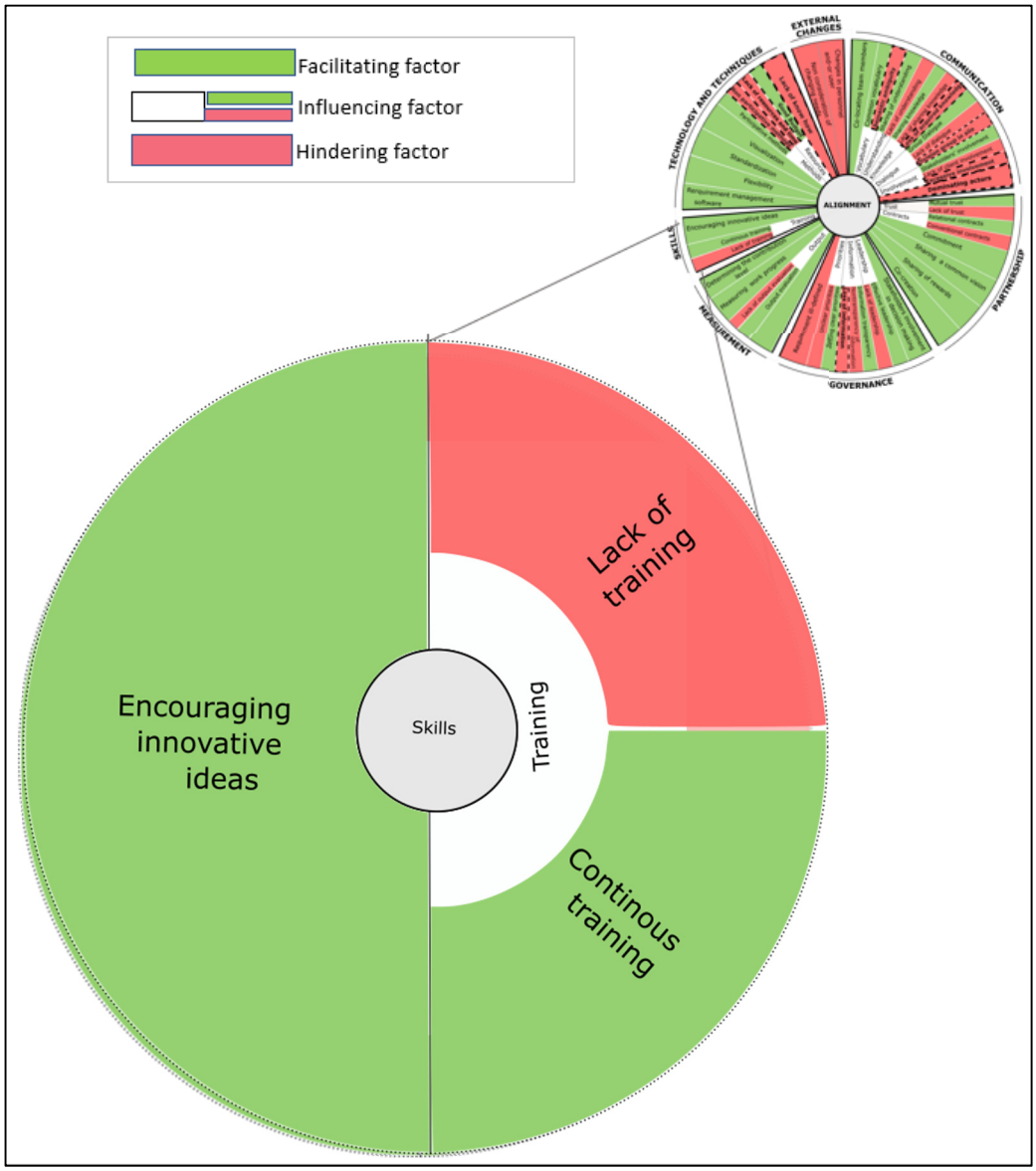


Figure 4.21 Total of factors identified based on both the literature and the case study: skills

However, as shown in the figure 4.22,encouraging innovative ideas was not identified by the respondent as a facilitating factor, during the project definition of the NCH. Only one factor

was identified: training (continuous training /lack of training). More specifically, a continuous training was addressed during both the planning and the programming, while a lack of it was identified during the preliminary design. Further, it was noticed that this factor influences others in the communication category (e.g., common vocabulary, sharing understanding), and also in external changes category (e.g., Changes in personnel and/or user).

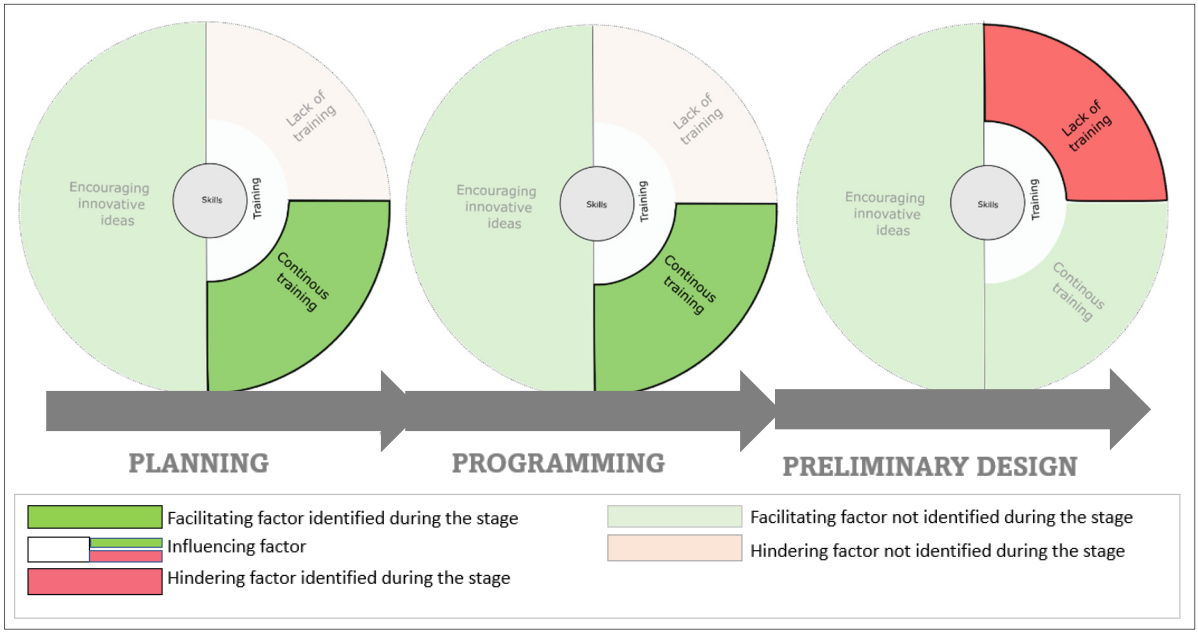


Figure 4.22 Factors related to skills, identified during each stage of the project definition of the NCH

4.4.6 Technology and techniques

In technology and techniques category, we have identified the three subcategories of factors: facilitating, hindering, and influencing. The following sections provide more details about that.

4.4.6.1 Facilitating factors

In this subcategory of factors, we have identified three factors: standardization, visualization, and flexibility (Table 4.10). The three factors were also identified in the literature.

Table 4.10 Alignment facilitating factors identified in the NCH project: technology and techniques

Facilitating factors	Planning stage	Programming stage	Conceptual design stage
Standardization	●	●	●
Flexibility	●	●	●
Visualization	●	●	
Requirement management software			

Standardization

The standardization factor was identified as an alignment facilitating during the whole project definition phase. This factor was addressed in order to improve the process of planning and programming and also to facilitate the design, as proposed in the literature. For instance, based on our analysis during planning and programming stages and even though the objective of each Lean activity was different, the process was often the same. In each activity the participants repeated approximately the same steps (Figure 4.23).

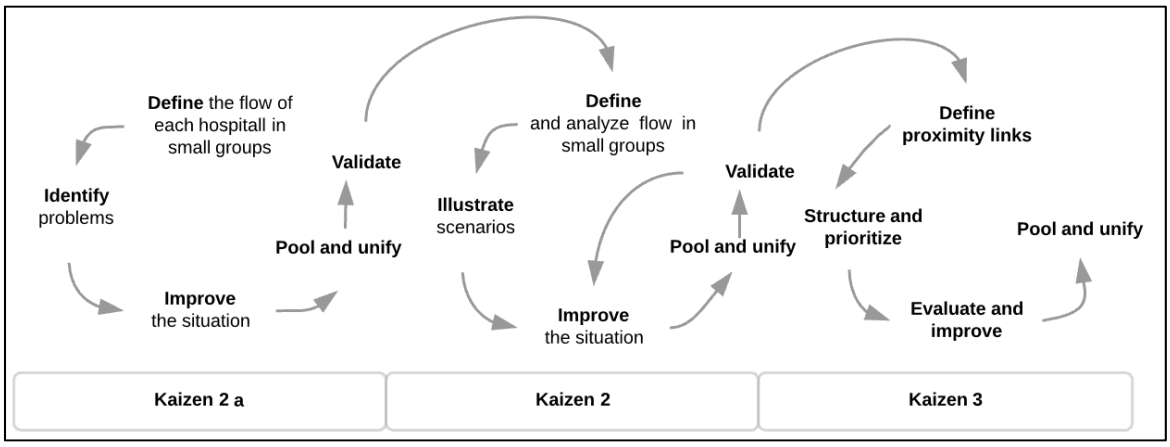


Figure 4.23 Standardized process (Lean activities)

They started with defining or identifying the actual situation in a small group of works, after that they identified problems and their root causes. Based on that they improved the situation or proposed a solution, and then, they finished by gathering and validating results of all groups.

The standardization factor was also addressed when designing spaces and rooms in order to improve safety and reduce risks of errors: "*Par exemple, les équipements sont toujours dans la même place, les chambres des patients vont toujours être de 50 m2, avec de la lumière naturelle et avec le même design intérieur"* (For example, the equipment is still in the same place, the patient rooms are always going to be 50 m2, with natural light and with the same interior design) [Design professional mandated for the design stage]. However, according to many respondents, unifying rooms is not easy to be achieved in mega hospitals because several spaces and rooms are unique and could not be standardized, for instance the case of emergency stretcher space: "*mais standardiser n'est pas toujours possible*" (but standardizing is not always possible) [Design professional mandated for the design stage].

Thus, standardization helps to decrease variation and costs and increase patient safety. It is an important factor to achieve an alignment and add value to patients. However, it remains difficult to be achieved in some hospital rooms due to their particularities.

Flexibility

Flexibility factor was identified during the whole process of project definition. In fact, stakeholders of the NCH were aware of uncertainties in future demand and recognized the need for flexibility: "*On est conscient qu'il y a des éléments qui évoluent des choses qui peuvent changer liés aux méthodes des cliniciens ou la technologie. On a donc mis un processus de changement de programme fonctionnel et technique*" (We are aware that there are elements that evolve, things that can change related to the methods of clinicians or technology. We therefore implement a process of change of functional and technical program) [Project manager of the SQI]. To deal with these changes in needs, the project manager along with construction professionals modified the needs transcribed in the FTP after its approval more than 20 times in order to help designers to develop a solution based on actualized needs. Further, another way to deal with unplanned changes was to prioritize to design flexible operation rooms and spaces: "*on a essayé de garder une certaine flexibilité lors de la conception*" (We tried to keep a certain flexibility during the design) [Design professional mandated for the design stage]. This flexibility should allow for example adding additional

floors or spaces if in response to changes of circumstances during the lifetime of the infrastructure.

Flexibility is thus an important facilitating factor for hospital infrastructure in today's highly unpredictable health care environment, and it should create a better alignment between needs and solutions.

