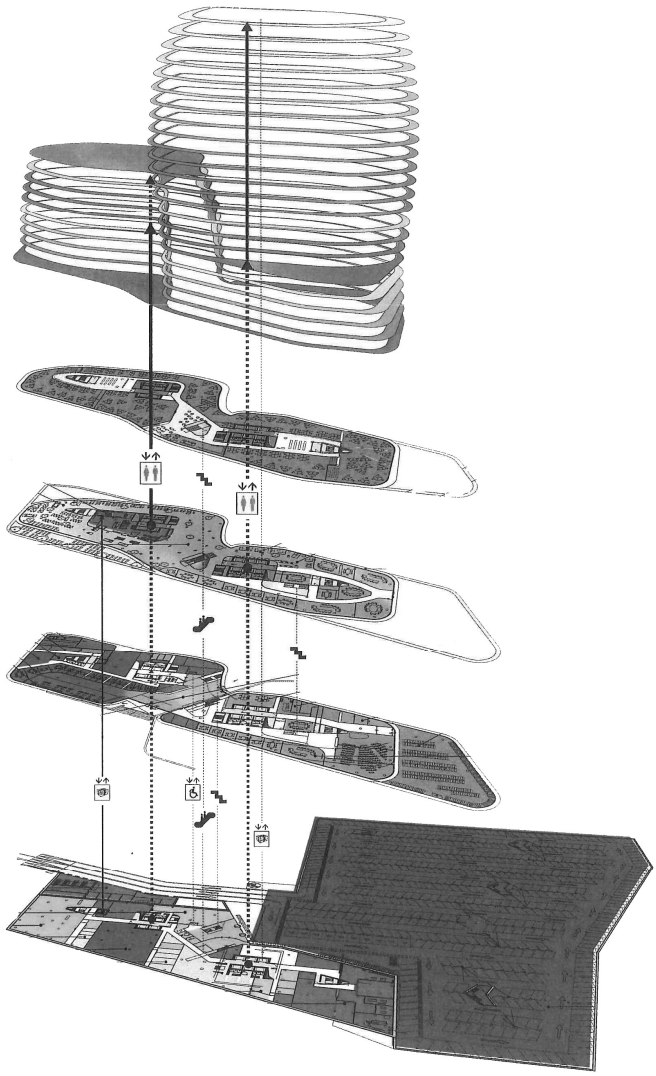
P5 | RE&H

Ehsan Mobareky Zadeh



IMPLEMENTING LEAN

In the process between developer and facility manager

"Having no problems, is the biggest problem of all"

- **Taiichi Ohno (Toyota)**

Msc Thesis, Real Estate and Housing, TU Delft, February 2012

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Preface

This report has been written according to the guidelines of the Real estate and Housing department at the TU Delft. This report is the official master thesis: *"Implementing lean in the process between developer and facility manager".*

The current problems in the Dutch commercial real estate industry led to the creation of this report. The lean philosophy, aimed on value creation, provided an interesting optimization process to be implemented and adapted in the research. By combining lean and the process between developer and facility manager, the following research question would be formulated:

How can Lean, when using its main principles in an early interaction, starting from the initial phase till the final phase of construction projects, between developer and facility manager, lead to an effective real estate project cycle and also result in an office building which fulfills the current demand of flexibility?"

By analyzing two cases: The renovation of the ministry of finance in The Hague and the construction of DUO in Groningen, the research question has been handled and answered. By means of interviews and a detailed (cross) case analysis, the main findings have also been be discussed and presented.

Conducting this research would be an important learning process which would enable me to understand the complex decision making processes between the main stakeholders in the building process. Therefore I have gained great insight in the practical field, resulting into this research thesis.

If reading this research leads to questions or suggestions, the reader can contact me on my email, as I am gladly willing to discuss these.

Ehsan Mobareky Zadeh
Hoofddorp, January 2012

Acknowledgements

The writing of this report has been one of the most significant and valuable challenges I have faced in my academic period. Without the support, patience and guidance of the following people and organizations, this research would not have been completed. Therefore I would like to express my deepest gratitude.

First of all, I would like to thank my two main mentors: Ruben Vrijhoef and Ype Cuperus. It was their experience and knowledge which helped me to understand the philosophy behind lean and lean construction. Without their academic expertise and professional guidance, I would not have been able to finish this research. The days when I walked in their offices without appointments and the time they made available for meetings were of great help.

The various lecturers who were and are still active at the Real estate and Housing department at the TU Delft, who gave their view on various aspects, helped me to form a solid insight on the research theme.

The organizations and especially the professionals which were part of the actual cases were extremely important. Their openness towards their experiences and the opportunity they provided to conduct my interviews were of essential importance to this research.

My parents and sister, who have always believed in my capabilities and who supported me throughout my whole study. Their support in times of difficulties was of great significance.

My friends, enabling me to free my thoughts and to relax in stressful periods.

My fellow graduate students of the Design and Construction lab at the TU Delft, as the lab meetings contributed to a solid formation of the final research theme.

And I would like to thank all those persons who I didn't mention, who have supported me on academic and personal level.

Executive summary

Introduction

This report is about the process between developer and facility manager in the real estate project cycle. In order to analyze such processes intensively, the lean philosophy originated from the car industry has been applied. As lean focuses on adding value in production lines by eliminating waste, we will focus on problems in the building industry.

The Dutch commercial building industry is currently facing great problems, which is noticeable when looking at the vacancy rate of office buildings. An important aspect leading to these problems has to do with the misbalance between supply and demand, as developers continue to create buildings which do not match users' demands. An important component of this misbalance is the missing link between project development and facility management. As facility management represents the building user (in the commercial industry) via logistics and exploitation, developers lose valuable user information. This information is needed by the developer to match the user's demand, especially in a demand-driven market.

When looking from a traditional perspective, it is noticeable that developers design as well as create buildings, and they then are only focused on delivering the building. When developers finish their contribution after the delivery phase, facility management comes into play. This shows that developers finish where facility managers start, which leads to a lack of integration between the stakeholders.

When referring to the lean principle it is noticeable that lean enables process optimization and can therefore play an important role in analyzing the process between development and facility management. Having reviewed and analyzed the lean philosophy, it has become clear that the lean-related literature is segmented in two parts; lean production and lean construction. Lean construction covers lean in the construction industry on a mainly operational level. When analyzing the lean literature on lean in the process between developer and facility manager no or limited data are available. As no specific lean literature on the process between these two stakeholders is available, there seems to be a grey area in this field.

Problem statements

After discussing the research and the problem areas in the previous part, two problem statements have been formulated:

"There is no specific lean theory focusing on the relation between facility management and project development, creating a knowledge gap"

"There is no clear link between developers and facilities management, creating a gap for developers on user-flexibility standards, resulting into a mismatch between office supply and demand"

The first problem statement has a theoretical orientation and is focused on the lean knowledge gap. The second problem statement has a practical orientation and focuses on the missing link between developers and facility managers. The objective of this research is to provide a profound solution on both problem statements. In order to reach this objective, various research questions have been considered. These questions are in accordance with the lean philosophy and they can be seen in the next part.

Research questions

The main research question:

"How can Lean, when using its main principles in an early interaction, starting from the initial phase till the final phase of construction projects, between developer and facility manager, lead to an effective real estate project cycle and also result in an office building which fulfills the current demand of flexibility?"

This research question refers to the usage of the main lean principles. These principles can be categorized as: 1) Value: What does the facility manager want? 2) Value stream: Which processes add and do not add value? 3) Flow: How to establish continuous flow? 4) Pull: Producing a service on customer demand. 5) Perfection: Establishing continuous improvement. In order to answer the main research question, the following subsidiary research questions were formulated. These questions are divided according to the lean principles:

Value

How are facility managers' needs currently determined by the developer and how intense is the cooperation with facility managers in order to gain the value knowledge?

Value stream

What are the roles and responsibilities of the facility manager and the developer in the real estate project cycle and which processes between these two stakeholders create value and which do not create value?

Flow

Which work practices between the developer and facility manager can be rethought and which barriers need to be eliminated in order to create continuous flow?

Pull

What are the facility manager's influences on the schedule and in what way can the process between facility manager and developer be made fully pull, leading to pull planning?

Perfection

How could continuous improvement be established and what does this mean for the relation between developer and facility manager

Research method and selected cases

The research methodology has played an important role in order to answer all research questions. The choice has been made to conduct a case study as this would provide the optimal quantity and quality of data in the time frame of the research. The case study would be conducted and analyzed by means of the Eisenhardt approach: "*Building theories from case studies*". By using this type of research, theory is built from case studies, meaning that hypotheses are formed at the end of the research. This approach has the advantage that hypotheses are formed throughout the research, creating a solid ground for their specification.

Two cases have been selected: The renovation of the Ministry of Finance in The Hague and the construction of the DUO building in Groningen. The reason for the selection of these two cases had to do with the intense involvement of facility management in the pre-usage phase. Other than traditional building projects, these projects integrated facility management in the pre usage phase. This would generate interesting data for this research. Both projects would be: Public-Private

Partnerships, making use of a so-called DBFMO (Design, Build, Finance, Maintain, and Operate) contract. These facts would play an important role in this research. The next step would be to analyze both cases.

Cross case analyses

When analyzing the value principle, it was noticeable that in both cases exploitation was of high importance. It was essential for the developer to meet the exploitation criteria, as the developer would be responsible for the exploitation period. This led to integral work processes between developer and facility manager. By intensely working together with facility management, information on exploitation and logistics would be gained. This would mean that the value determination would be of high importance for the developer and would lead to frequent interaction with the facility manager by means of weekly meetings and dialogue sessions.

When reviewing the value stream principle, it was noticeable that the roles and responsibilities of facility management and project developer were lifecycle-oriented. This would lead to the involvement of facility management in all stages of the project, from the initial till the usage phase. The DBFMO contracts used in both projects would be of great importance, adding value to the project as it led to the integration of design and exploitation. In terms of value-adding activities, the role of facility management in the Ministry of Finance project would be remarkable, as they would have a leading role in the realization phase. As the developer gave room to facility management in terms of their leading role in the realization phase, full integration between the two stakeholders would be possible.

The flow principle highlighted important barriers in both cases. The fact that the facility manager was present in technical departments created barriers. This had to do with their limited competency and experience in the pre-usage stage. The fact that a service-oriented stakeholder was present in technically oriented departments therefore did not create the needed value and should therefore be eliminated. The inexperience of facility management in the pre-usage stage can be seen as an important barrier, leading to decision-making failures in the project cycle. A remarkable barrier which was noticeable in the Ministry of Finance case was demarcation. As the developer comprised various organizations, processes were task-driven and not integrated. This meant that the various teams would conduct separate tasks, thus preventing integration. The construction of DUO would encounter problems in the field of information continuity, as key figures were not present in all stages of the project.

The pull principle analyzed in both projects showed the limited involvement of facility management in the planning procedure, leading to no pull planning. As facility management was no part of the planning process, no pull planning could be generated. An important reason for this development could be the inexperience and lack of competency of facility management in the creation of planning schedules in the pre-usage phase.

When analyzing the last principle: perfection, both cases showed usage of evaluation sessions. This gave stakeholders the chance to analyze aspects and to provide feedback. Usage of digital tools was also made. FMIS (Facility Management Information System) enabled both the facility manager and the developer to gather important data on exploitation. This would also lead to more cooperation between the two stakeholders in the usage phase.

The figure on the next page shows the most important results of the cross-case analysis.

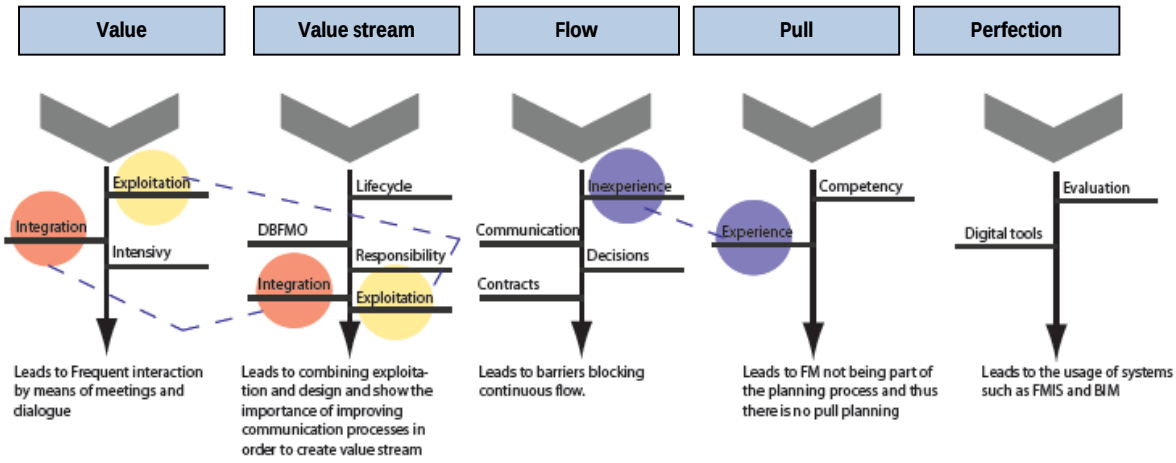


Figure A- Cross case table

Answering the main research question

"How can lean, when using its main principles in an early interaction, starting from the initial phase till the final phase of construction projects, between developer and facility manager, lead to an effective real-estate project cycle and also result in an office building which fulfills the current demand of flexibility?"

By implementing the lean principles in the process between developer and facility manager, an effective real-estate project cycle can be established. Firstly, value should be determined and the developer should concentrate on defining the wishes of facility management in the initial phase. This can be done effectively through frequent interaction by means of meetings and dialogue sessions. It is important that both stakeholders create a common objective in terms of end product, as this will show the developer the importance of determining facility management needs and thus intensify their cooperation.

After the value determination, the second lean principle: value stream, should be implemented. This can be done by clearly defining the roles and responsibilities of both developer and facility management and linking them to a building–life-cycle orientation, and thus on the long-term focus. By implementing a current-state map and eliminating non-value-adding activities such as the presence of facility management in the technical department, a value stream can be made. The focus on value-adding activities should then be made, whilst important aspects such as the life-cycle focus should also play an important role at this stage. This can be done by means of contracts; e.g. DBFMO. After identifying all value aspects, the value-stream map can be completed.