Visualization

Visualization was addressed during Lean activities organized during both planning and programming stages in order to facilitate the understanding of users. To do so multiple tools/techniques have also been used, more specifically, brainstorming, mappings, and mock-ups, etc. The use of these tools/techniques change depending on the objective of each step. For example, when the objective is to test or validate operating modes, the participant used small and full-size model of mock-ups. By using visualization tools/techniques, participants understand better the solution: "*ça évite les mauvaises interprétations et ça nous permet d'avoir une vision plus claire des solutions. On est dans le tangible est non pas l'abstrait*" (It avoids bad interpretations, and it allows us to have a clearer vision of the solutions. We are in the tangible, not the abstract) [doctor]. Visualisation gives thus a clear idea about each information discussed which make it easier for user mind to comprehend and therefore identify problems or areas that need to be improved. Visualization tools/techniques also facilitate the communication between the participants, as express by a member of clinical management of the NCH: "c'est une *une base de communication commune entre les cliniciens et les architects*" (It is a common basis of communication between clinicians and architects).

Unlike the traditional project definition practices when the visualization factor is a usually neglected, in Lean-led Design approach, this factor is addressed starting from the beginning of the planning stage. Addressing this factor impact other factor in communication category previously presented (see 4.4.1.2), specifically the factor of sharing understanding between users and design professionals.

4.4.6.2 Influencing factors

The following table summarizes the two alignment influencing factors identified in each stage of the project definition of the NCH: 1) methods (e.g., participation methods/Lack of participation methods), 2) resources (sufficient resources and time / Lack of resources and time). In fact, participation methods and lack of resources and time are similar to those found in the literature, while lack of participation methods and sufficient resources and time represents new factors identified based on our case study. The factors newly identified represents the opposite of those found in the literature. This explains the reason for creating this subcategory of factors in "technology and techniques" category and why we present these factors altogether.

Table 4.11 Alignment influencing factors identified in the NCH project: technology and techniques

Hindering factors		**Planning stage**	**Programming stage**	**Conceptual design stage**
Methods	Participation methods	●	●	
	Lack of participation methods		●	●
Resources	**Sufficient resources and time**	●	●	
	Lack of resources and time		●	●

Methods: participation methods /lack participation methods

While implementing participation methods (e.g., Lean activities) should facilitate the alignment between users' needs and design solutions: " *le Lean nous aide à être mieux alignés*" (Lean approach helps us to be better aligned) [clinician], a lack of participation methods could hinder it. As explained in section 4.3, both methods were implemented during the process of project definition. Participation methods were implemented during the planning stage and programming stage, non-participative methods were implemented at the end of the

programming stage (while drafting the FTP) and during the preliminary design stage: "*On revient au mode traditionnel pour l'élaboration des plans, car les concepteurs se sentent plus en confiance avec ce mode de travail que celui de la conception intégrée. Mais c'est aussi à cause du budget* " (We go back to the traditional way of drawing up plans, because designers feel more confident with this way of working than with integrated design. But it's also because of the budget) [member of the NCH clinical management team]. However, according to different respondents, the choice of a non-participative method was not the best decision taken. This changing may undo what it was previously done during the participative approach such as the loss of acquired knowledge (see. Section 4.4.1.3). It also could undo some decisions made previously in a collaborative way, since the strategy undertaken is different (see. 4.4.3.2).

To conclude on this point, participation methods should facilitate alignment between client needs and design solutions and a lack of participation methods could hinder that. However, changing from participation methods to nonparticipation ones have an adverse impact on the project definition process and leads to a misalignment between the decisions to take before and after. The implementation or not of such methods is mainly related to resources allocated to each project, as explained next.

Resources: sufficient resources and time / lack of resources and time

A lack of resources (human and budgetary) and time is one of well-known factors that impact the alignment. In the NCH project, while sufficient resources and time was allocated in order to implement Lean activities during the planning and programming, a lack of resources was identified during the preliminary design stage: "*les gestionnaires de projet veulent arriver aux résultats, mais ils ont un budget restreint. Ce n'est pas possible*" (Project managers want to get results, but they have a tight budget. It is not possible) [Mechanical engineer]. This explains the lack of implementation of a participative approach during this stage.

In addition, due to the limited budget, some needs requested by users were not considered during the design stage: "le *budget est un élément très important qui aide ou limite l'adéquation entre ce qui est exprimé et le réalisable*" (The budget is a very important element that helps or

limits the fit between what is expressed and what is achievable) [project manager of the SQI]. Considering all the needs may lead to an over budget. However, users that have participated during Lean activities were not aware of this limitation: "*On les fait trop rêver…comme s'il n'y a aucune contrainte"* (We make them dream too much ... as if there is no constraint) [clinical management of the NCH]. This created a gap between the list of needs defined by the clinicians during the *kaizen*, and those presented in the design solution.

Furthermore, due to the lack of time especially at the end of the programming stage, the technical part of the FTP was realized in a harry: "*parce que la démarche était tellement longue. On avait donc moins de temps pour la suite"* (because the process was so long. We therefore had less time for the next phase) [clinical manager of the NCH]. The design professionals had less time in order to develop the technical requirements, since the focus was more on elaborating the functional requirements. This leads to errors and rework. Thus, "resources and time" factor influences positively or negatively other factors depending on its existence or not in the process. For instance, having resources and time facilitate the innovation and the implementation of new methods (e.g., participative methods), whereas a lack of resources and time limit that.

4.4.6.3 Hindering factors

In this section we present a new hindering factor identified based on the NCH case study.

Table 4.12 Alignment hindering factors identified in the NCH project: technology and techniques

Hindering factors	Planning stage	Programming stage	Conceptual design stage
Lack of know-how		● — ●	

Lack of "know-how"

We mean by the lack of "know-how" a lack of knowing how to implement a method or managing a process. This factor was identified mainly during the programming stage,

especially when design professionals started to be involved in the process: "*il y avait les concepteurs qui devaient faire du Lean mais qui ne savaient pas comment le faire nonplus*" (There were designers who had to do Lean but didn't know how to do it either) [clinical manager of the NCH]. These professionals were responsible for organizing *kaizen* 3 and 4. However they did not have experience on how to implement such activities. In order to reduce the impact of this factor during process, Lean agents were contracted to support them during the organization and the animation of the different *kaizen*.

A lack of know-how was also identified at the end of the programming (when drafting the FTP). In the words of a clinical manager: *"c'est un problème, assez classique parce que nos firmes de professionnels au Québec sont très mauvaises pour rédiger des PFT. Les responsables de la rédaction ne savent pas comment le faire*" (This is a fairly classic problem because our professional firms in Quebec are very bad at writing PFTs. Editors don't know how to do it). In fact, the responsibility of the FTP drafting was given to junior architects, who have less practice and experience with the hospital project and who did not participate in the different *kaizen* organized. This led to errors and gaps between users 'needs and the translation of these needs in an FTP document and may explain the loss of information identified between the programming and the design stages (see. 4.4.3.2). Thus, achieving an alignment requires more than just enough staff but also sufficient experience and competencies.

4.4.6.4 Summary

Figure 4.24 summarizes the total of alignment factors associated with the technology and techniques category, identified based on both literature and case study combined: 4 facilitating,1 hindering and 2 influencing.

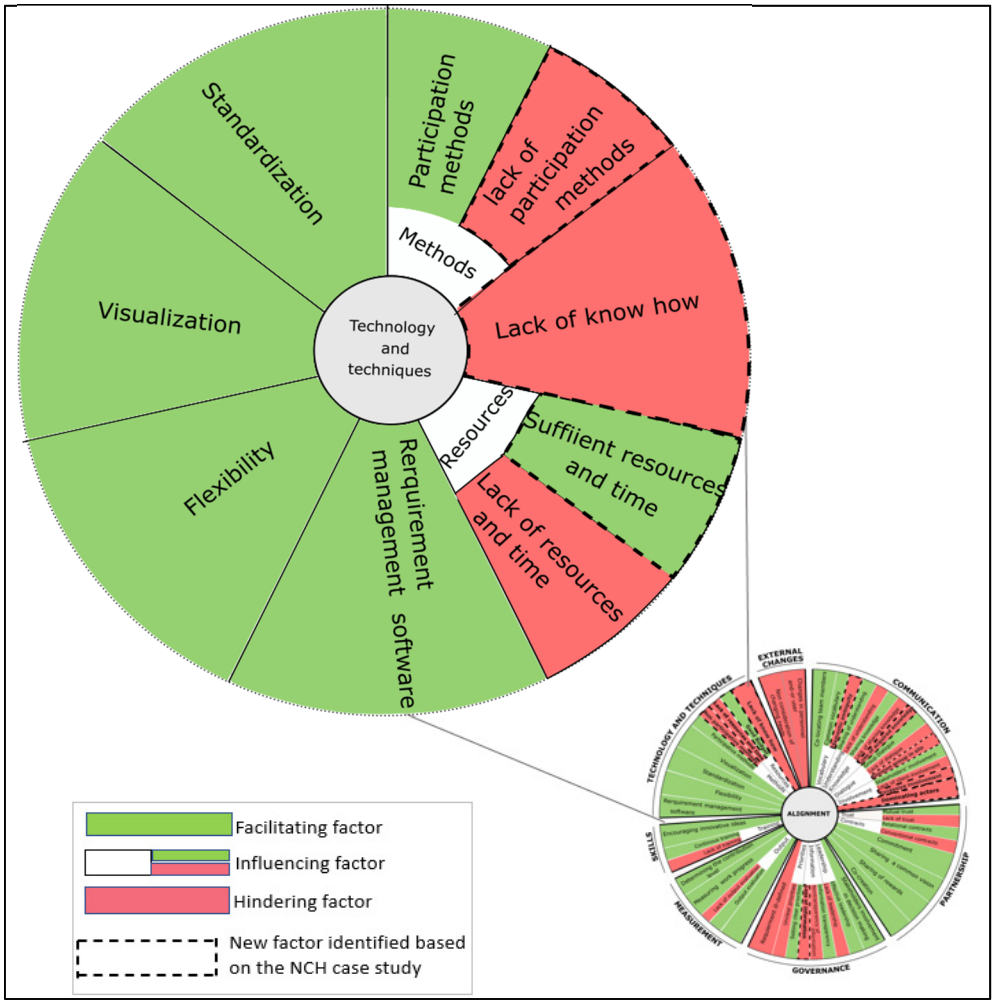


Figure 4.24 Total of factors identified based on both the literature and the case study: technology and techniques

In fact, among these factors, three were newly identified based on the case study of the NCH: lack of participation methods, lack of know-how and sufficient resources and time. While the lack of know-how is classified as a hindering factor, the two others (lack of participation

methods, and sufficient resources and time) are classified in the influencing subcategory since they represent the opposite of (participation methods and lack of resources and time.

Further, as shown in the following figure (4.25), factors identified change from a stage to another, except one (requirement management software) that did not appear during any stage of project definition. Further, as illustrated no hindering factor (red colour) was identified during the planning stage, unlike the design stage. In addition, some factors seem to be more important than others since they have a positive or a negative impact on the existence of other factors. For instance, resources and time influence the implementation of participation methods that impact on other factors such as sharing knowledge and sharing understanding (identified in the communication category).