The next step is to establish flow, by eliminating all barriers. By eliminating the presence of facility management in the technical department the first step towards creating flow is set. By looking at the inexperience and lack of competency of facility management in the decision-making process it is important to rethink this issue through educational means of facility-management employees. Also ensuring continuity by preventing the loss of information through the real-estate project cycle creates continuous flow. An important barrier which should also be prevented can be seen as demarcation. It is important that the development team is represented (preferably) by one

organization, preventing demarcation and enhancing integration. By establishing this, a more integral work approach can be reached, leading to fewer barriers in terms of integral working.

Pull will be implemented after establishing continuous flow. Here it is important for facility management to be involved in the planning process by means of pull planning. By, again, educational implementations in relation to planning, facility management can create possibilities to be more active in the planning process in the pre-usage stage. By starting with backwards planning (starting from the end), facility management will gain more responsibility and will be able to implement pull.

After implementing all these principles, it is important to complete the lean framework through means of: perfection. By emphasizing evaluations and by implementing evaluations during projects, control mechanisms such as feed forward can be utilized. Feed-forward mechanisms send signals to the next stage in order to implement perfection, thereby creating more efficiency. By also emphasizing the use of digital systems such as FMIS and BIM, the perfection cycle can be completed.

The implementation of these five lean principles according to the given descriptions can lead to an effective real-estate project cycle implying the creation of an office building according to the current demand of flexibility standards. This has to do with the fact that the integration of facility management can be seen as the integration of the building user in the pre-usage phase. As this will lead to the integration of exploitation and logistics, a building will be provided which will be easy to maintain and will be flexible according to logistical innovations. And thus it can be said that the information of facility management on the building user leads to this fulfillment of flexibility requirements.

Forming hypotheses

By means of the data analysis and by combining the main results with the existing literature, the following hypotheses have been formulated.

Value

"If the developer is responsible for the exploitation of a project, he will gain more interest in gaining value knowledge of facility management, leading to the treatment of facility management as integral part of the organization."

Value stream

"DBFMO contracts lead to the integration of development and facility management in a building project, benefiting both stakeholders and leading to an efficient the value stream".

Flow

"In large complex projects where process integration is essential, the development team should exist out of one organization, as multiple organizations representing the development team would in most cases lead to demarcation"

Pull

"The lack of competency on the hand of facility management in the pre-usage phase leads to their limited input of the scheduling process and thus no pull planning is generated"

Perfection

"The usage of digital tools such as FMIS and BIM will be of essential influence in future projects, as they provide essential data and help both developer and facility manager in creating the most efficient building as continuous improvements can be implemented "

Reflecting on the research problem

The first problem statement described a theoretical problem and showed the gap on specific lean theory focusing on the relation between facility management and project development. By applying and integrating the lean principles of: value, value stream, flow, pull and perfection in this research, relevant data are generated among the interaction process between developer and facility manager. The fact that both cases: the renovation in the Hague and the construction of the DUO building in Groningen, did indeed provide information on the process between developer and facility manager created the possibility to analyze these processes by means of the lean philosophy. Therefore it can be said that this research has generated theoretical information on the relation between development and facility management by means of lean thinking. This means that the theoretical problem has been handled and (partly) solved. It is important to acknowledge that this research can be seen as a first step in closing the gap on theoretical standards. However it takes more research on this specific topic to close the whole gap, as more data on more case studies are needed to provide different lean approaches from different researchers. Therefore this research can be seen as a first step towards more research.

When looking back at the second problem statement, the research on the case studies showed that there is a start in relation to the cooperation between developers and facility managers. It also showed, however, that such cooperation is relatively new and can be seen as unique in the field of development, as the integral projects involving facility management in the pre-usage stage does not occur frequently. The research also showed the various barriers and difficulties occurring in the processes between these stakeholders due to the fact that there has never been a clear link. However, it also showed positive developments and opportunities for future cooperation between the stakeholders. By analyzing both cases and by providing recommendations in the previous section, the process between these stakeholders is emphasized and various value-adding aspects are added. This means that the framework provided highlights a stronger integration between development and facility management, creating a better link between these two disciplines. As facility management represents and is part of the building user, the recommendations emphasize the fact that the user is involved in the pre-usage stage and thus matches supply and demand.

The interesting development in both cases is that the developers were also responsible for the building exploitation, and made it a must for them to integrate and cooperate with facility managers to provide a user-oriented building. It can thus be said that the provided recommendations do handle the practical problem and, when used correctly, they should result in a better match between supply and demand.

Table of content

Part 1

Introduction

1 Chapter one
Research introduction

Figure I – Silhouette displaying someone trying to analyze a problem
"We can't solve problems by using the same kind of thinking we used when we created them"
- Albert Einstein

Introduction

This chapter is the introductory part to this research. First a problem analyses will be conducted. The problem analysis will start with a study of project development in the current domestic market, analyzing the problems in the field of project development. The balance between demand and supply will also be handled in this paragraph in order to show the difficulty developers have in selling or renting their properties and or projects. The following paragraph will focus on the mismatch between developer and facility manager. Here problems which create a gap between these two stakeholders and the consequences of these problems are handled. The importance of this mismatch is emphasized on and will be discussed in order to understand the impact of this problem. The paragraph is followed by a part involving lean literature. As lean plays an important role in this research, the problem behind lean will be described. As there is a knowledge gap in the lean literature, important existing data will be used to describe and to put emphasize on the size of this problem in this paragraph.

After the problem analyses paragraph, the problems found will be converted into problem statements. This will be done in the problem statement chapter. The problem statements part will filter the main problems and will describe two main problem statements. These problem statements will exist out of one theoretical problem statement and one practical problem statement. After the problem statements part, the research questions will be handled. The main research question will be described, followed by several sub research questions which are needed in order to answer the main research question.

This chapter will be followed by chapter two, where the emphasis is put on the research methodology. It is important to notice that throughout the report abbreviations will be used. The main abbreviation used will be FM, meaning facility management.

1.1 Problem analysis

1.1.1 Project development in the current market

The project developers can be seen as the ones who are responsible for creating buildings which do not match the current demand, resulting into office vacancy. This vacancy issue is turning into a great problem and has to be dealt with (Bak, 2011:p5). Especially when there is a vacancy rate of 14% (Steinmaier, 2011:p1). Real estate gurus' emphasize that the core of the problem is related with project developers.

ABN Amro believes that the effect of new flexible office concepts will create an even larger impact on the vacancy rates. Demand for more durable office buildings will increase and project developers will be forced to focus more on restructuring and renovation plans (Abnamro, 2010:p24). This can be seen as an indication that the future will bring new trends in the real estate market. It is however important to know that 'waiting' with development projects is not an option, as waiting has financial consequences for developers. Therefore it is important that developers make small steps, however these steps need to be consequent (Klaver, 2011:p74).

The different stakeholders dealing with these issues in the real estate market each have different views. When looking at the largest real estate agency: DTZ, they also claim that project developers are creating the problem, as they keep on building large amount of offices. Various articles written about this specific issue all mention the project developer as key player, which shows the great responsibility of this actor (Marachal, Mullen, 2011:p18).The office vacancy can however have various reasons, one can say that there is such a large oversupply due to bad forecasting from developers and there are others who say that buildings are vacant as they no longer meet the present requirements, which creates a mismatch in the market (Geraedts, 2009:p1).It is therefore important that these new requirements are met, but this is difficult as developers do not focus on the long term, as they are driven by direct financial returns and not by the demand (Deckers, Boomsma, 2011:p1).It can be said that the new standard of office flexibility creates a new demand which is not reacted on, as great masses of office buildings are being build, while they are not needed (Marachal, Mullen, 2011:p18). Project developers play a crucial role in respect to the problems in the real estate market, it is however difficult to make them aware of this fact, as they do not deal with the direct consequences of the problems in the industry (Deckers, Boomsma, 2011:p2). A great consequence of the bad forecasting of developers and other stakeholders in the build industry has led to the high vacancy rates in commercial real estate in the Netherlands (Geraedts, 2009:p1). The fact that it is essential to take steps in the real estate market is clear for governmental parties and market parties, this sense of urgency is however not to be found when looking at developers. The reason for this is the fact that developers tend to be interested on short term investments, and forget to look at the long term horizon, leading to great amount of buildings created which meet the 'short term' demand (Gijzen,2011:p4).

The combination of the high vacancy rate, the upcoming of flexible trends in the building market and the sense of urgency which is missing among developers, does not form an optimistic scenario for the coming years. The high vacancy rate cannot be resolved on the short term, and is not the objective of this research. The flexible trends in terms of demand driven building however, is an important aspect which will be focused on. The mentioned missing sense of urgency among developers is likely to be changed in the coming period, as developers are nowadays facing great risks of project cancellation, leading to financial consequences for developers (Abnamro,2010:p24). It is therefore important to understand the fact that the current developments in the Dutch (commercial) real estate market is affecting all parties, making it crucial for them to react on these problems.

Satisfying demand in a rapidly changing market

The real estate market is cyclical, meaning that demand rises and falls in years' time. Normally, the supply and demand ratio is determined by the prices, meaning that high prices will lead to lower demands and vice versa (Chan ai Cheng, 2010:p1). Finding a balance between these two is difficult, especially when looking at the commercial real estate market.

The difficulty of finding this balance is easy noticeable when looking at the Dutch commercial real estate market. With a vacancy rate of 7 million m2 (Chan ai Cheng, 2010:p1), it can be said that there is an abnormal vacancy rate (Bak, 2011:p1).

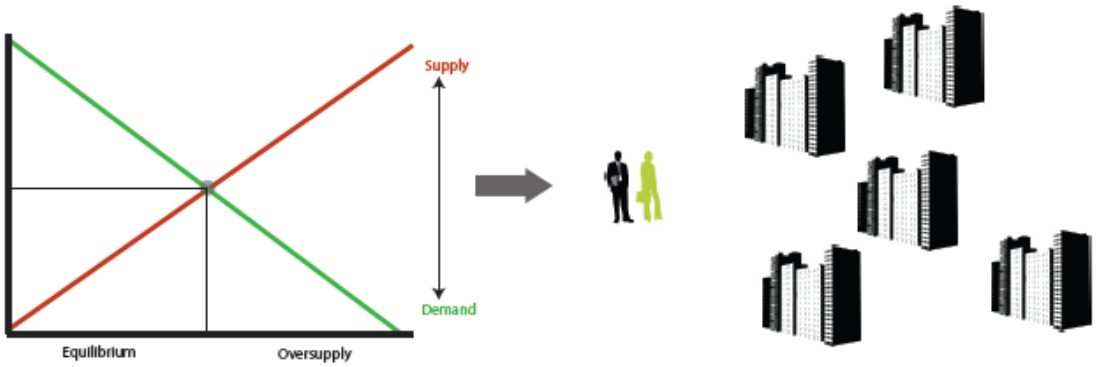


Figure 1 - Office supply and demand

The above figure shows the consequence when there is a mismatch between office supply and demand, namely oversupply. This oversupply issue is currently taking place in the commercial real estate market in the Netherlands.

The role of the project developer has changed the last couple of years due to this vacancy and the low demand rate in the real estate market. In the past developers made great rates of profit due to the rapid increase of real estate prices, enabling them to sell buildings to individual buyers. Nowadays this has dramatically changed, as it has become difficult for developers to find individual buyers (Wolters, 2009:p4).

Projects in the real estate sector are also greatly affected by the cyclical trend due to the fact that building projects plans start years in advance. In the Netherlands there are various examples in respect to this issue. An example can be seen when looking at Tilburg, where developers started with building plans three years ago, with the aim to develop office buildings next to the highway. In that period, the real estate market was already affected by the declining economic market, but there were still optimistic perspectives. However, the real estate market would be affected in such a negative way in 2010 and 2011, that this project would be cancelled. This is one example of many, showing the great difficulty which developers are facing (VanBerkel, 2010:p1).

The fact that there is an oversupply while there is a limited demand forms a great problem, as it becomes much more difficult for developers to sell or rent their building to potential building users. The combination of this oversupply together with the new flexibility trends in the real estate market, creates an even larger problem, making it difficult and in these times even impossible to find potential buyers for office buildings in the Dutch real estate market. This can be confirmed by looking at the Tilburg example and by looking at the Dutch real estate market in general. It is therefore important to understand the size of this problem in the real estate industry in order to react on it in an efficient and effective way.

1.1.2 Mismatch between developer and facility manager

Developers can be seen as the ones who form the supply side of the market, as they are the ones developing new buildings. The demand side of the market exists of the building users and is (in the commercial industry) often represented by the facility management department. In an optimal building environment, there should be a match between the supply (developer) and demand (facility management) (DeKleine, 2009:p2). If this could be realized in the current market this would not solve the vacancy issue, but it could lead to a better understanding of the demand (on the side of the developer) and would possibly lead to a building which would match the users demand. The facility management department would bring these flexibility standards forward to the developer; this is an important element which is currently missing as there is no clear link with facility management (DeKleine, 2009:p2). To highlight this aspect, an interesting quote can be used which can be seen underneath:

'Traditionally, the facility manager was approached when the building keys were given" (Niese, Janssen, 2011:p3)

The quote clearly shows the traditional approach of the facility management department which is not linked with the development processes. Therefore, in traditional projects where developers create office buildings, the facility management department is not consulted (Niese, Janssen, 2011:p2). When looking at large facility management firms it is noticeable that they are left out in the initial building process, while they see themselves as important players in the initial phase. This can also be seen when looking at the decision models used in projects, as facility managers often have no or a limited say in the building process (Niese, Janssen, 2011:p2).

These projects where developers create buildings and deliver them to the exploitation party (facility management), show a great mismatch as there has been no interaction in previous phases. The failure here is that building and exploitation are separated, meaning that the building is not optimal (in exploitation perspective) and can lead to high maintenance costs (DeKleine, 2009:p2). When analyzing the relation between real estate and facility management it is noticeable that traditionally; real estate is supply driven and little priority is given to the demand of building users. This forms a great problem in times where there is an oversupply and real estate becomes demand driven (DeKleine, 2009:p2).