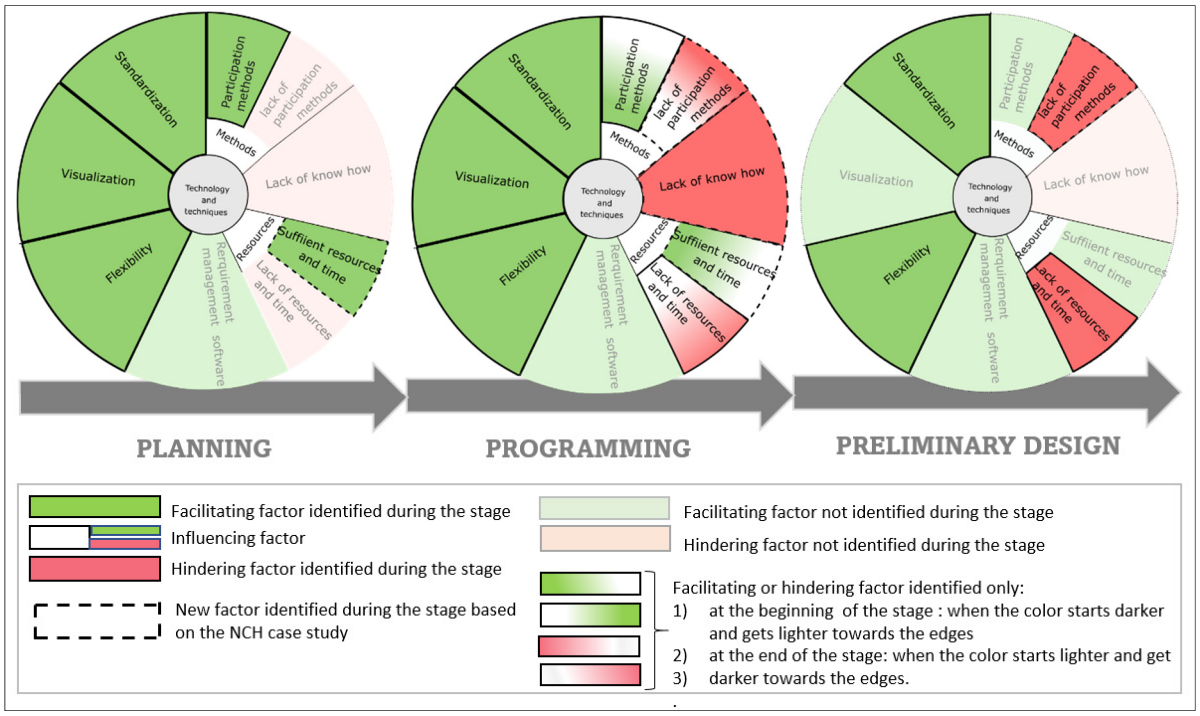


Figure 4.25 Factors related to technology and techniques, identified during each stage of the project definition of the NCH

4.4.7 External changes

As explained in chapter 3, this category only includes hindering factors. The following sections provide more details about this result.

4.4.7.1 Hindering factors

We have identified only one hindering factor: changes in personnel and/or users. As shown in the table (4.13), this factor has been identified during programming stage and between the programming and conceptual design stage.

Table 4.13 Alignment hindering factors identified in the NCH project: external changes

Hindering factors	Planning stage	Programming stage	Conceptual design stage
Non-consideration of changing needs			
Changes in personnel and/or user		●	●

Changes in personnel and/or users

Changes in personnel and/or users during and between the project definition stages were raised by design professionals, clinical and project managers of NCH, as a hindering alignment factor.

According to the clinical managers, the changes in the design professionals that occurred mainly between the programming and conceptual design stages have negative consequences on the consistency of leadership and the translation process (from the needs into the design solution), and (see. 4.4.3.2). One of the clinical managers phrased this as follows: " *le concepteur « bébé » qui n'a pas vécu avec nous les activités Lean, va dénaturer ce qu'on a fait lorsqu'il va dessiner*" ("the" baby "designer who has not experienced lean activities with us, will distort what we did when he will draw") [member of the NCH clinical management team]. As explained in the section 4.3, at the end of the programming stage, a call for tender was initiated to select a new team of professionals for the design stage: architects, electrical and

mechanical, and structural engineers. However, even though some of these professionals have participated in the Lean activity, according to the clinical managers, the change of them may distort the architectural concept and leads to multiple rework iterations.

The changes in users over the project have also been highlighted by the interviewees*:* "*Il y a des usagers qui changent, d'autres qui partent à la retraite. C'est un grand défi*" (There are users who change, others who retire. It's a big challenge) [project manager of the SQI]. Between the time that FTP was drafted and the beginning of conceptual design stage, a large number of clinicians have changed. As an example, the manager of the nephrology department has changed three times during this process. Because of that, several contradictions have been identified: " *il y a eu plusieurs contradictions à cause des cliniciens qui sont venus qui ne disaient pas la même chose que les cliniciens qui ont participé aux kaizens* " (there were several contradictions because of the clinicians newly involved did not say the same things as the clinicians who participated in the kaizens) [Design professional mandated for both programming and design stages]. The clinicians that have identified the needs and appropriated the project from the beginning are not the same clinicians consulted during the conceptual and design stages. In the NCH project, the design professionals became confused and lost between what was decided during the *kaizen* and the needs of the new clinicians.

Further, changes in personnel and/or users between the programming and schematic design stage also means that factors such as trust, sharing of understanding and the commitment previously addressed will be impacted. The professionals and the users should start to build again a new a trustful environment. However, it will be difficult if the approach chosen is not participative. In the NCH, a clinical manager explains that the impact of changes in users were reduced since the new users were involved during the *kaizen* 6 and 7 realized in parallel with the design stage, and different training sessions were organized in order to a new common ground. Another factor that could reduce the impact of the personnel turnover is a transparency of information shared during and across stages (4.4.3.2).

4.4.7.2 Summary

Figure 4. 26 represents the two hindering factors identified based on both literature and case study combined.

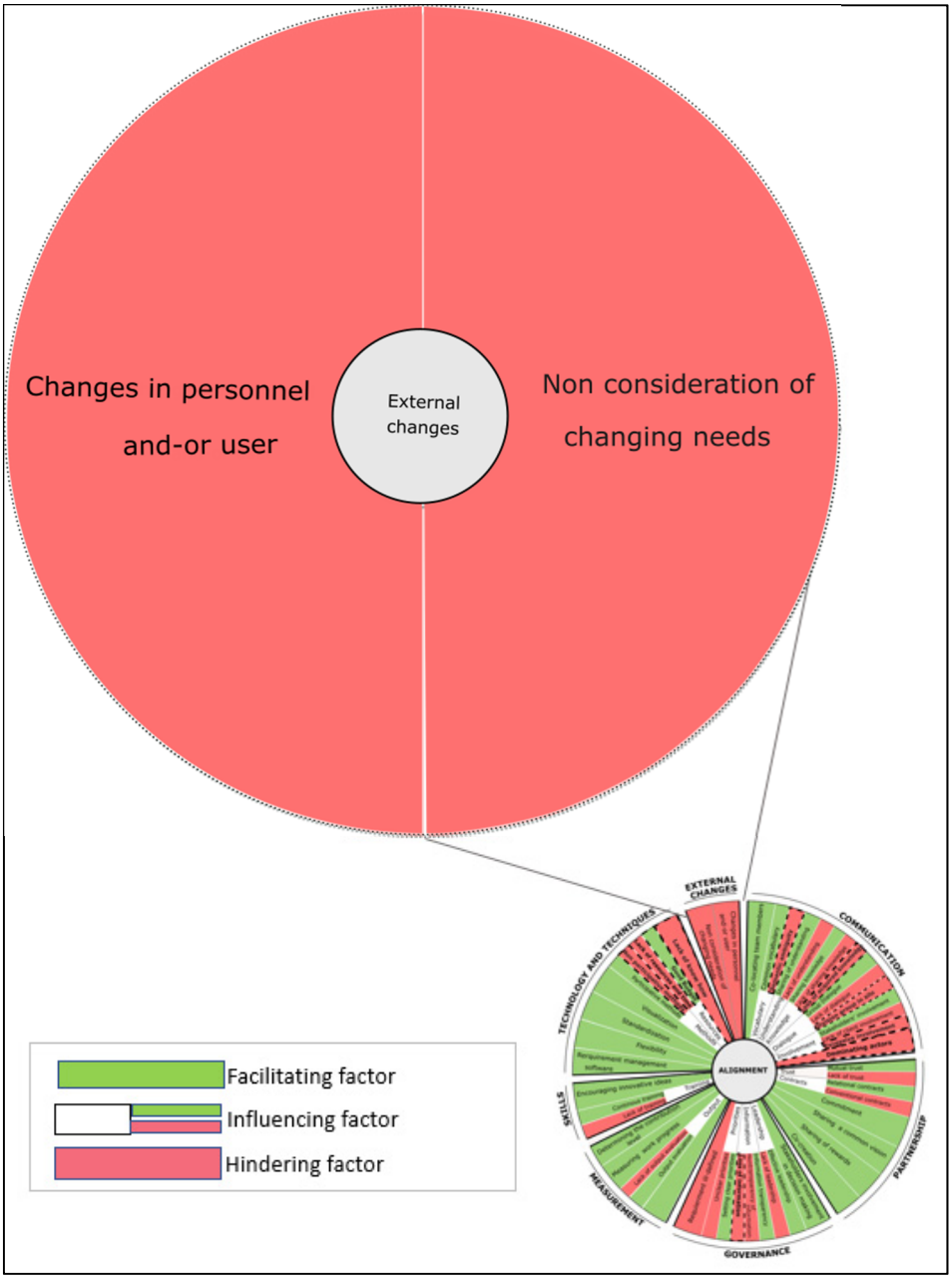


Figure 4.26 Total of factors identified based on both the literature and the case study: external changes

In fact, while in the literature we have identified both factors: non-consideration of changes needs and changes in personnel and/or users as hindering factors, in project definition of the NCH we have only identified changes in personnel and/or users. This factor was identified exactly during programming and preliminary design stages, and a lack of it during the planning stage (Figure 4.27).

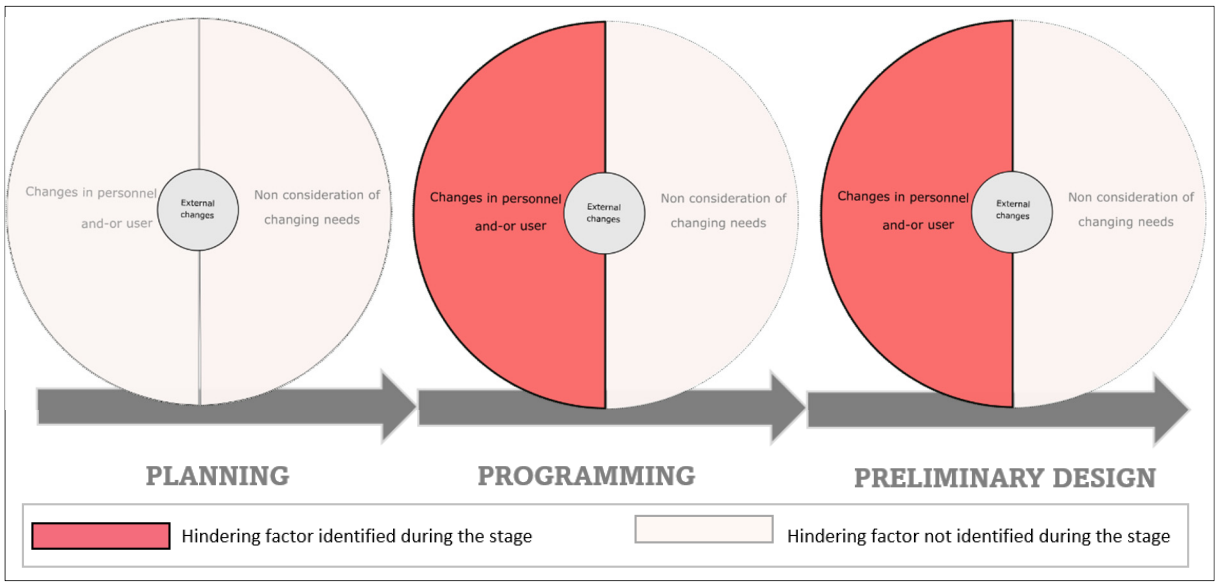


Figure 4.27 Factors related to external changes, identified during each stage of the project definition of the NCH

In the next section a discussion about the different findings will be presented.

CHAPTER 5

DISCUSSION

This study addressed the knowledge gap concerning factors that facilitate or hinder alignment between client needs and design solutions, widely regarded as one of the main challenges that most complex projects strive to successfully achieve.

The findings of this research are a number of alignment factors classified into seven categories and three subcategories that constitute a conceptual framework (Figure 5.1): 13 facilitating, 5 hindering, and 14 influencing; classified in: 1) communication, 2) partnership, 3) governance, 4) measurement, 5) skills, 6) technology and techniques, and 7) external changes. This framework was first developed based on a systematic qualitative literature review (Chapter 3) and then evaluated and revised based on the findings of our case study (chapter 4). Comparing the literature and the case study allowed us to identify not only the potential similarities and divergences but also novel relevant factors.

In next sections, these findings will be discussed in six different areas: 1) the identification of the factors and their classification, 2) alignment factors: literature vs. case study, 3) the significance of the "influencing" factors, 4) relationship between different factors, and 5) evolution of factors during the stages of project definition, 6) toward alignment assessment.

Figure 5.1 Total of factors identified based on both literature and case study: 7 categories and 3 subcategories

5.1 The dentification of the factors and their classification

Based on the case study we have identified different alignment factors that were not only identified based on the interviews but also based on the documentation reviewed. Let's take an example of "sharing of knowledge" factor. We assumed that this factor was addressed during the first two stages of project definition because:

1- We have found in the Sharepoint evidence, such as meeting reports, PowerPoint presentations of all Lean workshops organized, proving that knowledge and information were shared between the design professionals, clinical managers, project manager and users;

2- Different respondents expressed that, for instance a member of the NCH clinical management team said: " *Les kaizen ont permis non seulement aux professionnels de mieux connaitre les pratiques médicales et la réalité des cliniciens, mais aussi au personnel clinique (médecins, infirmiers, etc.) de connaitre les différentes limites du bâtiment"(*Kaizen not only allowed professionals to better understand medical practices and the reality of clinicians, but also clinical staff (doctors, nurses, etc.) to know the different limits of the building).

Further, to classify the factors identified, we used evidence from interviews. If we take the same example of "sharing of knowledge", this factor was classified in the category of communication because different authors and respondents connect the sharing of knowledge among the stakeholders with achieving an effective communication. For instance, a design professional highlighted that *" grâce à ce partage de connaissance, nous avons amélioré la communication entre nous (les professionnels) avec le client "* (thanks to this knowledge sharing, we have improved communication between us (the professionals) with the client) [Design professional mandated for the programming stage]. But then, it's true that we can classify some factors in more than one category, as an example: co-locating team members, could be classified in both communication and partnership, but in this research, the classification was based on the authors and case study context. It is therefore essential to use another case study in order to validate this classification in another context.

Furthermore, based on the research findings we have identified that some factors represent the opposite of others, more specifically those classified in the “influencing” subcategory (e.g., knowledge). We would like to specify here that it is true that we could have automatically present in the framework (see figure 5.1) the opposite of each factor identified. However, for the sake of intellectual honesty, we decided to present only those identified based on the literature or on the case study findings. More accurately, if the authors or the respondents mentioned the factor and its opposite as important to achieve or hinder the alignment, we consider both, if not we don’t. It is possible therefore to find a different result in other contexts or case study.

5.2 Alignment factors: literature vs. case study

The results show that most factors identified in the literature were also identified in the case of NCH. For instance, factors related to the communication and partnership category (Figure 5.2).

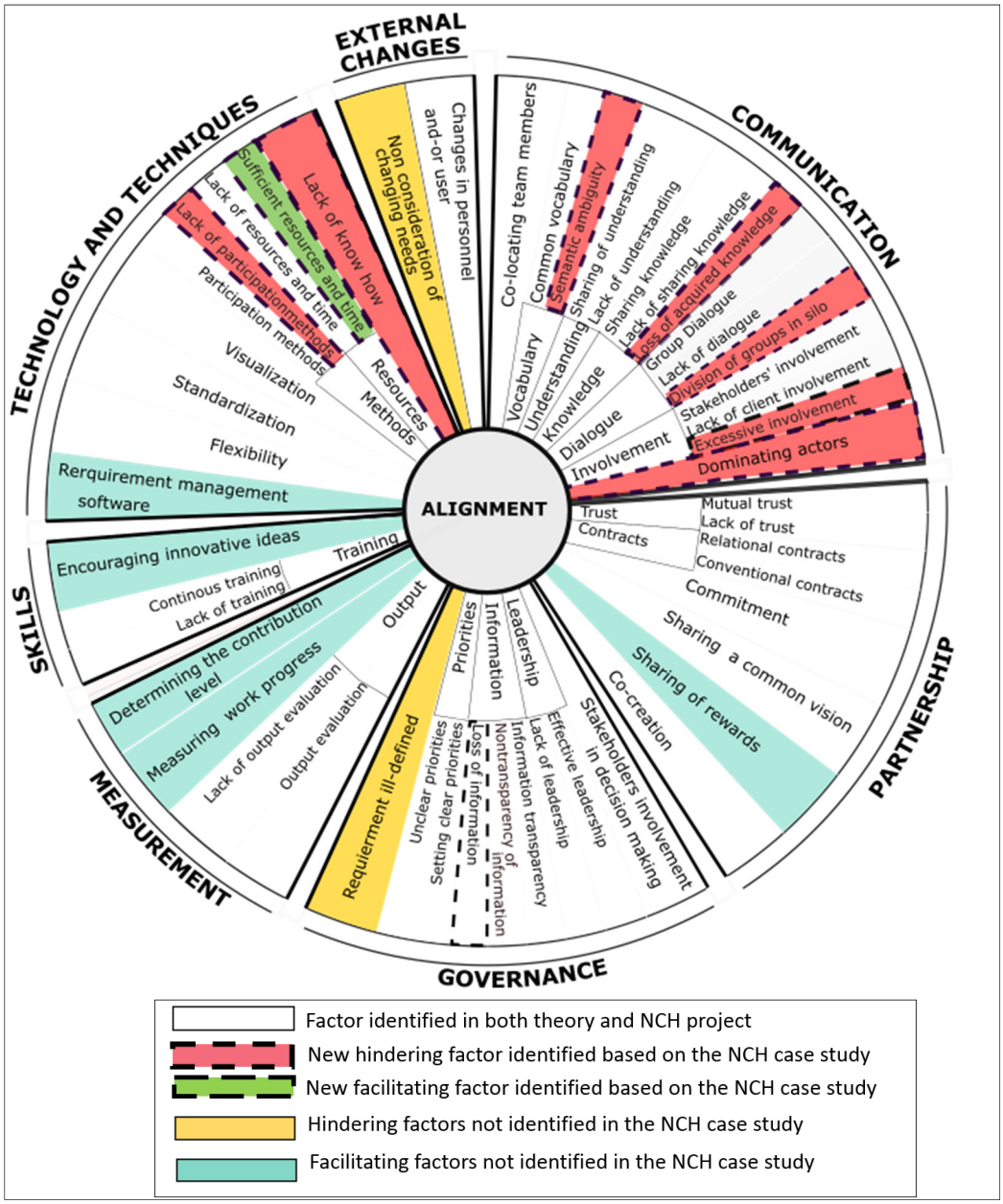


Figure 5.2 Alignment factors: literature vs. the NCH case study

However, a total of seven factors which were identified in literature were not identified during the NCH project definition or were not considered important by the respondents to achieve the alignment between client needs and design solutions, as follows:

- Two hindering factors
  - Non-consideration of dynamic needs;
  - Ill-defined requirements.
- Five facilitating factors
  - Sharing rewards;
  - Measuring work progress;
  - Determining the contribution level;
  - Encouraging innovative ideas;
  - Requirement management software.

Even though the above-mentioned factors were not identified based on our case study, we involved them in the final framework since we still considered them to be important in the process of project definition. Let us take the example of a hindering factor: ill-defined requirements. It has been proposed by different authors (e.g., Whelton (2004), Barrett and Stanley (1999)) as a major hindering factor, but it was not identified in the NCH project since according to the respondents, implementation of a participatory approach encourages the involvement of users in the project definition process thus facilitating the clarification of needs and consequently definition of the requirements: "*c'était une démarche quand même solide, elle nous a permis de bien analyser et comprendre les besoins des usagers"* (it was still a solid approach, it allowed us to analyze and understand the needs of users) [member of NCH clinical management team]. According to the interviewees, the *kaizen* sessions during both the planning and the programming stages enabled designers to better understand the functional needs and translate them into requirements transcribed in the FTP.

Regarding the second hindering factor that was not identified in our case study (non-consideration of dynamic needs), interviewees seem to believe that design and construction professionals are already aware of this dynamism: "*On est conscient qu'il y a des éléments qui*

évoluent des choses qui peuvent changer liés aux méthodes des cliniciens ou la technologie. On a donc mis un processus de changement de programme fonctionnel et technique" (We are aware that there are elements that evolve, things that can change related to the methods of clinicians or technology. We therefore implement a process of change of functional and technical program) [SQI project manager]. This means that an awareness and consideration of evolving users needs exist, since the FTP was modified several times. However, it is important to consider that implementation of the Lean-led design approach ended in 2016 and the NCH buildings are still in design/ construction stages up until the present day. There is not sufficient hindsight to enable a reliable assessment of the dynamic needs and whether these needs were considered during design /construction stages of the NCH project.

The method in this study did not allow us to assess the importance and role of the 5 facilitating factors in the literature identified by authors such as Griffith and Gibson (2001); Bond-Barnard et al. (2018); Bingham, and Gibson et al. (2019), in ensuring alignment between client needs and design solutions in the NCH project. It is important to note, however, that some interviewees pointed out the benefits of considering some of these factors (e.g., sharing rewards): "*Il est vrai que lorsqu'on est dans un contexte où les risques et les pertes sont partagés, les résultats sont toujours meilleurs*" (It is true that when you are in a context where risks and losses are shared, the results are always better) [Design professional mandated for the design stage].

Besides that, we have identified 9 factors based on the NCH case study that were not found in the literature as follows:

- One facilitating factor
  - Sufficient resources and time.
- Eight hindering factors
  - Dominating actor;
  - Division of dialogue groups in silo;
  - Semantic ambiguity;
  - Lack of know-how;

- Excessive involvement;
- Loss of acquired knowledge;
- Non-participative method;
- Loss of information.

Let us take the example of the facilitating factor "*sufficient resources and time*" classified in the category of technology and techniques (Figure 5.3). While in the literature a "*lack of resources and time*" was identified as a hindering factor for alignment, it was noted by several interviewees (design professionals and clients) that having resources and time at the beginning of the project definition (planning and programming stages) obviously contributed to the project success: " *le budget est un élément très important qui aide ou limite l'adéquation entre ce qui est exprimé et le réalisable*" (the budget is a very important element that helps or limits the fit between what is expressed and what is achievable) [SQI project manager]. Some respondents have also insisted that one of the main reasons for the lack of implementing a participative approach during the preliminary design stage is the lack of resources and time, as quoted by a member of the NCH clinical management team "*On revient au mode traditionnel pour l'élaboration des plans.... c'est à cause du budget*" (We are going back to the traditional way of drawing up plans ...it's because of the budget).