In the building industry the traditional build model is used widely and a tender for lowest price is most of the time priority. This often effects the adaption of innovative processes in the building phase affecting an important innovative stakeholder; the facility manager. By leaving out the facility manager, a gap is created among the building provider and the building user. This shows the challenge which lies ahead for facility management to close this gap (Vermeulen, 2008:p97).

A positive development is noticeable however, as nowadays a small linkage can be found between the two stakeholders when looking especially at new PPP (Public Private Partnership) and DBMFO (Design, Build, Maintain, Finance and Operate) projects, where in some cases facility management is involved in the pre-usage stage. An example is the ministry of finance in The Hague. These projects however, can be seen as relatively unique, as they are not standardized in the construction world, but it is a development which is seen more often (Niese, Janssen, 2011:p3). The fact that there is no clear link between developer and facility manager is therefore an important aspect to focus on as supply and demand in a building market needs to be balanced; it is therefore seen as a challenge for both parties to integrate and to overcome this problem.

1.1.3 Lean knowledge gap

When looking from academic perspective, it is obvious that a great deal of literature has been written concerning the lean philosophy. Womack and Jones had a breakthrough with the book: The Machine that changed the world (1990). This book described the great breakthroughs in the manufacturing world, starting from the mass production system introduced by Henry Ford and ending with the new lean philosophy. After that period, Womack proceeded with Lean thinking (1996) and gave a more in depth view on lean in the car manufacturing world followed by titles such as: Learning to see (1999) and the Toyota way (2004). The books written by Womack all give a clear view on the lean philosophy and the implementation of lean in the Toyota Company. The first lean philosophy applied on the construction however, began in 1997, as Glenn Ballard and Greg Howell founded the Lean Construction Institute (LCI). The LCI would develop the Lean Project Delivery System (LPDS), which applies principles pioneered in manufacturing to construction. According to the LCI, the LPDS tools:

"Facilitate planning and control, maximizing value and minimizing waste throughout the construction process" - (Leanconstruction, 2011: online)

It can be said that the LCI is the main knowledge center concerning lean construction, as they developed and reformed the lean theory in the construction world and spread their knowledge into the world by means of seminars and articles. When analyzing the articles and journals published by the lean construction institute however, it becomes clear that there is a grey area on the specific research field, namely; lean in the process between developer and facility management.

Articles on BIM (Building Information Modeling) can be found, analyzing the effect of lean by integrating BIM among architects and the contractor, but the facility manager or user representative are not mentioned (Wilhelm, 2007:p4). Also when focusing on the lean construction methodology in these articles, the pro's and con's of lean construction are discussed, but no link is made to facility management or facility workplaces (Gaba, 2005:p2). When looking at the lean construction literature, great deal of general principles can be found, as integrated teams, decision making processes are mentioned. However, a link with these principles and the field of facility management/project development is not made (Pinch, 2005:p2). More literature on integrated project delivery and various contract forms linked with lean can be found, but a view on facility management/project delivery cannot be seen (Darrington, 2011:p1) (Smith, Et al, 2011:p2). The author Alarcon also provides lean construction theory by means of a book: Lean construction (1997). An important aspect of this book is on how to identify waste in lean construction and therefore it provides a full waste methodology. However, here no focus is put on facility management or the building users, leading to no link with this research topic (Alcaron, 1997:p392).

It cannot be denied that there is a grey area on lean in the relation between facility management and project development. An important reason can be the fact that lean has greatly focused on the production of product lines and looked into processes rather than buildings. Also literature segmented on lean construction does not cover the process between facility management and project development. However, when focusing on nowadays developments in the problematic commercial building market, it can be said that this lean philosophy is missing information on an interesting topic thus creating a knowledge gap. This knowledge gap is important for this research as the lean philosophy can add great value to the process between developer and facility manager. Due to this, great focus will be given on lean and on how to integrate lean into the two stakeholders in order to close this grey area and thus knowledge gap.

1.2 Problem statements

When summing up the main problems in the problem analyses it is noticeable that project developers play a crucial role in the building market and are facing great problems due to the oversupply in the commercial building market. A market which is dominated by oversupply on the one hand and which is missing flexibility (in terms of flexible buildings according to the wishes of building user) creates large problems for developers.

Moreover, it can be said that there is no clear link to be found between developer and facility management. This can be seen as a cause of the creation of inflexible buildings; which is a large problem in times of an office market dominated by great oversupply. The fact that new office trends lead to aspects such as a decrease in the m2 per employee makes it even more difficult for developers to create a building which match the demand.

The mismatch between supply on the hand of the developer and demand on the hand of facility management means that flexibility is missing and therefore plays an important role in this research.

From lean perspective, the academic literature available shows that there is a knowledge gap as no literature on the specific theme is present. In the last couple of years a shift has been made to apply lean in construction, which can be seen when looking at the Lean Construction Institute. This means that Information concerning lean construction is present; however the current information available does not cover the process between developer and facility manager. The focus to be found is set on developments such as BIM, which are important tools, however room should also be made for developments within the real estate branch such as the aspects handled in this research. As this is not the case a knowledge gap is created, which can be seen as an important problem in relation to this research.

When analyzing these findings, the problem statement can be divided in a theoretical problem statement and a practical problem statement. The theoretical problem statement focuses on theoretical aspects and the practical problem statement puts emphasis on the main practical problem to be found in relation to this research. Firstly, the theoretical problem statement can be seen underneath, followed by the practical problem statement.

Theoretical problem statement:

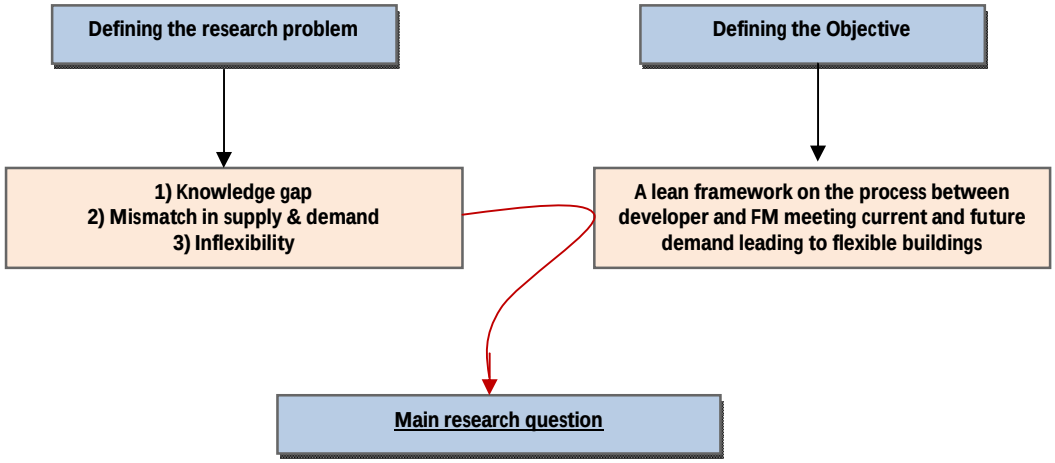
"There is no specific lean theory focusing on the relation between facility management and project development, creating a knowledge gap"

Practical problem statement:

"There is no clear link between developers and facilities management, creating a gap for developers on user flexibility standards, resulting into a mismatch between office supply and demand

1. 3 Research questions

In order to conduct this research, a set of clear research questions have been formulated. The aim of the research question is that it handles the problem and will lead to the objective of the research. In order to provide such a research question, the framework underneath has been used.