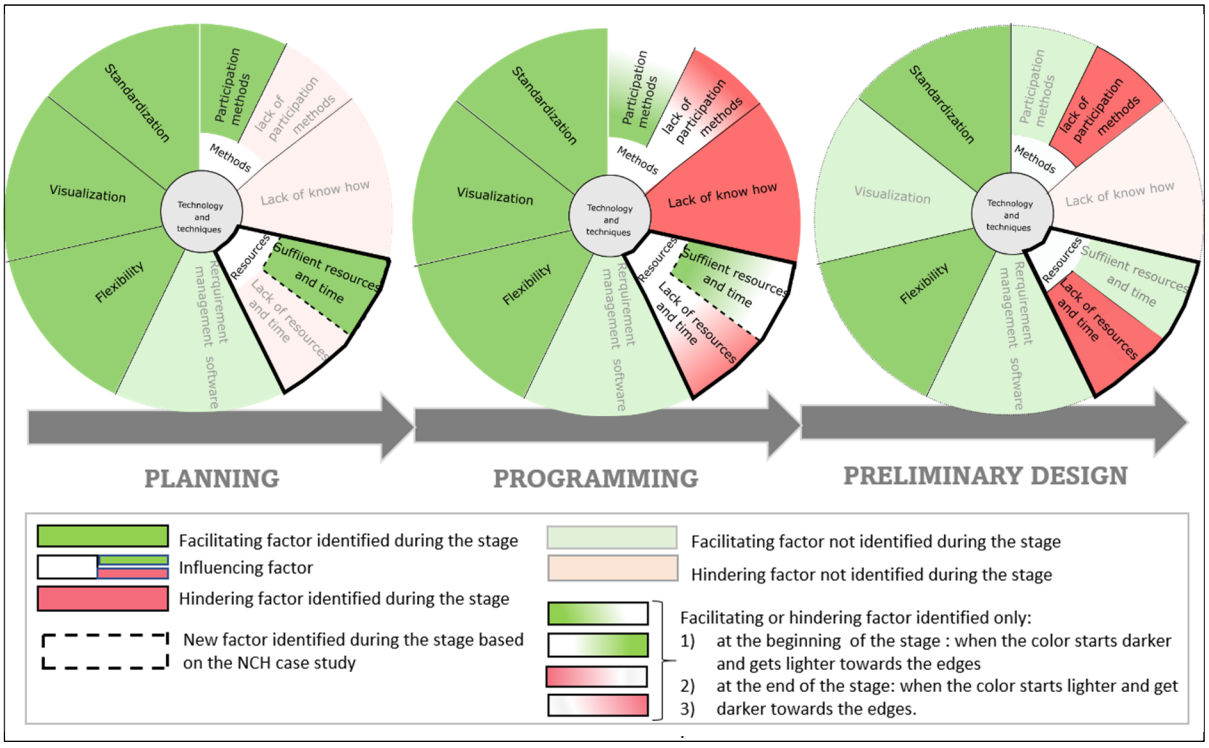


Figure 5.3 An example of "resources and time" factor as classified in the technology and techniques category

Another example of a new hindering factor is "*semantic ambiguity*" which was identified based on the case study and classified in the communication category (Figure 5.4). While in the literature authors such as Chocron and Schorlemmer (2020) and Whelton et al. (2001), presented common vocabulary as a facilitating factor (see chapter 3), in the NCH project not only we identified the same factor in the process but also its opposite. In fact, "semantic ambiguity" was identified exactly when design professionals mandated for programming and design stages started to be involved in the process. In spite of the effort in the first *kaizens* to create a common vocabulary and understanding: *"On a amené les usagers et les architectes à utiliser le même vocabulaire afin d'avoir une base commune" (*We encouraged users and architects to use the same vocabulary in order to have a common basis*)* [member of the NCH clinical management team], there is still a semantic ambiguity between users and designer according to the latter. As quoted by some of them:

> *"Les usagers mélangent souvent les cartographies de processus (comment ils vont travailler) versus nos plans architecturaux"* (Users often mix up process maps (how

they will work) versus our architectural plans*)* [Design professional mandated for the program stage].

"Ils ont de la misère à comprendre tout ce qu'on explique…" (It is difficult to make them understand what we explain) [Design professional mandated for both the programming and design stages].

According to these respondents, as a result of "semantic ambiguity", it is challenging to make users understand the objective of each exercise or workshop, which consequently impedes makes "*sharing of understanding*".

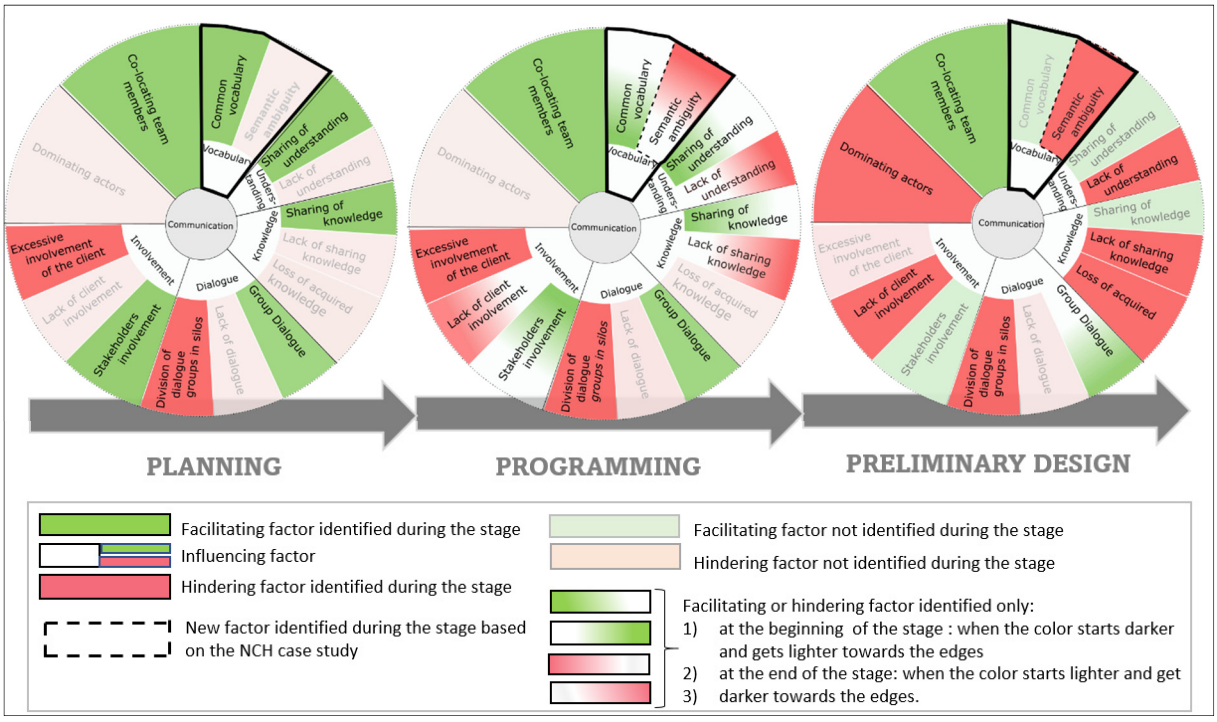


Figure 5.4 An example of "semantic ambiguity" factor, as classified in the communication category

Furthermore, some of the new factors were unexpected to be identified even less in a Lean context as a hindering factor, for instance *excessive involvement of users*. While the majority of authors (such as Grunden & Hagood, 2012 and Schouten et al., 2020) have recognized the benefits of involving users to facilitate alignment in the process of project definition, in this study we found that excessive involvement could have an adverse impact. In fact, in the NCH

project, many participants were involved during each *kaizen* (between 50 to 400 as found in the documentation). This involvement could be considered beneficial since HEJ and L'HDQ users interacted with each other. However, it could potentially make the process even more complex as indicated by a clinical manager: "*ça ralentit énormément le processus et ça le complexifie"(it slows down the process enormously and makes it more complex).* According to some clinical managers and Lean organizers, maintaining harmony among a large number of users during *kaizen* sessions were not easy thus representing a risk associated with the participative approach.

Therefore, by comparing the results of the literature review and the case study, we ended up with a revised framework, presented previously (Figure 5.1), which involves different alignment factors. It should be noted that even if the way in which this framework is presented gives the impression that factors in each category are completely dissociated from each other, the relationships and the hierarchical order among these factors seems to be established based on their degree of importance and influence on the alignment between client needs and the final outcome. These two points will be more thoroughly discussed below.

5.3 The significance of the "influencing" factors

Figure 5.5 illustrates the evolution of the framework (before versus after the case study) regarding the influencing factors. As can be seen, the number of influencing factors increased from 11 to 14, as well as the number of facilitating and hindering factors that involved each influencing factor (e.g., based on the literature "dialogue" was divided into 1 hindering "group of dialogue" and 1 facilitating factor "lack of dialogue", while based on the case study this factor is divided into 1 facilitating "lack of dialogue" and 2 hindering "lack of dialogue and Division of dialogue groups in silos").

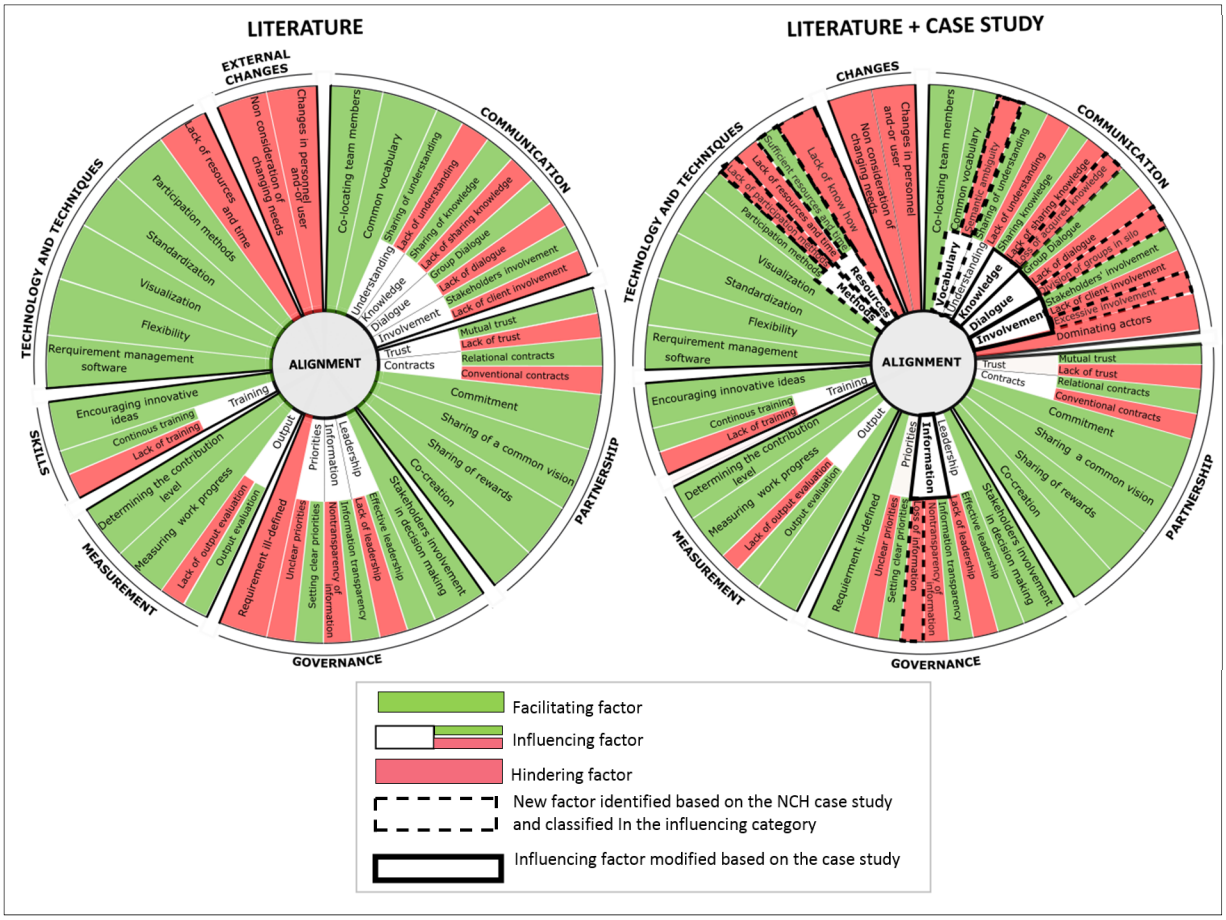


Figure 5.5 Evolvement of influencing factors: literature vs. case study

In fact, almost 7 of the 9 newly identified factors were classified in the category of influencing factors since they represent the opposite or treat the same subject of others already found in

the theory. For instance, loss of acquired knowledge as a new factor was classified as *influencing* based on the case study especially when the participative approach was abandoned, and a traditional non-participative approach was adopted. This hindering factor was added to an influencing factor that concerns "knowledge" along with "lack of sharing knowledge" and "sharing of knowledge" which were already classified, based on which we could say that an influencing factor can be represented by more than only 1 facilitating and 1 hindering factors. Furthermore, unlike other subcategories when a factor is only facilitating (e.g., co-locating team members) or only hindering (e.g., dominating actors), a factor is a double-edged sword in the influencing subcategory (e.g., knowledge). This means that it can simultaneously be facilitating and hindering to alignment, green or red, depending on if it is addressed or not. This gave it more leverage in our framework since the total of number of factors in this category is 13 and each factor in this subcategory is at least divided into two.

All this brings us to these questions: how powerful is the impact of an "influencing" versus a facilitating or hindering factor? Could an influencing factor incorporating more than one factor (e.g., knowledge), be considered more important than others?

Although the adopted methodology and the uniqueness of our case study do not allow for determining the most important factor(s) to achieve alignment, some deductions could be made based on our analyses as well as the interviews that we have carried out with both professionals and clients.

An example of one of the influencing factors usually raised by interviewees is "resources". This factor involves both "lack of resources and time" and "sufficient resources and time" and could be considered important since it impacts other influencing factors such as "participation methods". More specifically, without resources and time it is neither possible to implement Lean activities nor viable to consider all user needs. As quoted by a SQI project manager: " *le budget est un élément très important qui aide ou limite l'adéquation entre ce qui est exprimé et le réalisable*"(The budget is a very important element which helps or limits the match between what is expressed and what is achievable). This result is in fact in line with what

Hicks et al. (2015) propose. According to these authors, a lack of resources and time have an impact on the innovation regarding and the implementation of participation methods such as Lean activities.

The “method” factor that involves both “participation methods" and "lack of participation methods”, is also considered to be an important influencing factor, according to the literature review and the interviewees. In fact, according to the majority of authors (e.g., Grunden and Hagood (2012) and Hicks et al. (2015)), it would be difficult to reach other facilitating factors such as sharing of knowledge and understanding between users and designers, without participation methods. This result is in line with what is found in NCH. There is a consensus about the importance of Lean methods in the success of a project, as phrased by some of them:

“Je pense que tous les ateliers ont été vraiment pertinents! On ne serait pas arrivé sans ça…” (I think all the workshops were really relevant! We wouldn't have arrived without it) [project manager of the SQI].
“Grâce à ce type d'approche, on arrive à mieux communiquer et se comprendre avec les architectes ”(Thanks to this type of approach, we can better communicate and understand the architects) [Clinician].
“*Contrairement au mode traditionnel unidirectionnel, cette démarche permet no seulement aux professionnels d'apprendre des nouvelles pratiques, mais aussi aux personnels cliniques (médecins et aux infirmières) de connaitre les différentes limites du bâtiment*” (Unlike the traditional unidirectional mode, this approach not only allows professionals to learn new practices, but also clinical staff (doctors and nurses) to know the different limits of the building) [member of the NCH clinical management team].

Even though different authors and respondents highlighted the importance of implementing a participative approach such as Lean-led Design, we could not demonstrate, based on this research findings, that implementing such a participative approach automatically ensures an alignment between user needs and design solutions. We have noticed, however, that methods factor (non-participation /participation methods), classified as an influencing factor have a

considerable impact on the existence of other factors that are exclusively facilitating or hindering (see. 5.4).

Furthermore, it can be clearly seen in figure 5.6 how colours turn from green (facilitating) to red (hindering). In fact, when the influencing factors were facilitating at the beginning of the project definition process (e.g., participation approaches, sufficient resources, sharing of

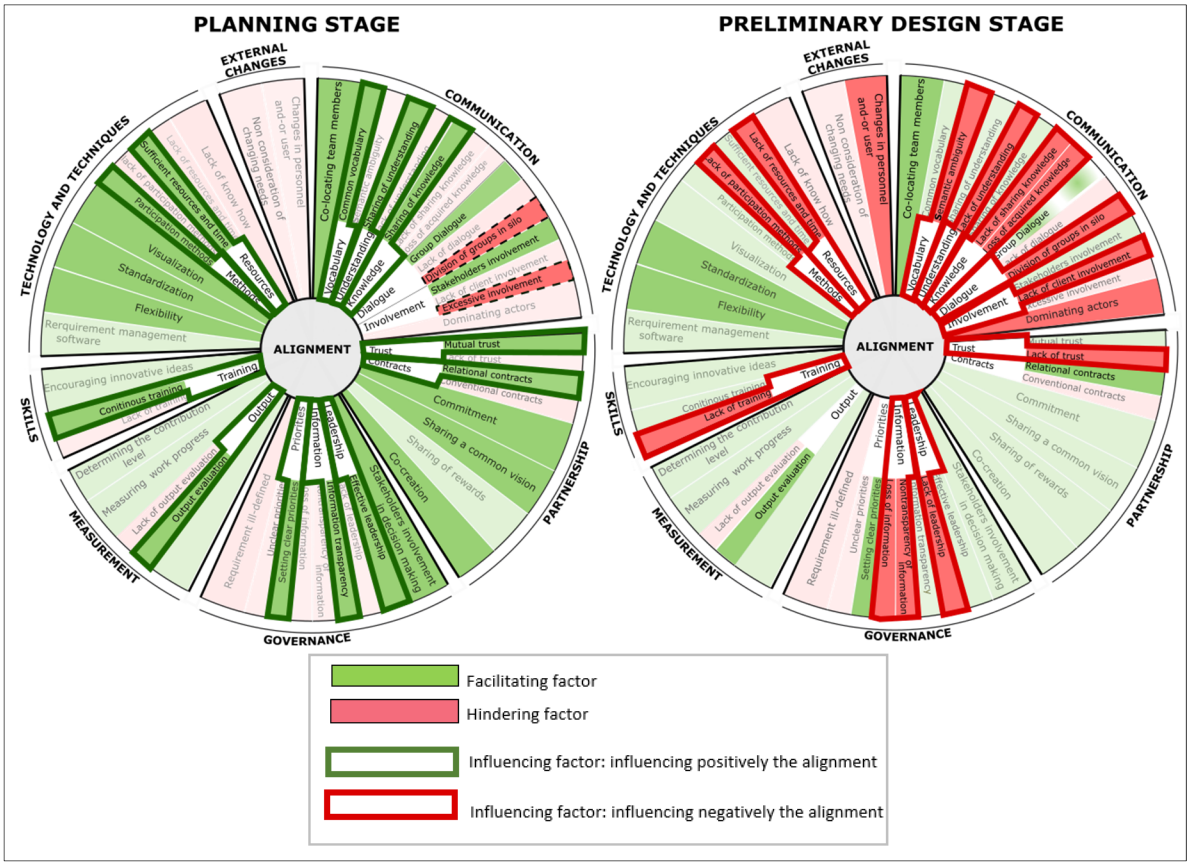


Figure 5.6 Influencing factors: between planning and preliminary design stages of the NCH

knowledge, sharing of understanding), other factors that were exclusively facilitating were also automatically addressed (e.g., commitment, sharing of common vision, co-creation). However, when the same influencing factors turn from green (facilitating) to red (hindering) at the end of the process when there is a lack of resources and a non-participative approach is adopted,

many factors that had been exclusively facilitating disappear (e.g., visualization, commitment, etc.) and other factors that hinder alignment (e.g., dominating actors) replace them.

This finding could be seen as an interesting indicator showing the importance of such influencing factors in achieving alignment, to be explored in other subsequent studies with more details. It could also indicate the existence of potential relationships among the different identified factors, as follows.

5.4 Relationship between the different factors

Identifying the interdependence among all the factors that affect the alignment requires an evaluation of interaction and criteria and thus a specific methodology that we did not adopt in this research study. However, based on our analysis of the NCH project, it is possible to define three typologies of relationships between the identified factors: 1) independent factors, 2) co-evolving factors, and 3) trigger factors.

1- **Independent factor:** Existence of them during the process does not depend on the existence of other factors (e.g., co-locating team members or standardization), figure 5.7.

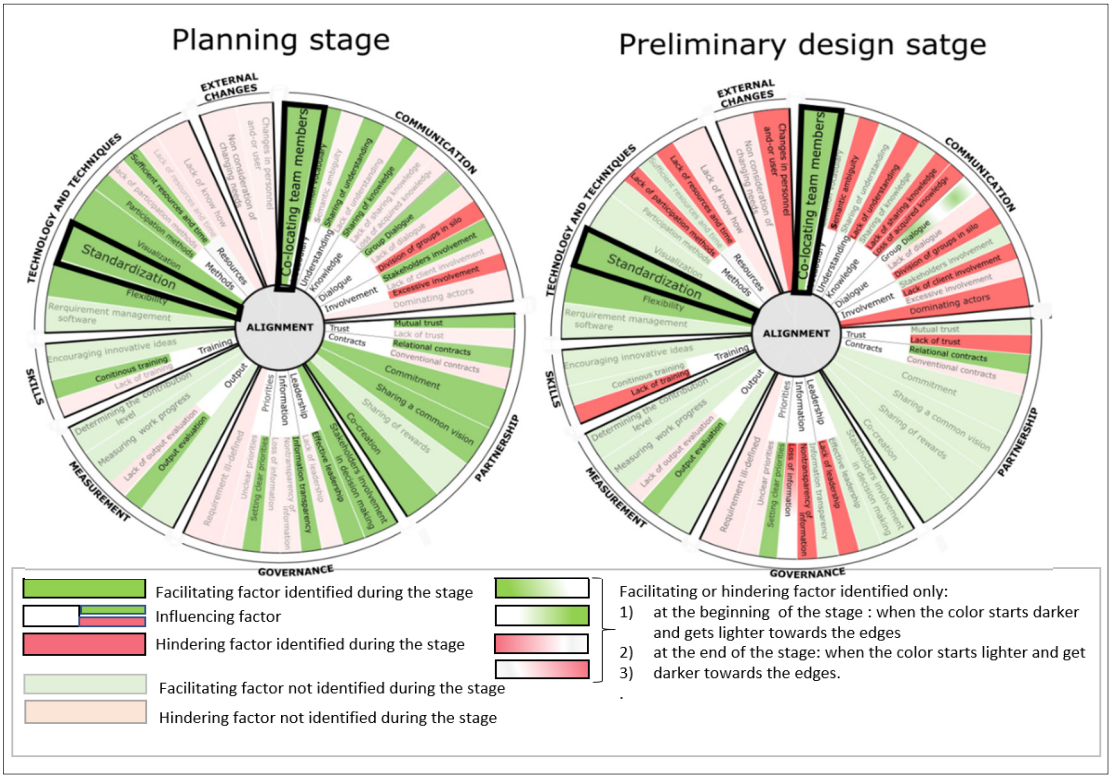


Figure 5.7 Between the planning and preliminary stage: standardization and co-locating team members

Let us take the example of the "standardization" factor. This exclusively facilitating factor was mainly addressed by design professionals to increase patient safety by unifying certain hospital

rooms. This factor was addressed during the whole process of project definition of NCH, as illustrated in the figure (5.7), and was not impacted by the changes that occurred with other factors (e.g., change in methods or resources) thus does not represent a facilitating factor impacted by the influencing one (as explained in the previous section 5.3).

2- **Co-evolving factors:** They evolve together in time. For instance, the two influencing factors: vocabulary (common vocabulary / semantic ambiguity) and understanding (sharing understanding / lack of understanding) (figure 5.8).