"How can Lean, when using its main principles in an early interaction, starting from the initial phase till the final phase of construction projects, between developer and facility manager, lead to an effective real estate project cycle and also result in an office building which fulfills the current demand of flexibility?"

Figure 2- Research question framework

The framework above shows that the objective can only be reached by handling the problem. The lean knowledge gap together with the mismatch in supply and demand leading to inflexibility has to be dealt with. If these items are resolved, a lean framework showing the process between developer and facility manager will be made, which could lead to satisfying the flexible demand. Combining objective and problem has led to the main research question. The research question shows that the emphasis is put on the real estate project cycle. This word use is specific, as the real estate project cycle looks at the whole construction cycle, starting from the initial phase, than moving to the design phase, shifting to the execution phase and eventually looking at the usage phase. It is important that the whole cycle is used as the knowledge of the facility manager (Niese, Janssen, 2011:p3), is integrated in the pre-usage phase. This will lead to a full integration of facility management and project development.

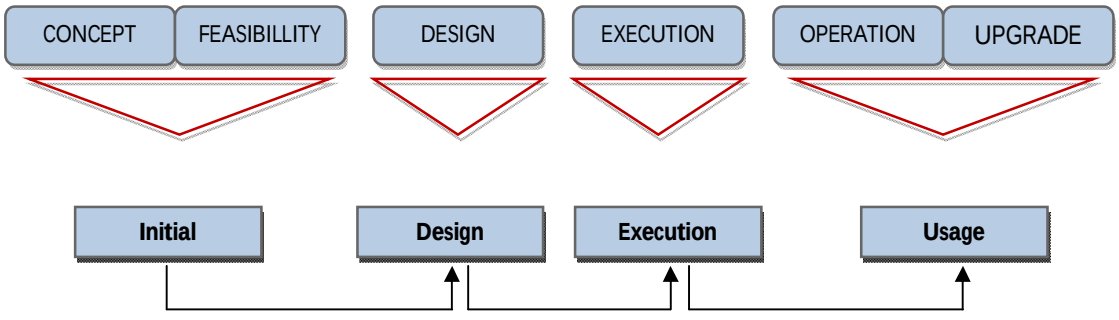


Figure 3- The real estate project cycle

The basis of the research question can be found in the main lean principles, as those principles are applied in the process between developer and facility management. This means that the sub research questions will handle these lean principles in combination with the process between developers and facility managers. The sub research questions will consist according to the five essential lean principles. These five principles are summarized underneath (Womack, Jones, 2003:p16-26).

1. **Value:** Defining value in terms of what the customer wants
2. **Value stream:** Which processes add value and which do not add value?
3. **Flow:** How to create continuous flow?
4. **Pull:** Producing a service until the customer ask for it
5. **Perfection:** Establishing continuous improvement

1) Value

- *How are the facility managers' needs currently determined by the developer and how intense is the cooperation with the facility manager in order to gain the value knowledge?*

2) Value stream

- *What are the roles and responsibilities of the facility manager and the developer in the real estate project cycle and which processes between these two stakeholders create value and which do not create value?*

3) Flow

- *Which work practices between the developer and facility manager can be rethought and which barriers need to be eliminated in order to create continuous flow?*

4) Pull

- *What are the facility manager's influences on the schedule and in what way can the process between facility manager and developer be made fully pull, leading to pull planning?*

5) Perfection

- *How could continuous improvement be established and what does this mean for the relation between developer and facility manager?*

By answering these research questions a profound answer can be given at the main research question. Each principle is related to each other, this can be seen in the illustration underneath.

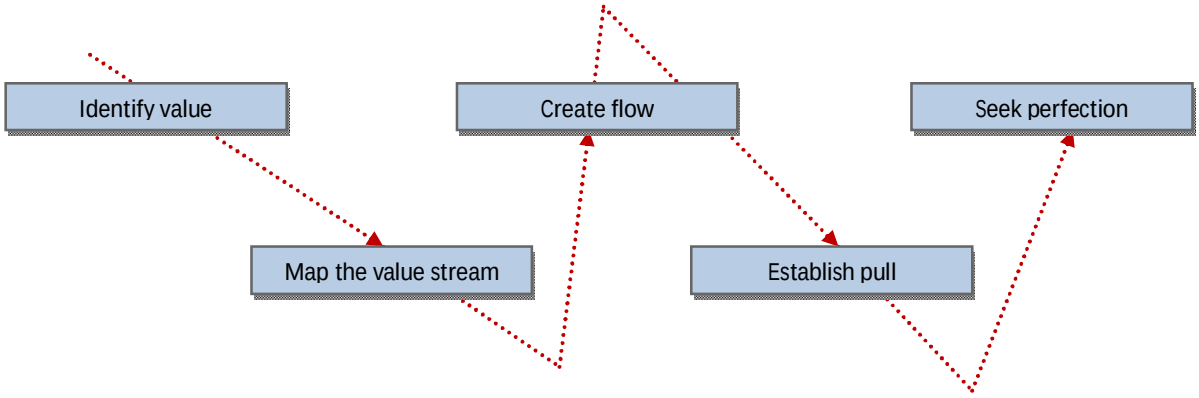


Figure 4- All five lean principles

Conclusion

When concluding this chapter it can be said that the problem area of this research can be defined as the lean knowledge gap and the mismatch between facility management and project development leading to an office supply which does not meet the users demand. As users demands are not met, aspects such as exploitation and logistics provide problems and make a building less attractive. This creates a great problem for the real estate world, especially for developers as their current buildings do not take these aspects into consideration. The problems will affect developers as it becomes difficult to sell or rent their buildings in a market dominated by oversupply. It is therefore a problem which has to be analyzed.

In order to handle these problems the research will focus on the research question stated. It is important to use the lean principles as guidelines in order to answer the research question. This can be done by integrating the lean principles in the research, consisting of: value, value stream, flow, pull and perfection.

2 Chapter two
Methodology

Figure II – Magnifying glass used to emphasize the research methodology

"Research is to see what everybody else has seen, and to think what nobody else has thought"
- Albert Szent-Gyorgyi

Introduction

After discussing the problem analysis and the research questions in the previous chapter, this chapter will focus on the methodology which has been used in order to handle the research problem and questions.

In the first paragraph the primary and secondary data used will be discussed. The methods of these data collection forms which have been applied will be mentioned and a look will be given at the advantages and disadvantages of these data collection methods. The paragraph will be followed by a detailed description of the chosen case study method. This will be done by means of analyzing the Eisenhardt theory and the steps needed to conduct this theory. The next paragraph will focus on coding and case study protocol. Here the definition of coding and the used code list in order to analyze the interview data will be described. The actual code list can be found in the appendix, showing the actual coding protocol. After this is done the case study protocol applied will be handled, showing the protocols used in order to conduct the case studies. Furthermore, the research design will be displayed, showing the various deadlines on delivering the research products which needed to be met.

The final paragraph of this chapter will focus on the research limitations. In this paragraph those aspects which will not be handled in this research will be focused on. This is done in order to prevent confusion on the further outcome of this report.