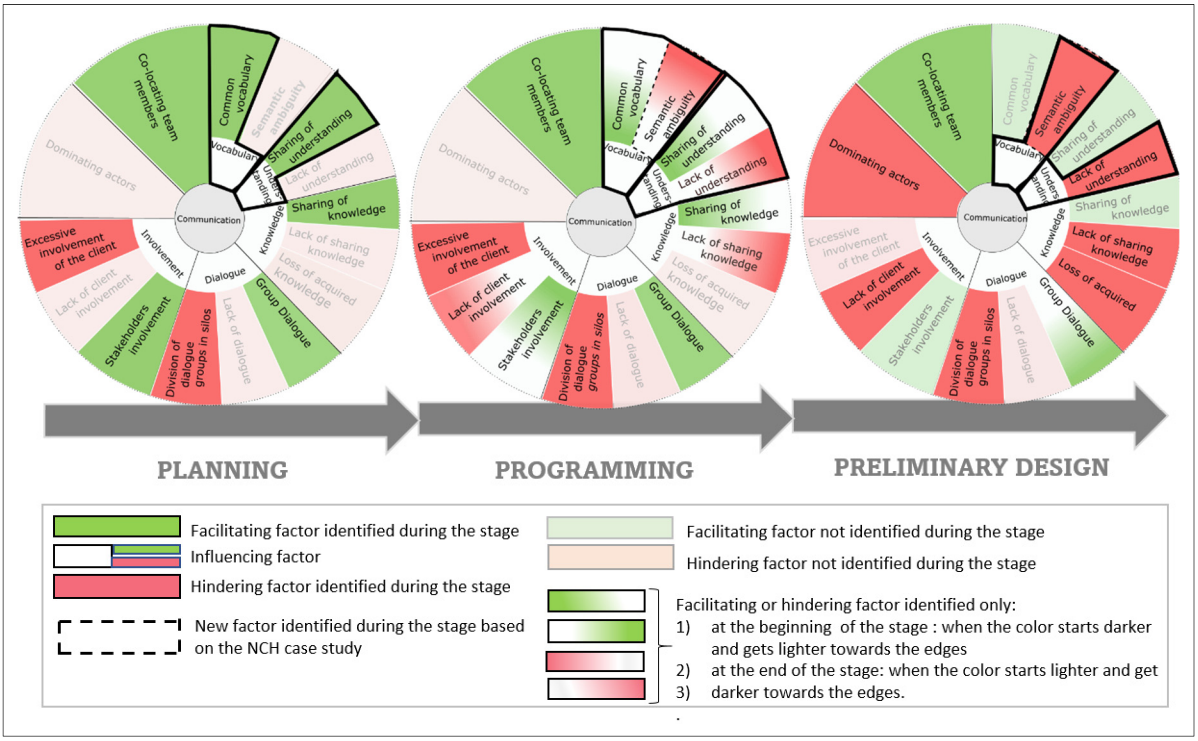


Figure 5.8 An example of co-evolving factors: “vocabulary” and “understanding”

In fact, based on the NCH case study these two factors are interconnected, evolve the same way. More specifically, when a common vocabulary was developed during the first *kaizens* by introducing new vocabularies to users (e.g., area, square meters), sharing of understanding was established. The reverse is also true, when the designers started to be involved during the project definition process, semantic ambiguity was identified between them and users and thus a lack of understanding was detected. This results support what other researchers have

previously pointed out (such as Whelton et al. (2001),Chocron and Schorlemmer (2020), Mazur et al. (2017)), that present these two factors to be important in achieving mental alignment as well as being the main pillars of communication.

3- **Trigger factor:** Factors that generate and trigger other factors (e.g., methods or also resources and time).

If we take the example of "methods: participation methods/lack of participation methods" classified as an influencing factor, we can say that it is a trigger factor because (Figure 5.9):

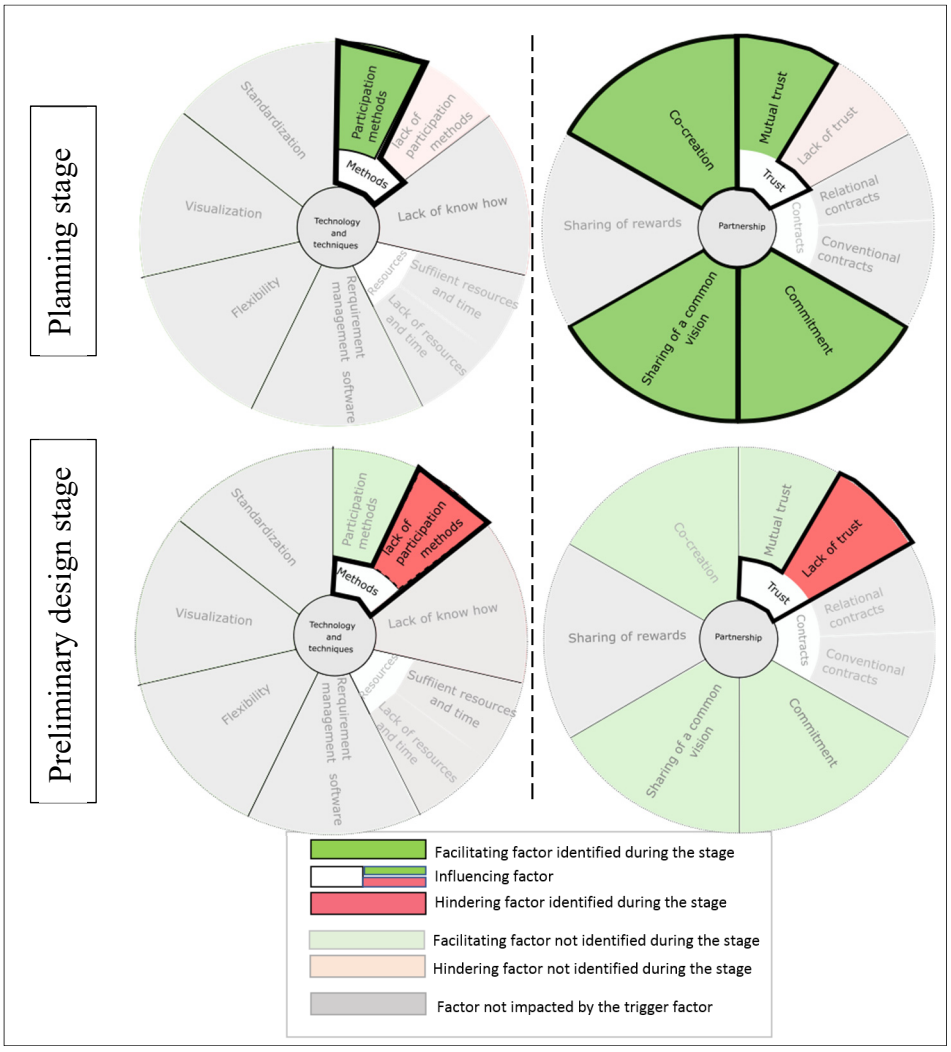


Figure 5.9 An example of a trigger factor: methods (participation methods / lack of participation methods)

- When Lean methods (participative) were addressed during the planning and programming stages, different facilitating factors were consequently generated (e.g., trust, commitment, sharing of a common vision).
- When a traditional method was adopted during the preliminary design stage, all facilitating factors disappeared (e.g., commitment, sharing of a common vision, trust, etc.) and different hindering factors also appeared in the process (ex. lack of trust, etc.).

In addition to the significance of some of the factors in promoting alignment as discussed in the previous point 4.5.2, it is also possible to question whether the kind of relationship between factors could make a factor or a category more or less important in order to achieve an alignment.

Let us take again the example of the most important trigger based on the case study: resource and methods. If the focus is on categories, it can be noticed that both factors are classified in the "technology and techniques" category. This could thus be classified as a top-ranked category because it contains two trigger factors that participate in the appearance or the elimination of other facilitating or hindering factors classified in other categories such as communication (e.g., common vocabulary, sharing of knowledge).

Therefore, it is possible to investigate if the priority of a factor is related to the kind of relationship it has with others? Or if the significance of a category is related to the kind of relationship that its factors have with others? And is this priority maintained during the time? These are questions that could be examined in future investigations, the methodology of which allows the identification of a certain hierarchy between these factors.

5.5 Evolution of alignment factors during project definition stages

In chapter 4, we have not only identified different factors but also observed how they have evolved between the planning, programming, and conceptual design stages during project definition, therefore representing one of the most important findings of this research. Figure 5.10 illustrates how these factors evolve during these three stages.

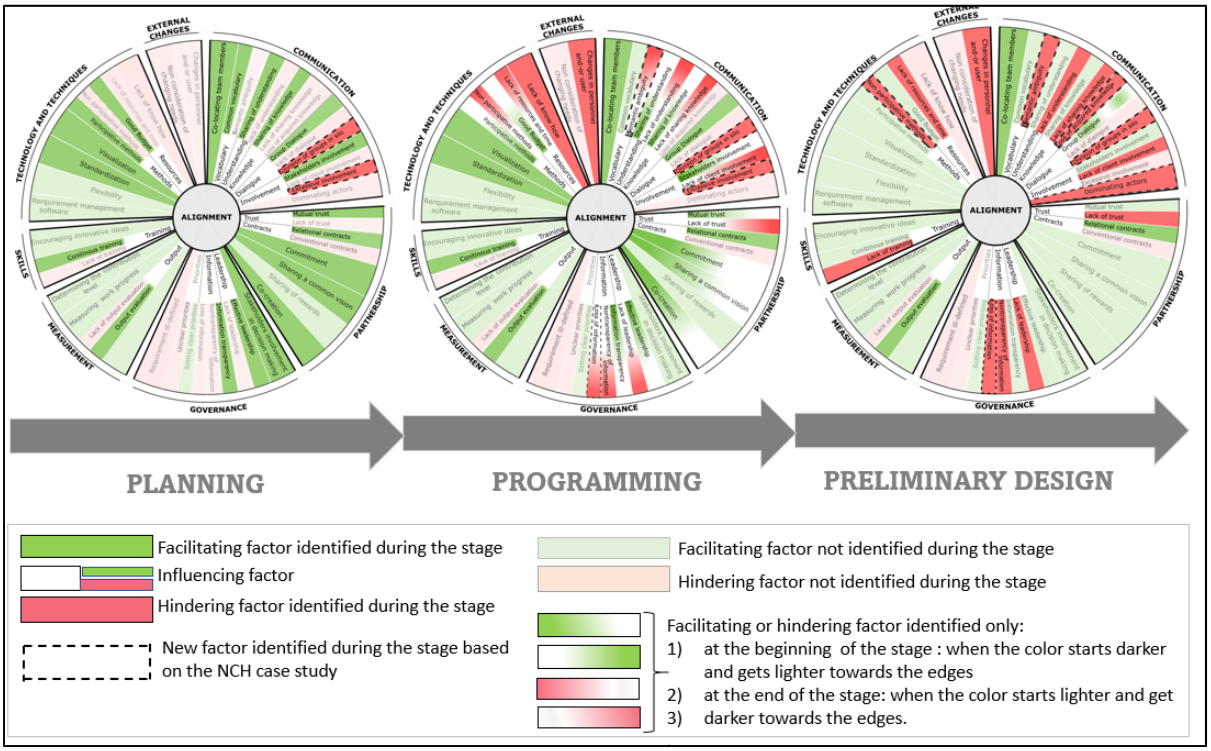


Figure 5.10 Evolution of alignment factors during project definition stages

What interests us in figure 5.10 is the evolution of factors over time. It can already be seen that almost all facilitating factors that appeared during the planning stage disappeared during the preliminary stage and vice versa (e.g., the majority of facilitating factors like communication, governance, or technology and techniques). These changes are mainly related to changes in the undertaken approach in the project definition process. Once the Lean "participative" approach was replaced by a conventional one, different hindering factors appeared. Not only that but some factors resulted in a reversal of what was previously achieved. According to the interviewees, the change of the approach, as described previously, is the result of different

reasons such as: budget and preferences of design professionals: "*On revient au mode traditionnel pour l'élaboration des plans, car les concepteurs se sentent plus en confiance avec ce mode de travail que celui de la conception intégrée. Mais c'est aussi à cause du budget"* (We are returning to the traditional way of drawing up plans, because designers feel more confident with this way of working than with integrated design. But it's also because of the budget) [member of the NCH clinical management team]. In fact, some designers claim that in the NCH project, there is no necessity to implement an integrated design process since all stakeholders are co-located: "*Je ne pense pas qu'on a besoin de changer d'approche. Ici on arrive à communiquer rapidement avec le bureau d'étude"* (I don't think we need to change the approach. We communicate effectively because we are in the project office) [Design professionals mandated for the design stage]. According to them, it is an informal integrated design process.