After handling the methodology, the next chapter will focus on the theoretical framework. In that chapter a lean literature is conducted, showing the most relevant aspects of lean in academic perspective.

2.1 Primary and secondary data

Primary data: *Interviews*

The interview is an important aspect of the research, as this will provide the opportunity to contact key stakeholders of the project and to ask them for their opinion and experience. The advantage of interviewing is that it is possible to ask important stakeholders why they made a specific decision. On the other hand there are also disadvantages of taking interviews. The type of data gained cannot always be fully reliable, as people are not always aware of their own behavior. Another aspect of the disadvantage is that people tend to be more positive and will therefore mainly avoid negative experiences (Baarda, DeGoede, 2001:p75). The interviews to be conducted can be divided by means of the two stakeholders: project developer and the facility manager. Other stakeholders who have also participated in the projects which have seen and experienced the cooperation between developer and facility management can also deliver interesting data; this has to be taken into account. In order to gain more knowledge on the lean theory however, academics on lean have and will be further consulted; this will be done in more informal conversation form, as the main lean specialist is part of the graduation mentor team. The stakeholders and aspects to be taken into account are listed in the figure underneath. Additionally, the interview questions used can be seen in appendix 2 and 3.

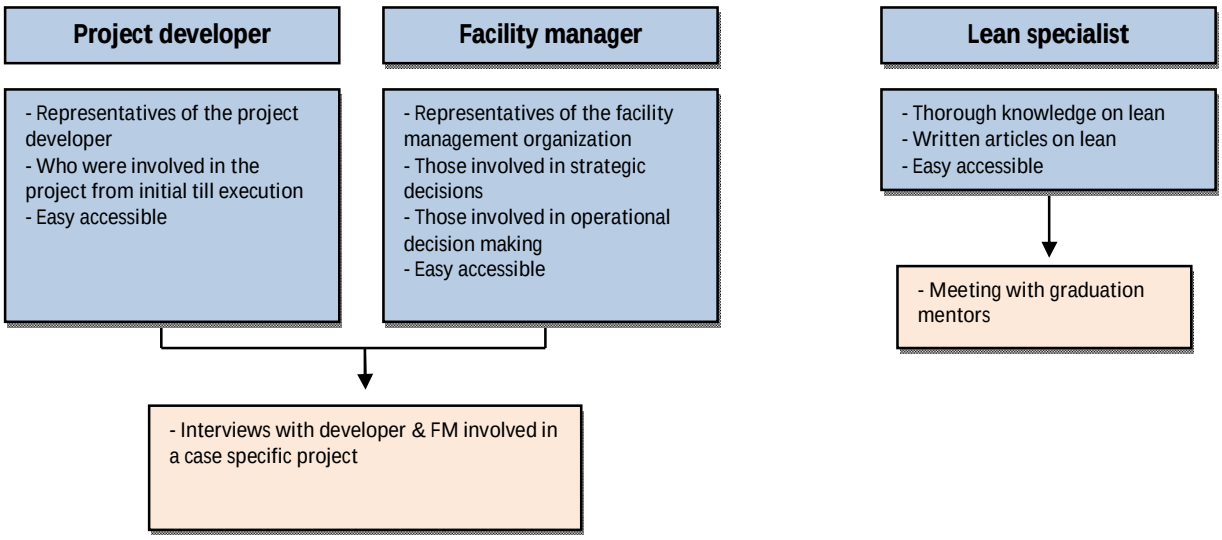


Figure 5- Interview diagram

Secondary data: *Archives*

In order to gain valuable material from the work field; archives from existing data will be used as it is an important source. These archives can be: PowerPoint presentations from case studies, case documents such as process and project charts and other type of documents. With these documents it is possible to gain other views on the projects to be studied and thus can be used as valuable data.

Secondary data: *Articles and video material*

As a great deal of articles can be found on the cases which will be handled, articles can be seen as important source of information, and will therefore also be used as secondary data in this research. Also video material, in terms of taped interviews on the cases will be used, as these provide interesting data.

2.2 Case studies: Eisenhardt

The most appropriate form of approaching this research project is by means of case studies. The case study methods have the advantage that it deals with a real world business scenario where the most important decisions can be analyzed. With case studies the most important opportunities and problems within an organization can be analyzed and measures can be taken. An important consideration to keep in mind is that the case study should identify key issues and problems, should provide alternative courses of action and draw the most relevant conclusions (Laudon,2007:p234).

In order to be specific and work structured, the theory of Eisenhardt (1989) will be used. Eisenhardt has written the article: *"Building theories from case study research",* which shows all the needed steps to be taken for this type of research (Eisenhardt, 1989:p532). These steps can be seen in appendix 4.

The first step is to get started by formulating research questions. A choice has been made to also start with the literature study, as this sequence is more appropriate in this graduation research and will provide essential data in an early stage. When this is done, the needed cases can be selected, this is done as the population is selected. The cases selected are: Renovation of the ministry of Finance in The Hague and the new DUO building in Groningen. These two cases are selected as they make use and integrate facility management in an early stage (Eisenhardt, 1989:p532).

When looking at the third point; instrument and protocols, multiple data collection methods need to be applied in order to maximize efficiency. A choice can be made to use qualitative or quantitative data; these can also be combined to reach optimum quality. In this specific research the use of qualitative data will be made. In the fourth step, you enter the field; here it is important that the data collected is analyzed, including field notes. The field will be entered mainly by means of interviews with project stakeholders. Then, the data will be analyzed both within one case and a cross-case analysis will take place. By means of the cross case analysis, universal findings can be noted. This means that data gathered from the renovation of the ministry of finance and the DUO building will be compared. If this is done and all data is collected, a hypothesis can be shaped. Here it is important to search for '*why* 'behind each relationship (Eisenhardt, 1989:p532).

After the hypothesis stage, a comparison will be made with literature used in this research. By doing this, an objective view can be generated, providing the optimum quality. The last step is the closure stage, where theoretical saturation is applied, creating an academic report (Eisenhardt, 1989:P533). By applying these steps, a structure, coherent case study can be conducted. It is important that the study is done by multiple cases, as the cross referencing method will create an objective viewpoint and will reach the optimum quality. On the next page, the activities of this research and the reasons are implemented in the Eisenhardt table on the next stage (Eisenhardt, 1989:p532).

It is important to understand the difference between this type of research and the most frequent form of research where first a hypothesis is formed and then research is done. By developing hypotheses after entering the field, sharp hypotheses can be formed as a great deal of data is generated and relations between variables can be strongly justified and thus strong hypotheses can be generated.