Furthermore, as discussed in the previous sections (5.3 and 5.4), some factors led to the elimination of several others. For instance, during the preliminary design stage a loss of acquired knowledge was identified among users since they did not understand architects' decisions, even though a big effort was made during Lean activities to share knowledge among them. Let us recall that five Lean activities in the form of *kaizen* were organized in different days, but: "*Les gens ont tendance à oublier un peu les discussions qui ont eu lieu lors de la démarche Lean*" (People tend to forget a little about the discussions that took place during the Lean process) [member of the NCH clinical management team]. The time between the last *kaizen* and the first user involvement in the next stage was approximately 1 year, which could explain the loss of acquired knowledge. Furthermore, several problems have been identified between programming and schematic design stages. The transition between the two stages was problematic since not only the design professionals but also the general approach had changed thus different hindering factors were identified, e.g., loss of information.

This leads us to think about the importance of considering the project definition process as a single phase in order to achieve an alignment. The planning and programming stages should not be seen as distinct stages separated from design. Further, we could say that more important

than addressing the alignment, is to maintain the continuity of addressing them, not only during the project definition stages but also between the stages. This conception is in line with that of Griffith and Gibson (2001) that highlighted the importance of addressing horizontal alignment during the project life cycle.

In the NCH project, even though a conventional approach was implemented during the design stage, a Lean-led design approach was adopted again in parallel with it, exactly at the end of the project definition phase. Two iterative Lean activities were realized: *kaizen* 6 and 7. The intention of these *kaizens* were to ensure the alignment between both hospitals in order to prepare the move to the new NCH building. However, due to time limitations we could not investigate whether the alignment between user needs, and the final delivered outcome was really achieved. In fact, until the drafting of this report, none of the NCH buildings were operational. Phase 1 of the CIC is still in the transition stage while phase 2 of the project is still between the design and construction stages. This means that, we cannot evaluate if according to users, the NCH buildings fit for the purposes and intended use or not. Therefore, it can be very informative to investigate this matter in a further study.

5.6 Toward alignment assessment

Current research reveals that alignment between client needs and design solutions is a potent source for user value generation and thus project success. To that end, we developed a conceptual framework (see figure 5.1) based on a comparison between the literature and the findings of the NCH case study which summarizes the main factors impacting alignment: facilitating and hindering.

In fact, the proposed framework can help managers (e.g., clinical managers or project managers) understand how to attain alignment or compare different stages of the project and see the evolution of factors in time. By analyzing the alignment factors, managers can assess, evaluate, establish corrective strategies to improve the situation at hand and to identify collective lessons for continuous project improvement.

However, the framework summarizes a large number of factors that could be challenging for a manager to successfully evaluate all of them simultaneously. That's why, the classification of factors into different categories and subcategories provides flexibility for managers to prioritize what seems more important for them to be addressed based on their context and needs. Further, by comparing the framework developed based on the literature and the case study findings, we realized that some factors could be seen as methods or inputs, while others could be seen as results (outputs) of the implementation of these methods. Let's take an example of that, the factor "co-locating team members" in the project office could be seen as a method in order to achieve a "sharing of knowledge" among them. This means that even though both factors are presented in the framework as factors in the same level, they are in different levels.

Another point we wish to make pertains to the fact that, the factors presented in the framework could be divided into two types. Factors in which managers could act directly and factors that managers can just observe. Let's take an example of the first type. The "early involvement of clients" during the project definition represents a factor that should facilitate the alignment.

Addressing or not this factor is a decision that managers can take. They can decide to involve or not the client during the project definition. Now, let's take an example of the second type of factors (observables): "sharing understanding." Even though, managers decide to address the "sharing understanding" between the stakeholders' factor during the project definition, it's not easy to reach that. Implementing methods such as involving clients or also co-locating team members doesn't mean that the "sharing understanding" factor will be successfully reach. This means that factors in this typology cannot be managed easily. They represent points of attention for the managers.

Therefore, the classification of factors by categories or typologies could facilitate to the managers the evaluation of them in order to assess the alignment during the project definition. Nevertheless, it is important to mention that this framework is still in an abstract level since it is only validated in a single case study, but it opens a path of research that until now has been largely neglected. Considering the fact that alignment might be sensitive to certain contextual conditions and organizational elements, the proposed framework should be tested in further empirical research studies. Future research could operationalize and evaluate the proposed framework in other healthcare projects and compare the results with different complex contexts such as airports since large samples would provide more robust results.

CONCLUSION

This research study aimed to improve alignment between client needs and design solutions during the project definition stage in a complex context with the assumption that a higher alignment provides more values to end-users. More specifically, the following question was at the heart of this investigation: What are the factors that impact the alignment between client needs and conceptual design solutions during project definition of a hospital with a Lean-led design approach?

To that end, this study adopted a post-positivist position along a qualitative research strategy to analyze the collected data. The research framework was divided into three steps. The first one represents a qualitative systematic literature review of 122 papers aiming at identifying and comparing alignment factors in both areas of construction (construction project management and Lean-led design) and information technology (IT). The rationale for reviewing alignment factor in contexts other than Lean-led design (our research context) is the fact that only 9 papers were identified in our research context which do not explicitly address alignment factors per se. Another reason for this consideration is that the issue of alignment has been widely studied in IT and construction project management.

In the second step, this framework was evaluated (falsified /confirmed) based on a longitudinal case study, a mega-hospital in Quebec called *nouveau complexe hospitalier* (NCH), due to two main reasons:

- This was an "extreme" project, representing in fact one of the biggest and first-ever projects that implemented the Lean-led design approach in Canada during the project definition.
- It a longitudinal case that help us studying the alignment at different time points in time (planning, programming, and preliminary design stages), and analyzing how certain conditions changer time.

Therefore, two data collection strategies were used: documentation (more than 10 000), and semi-structured interviews and focus groups (a total of 28). The combination of data from

different sources should ensure research reliability and validity. Findings of the second step not only allowed to falsify or confirm the validity of the framework but also helped identify new factors. By combining and comparing the identified factors based on a systematic qualitative literature review with those of the case study, a revised version of the framework was developed which represents the third and last step.

Therefore, the main theoretical contribution of this research study is the presentation of an alignment framework, presenting alignment factors in seven categories and three subcategories. Overall, 13 facilitating, 5 hindering, and 14 influencing; classified in seven categories: 1) communication, 2) partnership, 3) governance, 4) measurement, 5) skills, 6) technology and techniques, and 7) external changes.
Definitions of the terms of interest are presented below:

- Facilitating factors: The ones that positively impact alignment. When addressed, they facilitate alignment and when not addressed they do not hinder it.
- Influencing factors: The ones that can both positively and negatively impact alignment, which means that when they are addressed, they facilitate it and when not, they hinder it.
- Hindering factors: They negatively impact alignment.

The identification of these factors and their classification represents the first step to develop an assessment alignment tool, or a maturity alignment model, as realized in other sectors, where the alignment issue is widely studied, such as IT ones. As an example of that, the development of the well-known strategic alignment maturity model (SAMM) started by identifying facilitating and hindering alignment factors. Further, the comparison between alignment factors identified in IT with those of construction (identification of different similarities and some divergences) is also a theoretical contribution of this research. Bringing knowledge from IT to construction could inspire researchers and help to improve current practices.

Another contribution of this research study is a longitudinal investigation that provided valuable insights into the evolutionary nature of alignment in time: between planning,

programming and schematic design stages. This alignment dimension is usually neglected according to Griffith and Gibson (2001). However, our results showed the importance of comprehensive longitudinal assessment and maintenance of alignment. A lack of this assessment may lead to loss of previous achievements, comparable to what happened in the NCH case study. Despite all Lean activities for addressing the alignment facilitating factors, the majority of factors transformed from facilitating to hindering when the participative approach was abandoned.

This study also has important managerial implications since the proposed framework could be useful for managers to assess and evaluate projects and thus take actions to improve the alignment between client needs and design solutions during project definition, by suggesting the factors that should be addressed and the factors that should be controlled and stopped. Furthermore, by providing a classification of factors, managers can have more flexibility to prioritize a specific category.

Limitations and perspectives

Despite all the planning and efforts that are invested in this research, findings of this study are on a rather abstract level, the proposed framework was only tested in a single case study. Research is rarely conclusive. According to Glaser and Strauss: "*When generation of theory is the aim, [...] emergent perspectives can easily occur even on the final day of a study or when the manuscript is reviewed in page proof: so the published word is not the final one, but only a pause in the never-ending process of generating theory*" (B Glaser & A Strauss, 1967, p. 40). This means that the results can generate new questions that will be the basis of other research projects (Leedy & Ormrod, 2010, p. 7).

This is why it would also be interesting to compare the results of applying this conceptual framework in different types of complex projects such as cultural buildings or airports, where several functions and different types of users interact.

This research is also subject to some limitations that can be addressed by future researchers in the field, even though the main objective, which was to create a framework to examine

alignment, was achieved. In fact, the validation of this framework is limited to only one single case study, which limits its generalization even if different stages of the project definition have been compared. While this qualitative research can hardly accomplish the external validity of a quantitative analysis, as suggested in the post-positivist posture, it is necessary to recall the originality and uniqueness of such a research context, which is not often easily accessible. Furthermore, it's true that we cannot generalize all the findings, but we can generalize part of it. For instance, we cannot assume that all factors presented in the conceptual framework will be found in other mega hospital project, but we can assume that some factors are more important than others (e.g., trigger factors) or some factors co-evolve together (e.g., common vocabulary and sharing of understanding).

We based our work on different theories in the literature to propose a novel framework. This framework was then compared with a single case study that perhaps can aid researchers who seek to increase the objectivity and reliability of their results by field-study analyses. A multiple case study would then provide more robust results as well as determining potential differences between cases. Therefore, our exploratory research framework is part of a continuum of research on the alignment between needs and design solutions when using participative methods. The development of this framework is only the first step towards improvement of alignment. As a result, more research seems necessary to provide additional findings and validity to the proposed framework. So, some suggestions for future research are proposed here.

First, future research can investigate whether there is an alignment between the first intentions and the outcome buildings once the NCH buildings are delivered and operational. The objective is to investigate the impact of implementing such a participative approach in delivering buildings that fit for the intended purpose and use, in a highly dynamic and complex context.

Future research could also empirically validate and verify whether the identified facilitators, influencers, and inhibitors in this study are present in other healthcare projects and/or whether

other facilitators and inhibitors will emerge in other contexts or case studies. It could also be interesting to investigate the existence or non-existence of a hierarchical factor structure.
Another potential investigation can conceptualize the identified alignment factors as an assessment tool or a maturity model with different scales which can enable the measurement and monitoring of alignment in dynamic and complex projects, to guide decision makers towards aligning client needs with design solutions.

Before concluding, we felt it necessary to recall that this interdisciplinary research is conducted from the point of view of an architectural engineer adopting a qualitative research methodology, usually recruited in humanity studies and social sciences. In fact, managing alignment is a complex process that involves various steps across many phases, thus interdisciplinary research is needed to understand and effectively deal with this complexity. The contribution of this research study is therefore directly useful for the research community and also construction professionals, but, of course, not enough to solve all alignment issues. Pursuing such a research approach and subject in engineering schools and by engineers are therefore necessary to promote multidisciplinary understanding and dialogue between different professions.

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