Table 1- Eisenhardt research approach

Step	Activity	Reason
Getting started	**Defining research question & literature study:** ***RQ:*** *Can the usage of **lean** principles in an early interaction, starting from the initial phase till the final phase of construction projects, between **developer** and **facility manager**, lead to an effective real estate project cycle and also result in an office building which fulfills the current demand of **flexibility**?"*	The research question focuses the research on four important aspects: Lean, Developer, Facility manager and Flexibility. The focus is also set on the real estate project cycle, showing a focus on all stages of the project cycle
Selecting cases	**Specified population:** The cases match the criteria of integrating FM in an early stage: Ministry of finance, Den Haag DUO Groningen	These cases are theoretically useful as they match the research. The choice has been made to not focus on cases which do not match the research, due to time limitation
Crafting instruments and protocols	**Multiple data collection methods:** - Interviews - Archives - Articles	By using primary data such as interviews, essential and reliable info can be gathered. Secondary data such as archives and articles create a reliable framework
Entering the field	**Overlap data collection and analysis, flexible and opportunistic data collection mt:** - Gaining detailed info by means of interviewing stakeholders	By trying to gain detailed inside information, the researcher can get unique info on cases
Analyzing data	**Cross case analysis:** Data from case 1 will be compared with data case 2	By comparing data from case 1 with case 2, the outcome can be more reliable
Shaping hypothesis	**Search evidence on relationships:** Each lean principle will have one hypothesis, meaning that there will be five in total	By using hypothesis on each lean principle, the lean theory can be tested on all principles
Enfolding literature	Literature comparison on the literature study	By looking back at the literature study, firm conclusions can be mad
Reaching closure	Theoretical saturation : Hand in report	The report is the final outcome of the whole research

2.3 Explorative research

The empirical cycle consists out of five phases. The first phase focuses on collecting empirical data which is needed to form a hypothesis. In the induction phase the hypothesis is actually formed. The third phase; deduction, looks at the possible outcomes of the hypothesis. The testing phase looks whether the hypothesis was actually true and in the last phase; evaluation, possible new researches are formulated (De.Groot, 1961:p29).
The regulative cycle starts with a diagnosis phase, where a diagnosis of a case and thus a problem is formulated. After this phase, a plan is made, which is focused on solving the problem stated in the previous stage. Then, the action phase starts, by means of observations done. After this phase, the evaluation phase follows; here the processes observed are evaluated. The last step is to define a new practice problem (Gruijters, 2003:p15).
The reflective cycle looks in the first phase at the cases to be selected. Here, a choice has to be made for the most interesting cases. Then, after a choice is made, the processes in the regulative cycle will be followed. When this is done, a reflection on the results will be given. When these phases are done, the gained design knowledge can be translated and transferred (Gruijters, 2003:p16).

Combining the most important elements
After reflecting on these three cycles, the choice has been made to combine the most important (in the view of the research to be done) elements in one cycle. This would result in the following cycle, existing out of five phases; the observation phase, the diagnosis phase, the plan phase, the induction phase and the evaluation phase. An important factor which has led to this specific cycle has to do with the fact that the Eisenhardt theory is used. The research will start with the observation phase. At this stage data will be collected and the Eisenhardt steps: getting started, selecting cases and creating instruments will be applied. The second stage is the diagnosis stage. Here, the problem area will be formulated as the Eisenhardt step of entering the field will be applied. By entering the field detailed information will be gathered which will lead to a close look of the various problem areas. The third stage is the plan stage; at this stage the methodology on how to solve the problem will be implemented. This will be done by cross case analysis (according to Eisenhardt). In the induction phase hypotheses will be formulated, this will be based on the data collected at that point and will be confirmed by enfolding literature (Eisenhardt). The last stage will be the stage were possible new study recommendations will be given and will be the closure stage where the final report will be handed in. In the last stage all research questions will be answered and possibly, a framework will be created which will show the various processes between developer and facility manager, see figure 6.

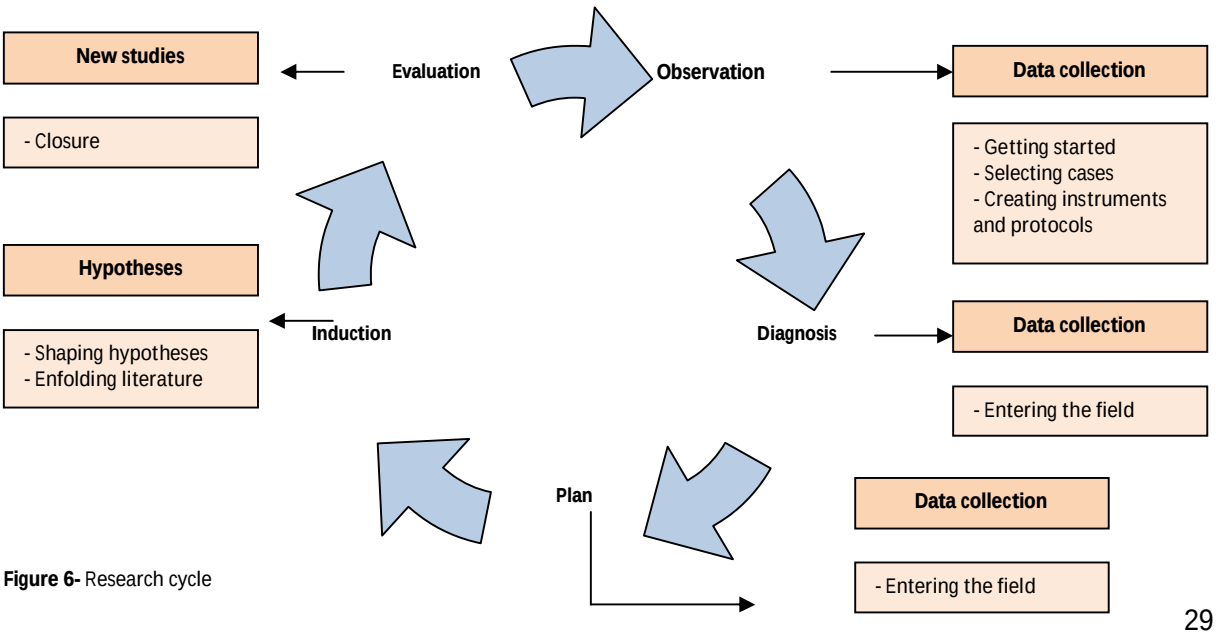


Figure 6- Research cycle

2.4 Coding and case study protocol

Coding

An important tool to be used in qualitative studies is coding. Coding can be defined as:

"A systematic way in which to condense extensive data sets into smaller analyzable units through the creation of categories and concepts derived from the data"(Lockyer, 2004:p137)

Coding can be seen as an essential tool as it systematically categorizes the data you collect from questionnaires and interviews. As interviews will take place, coding needs to be applied. Coding helps to enable the researcher to analyze data and to generate a general theory *(Lockyer, 2004:p137)*. There are several levels of Coding, the main levels are:

1) **Open coding**; breaks down, compares and analyses data
2) **Axial coding**; makes connections between categories after open coding
3) **Selective coding**; selects the core category, relates it to other categories and confirms, explains those categories (Strauss, 1990)

When interviews take place, codes are developed after the data collection and during the data analyzed phase, which means that they will be made after the interviews have taken place. Firstly, a transcript will be made; this will be read line by line and will be divided into units. These units are segmented and will be coded. During the coding phase, a master list will be kept, this is a list of all the codes that are developed and used in the research study (Johnson, 2007:p1). The code list used can be found in appendix 6.

Case study protocol

Use of a case study protocol is needed in order to properly conduct the case studies. A case study protocol can be seen as a set of guidelines that can be used to structure and govern a case research project (Yin, 1994). The case study protocol will outline the procedures and rules concerning the research approach before, during and after a research project (Maimbo, Pervan, 2005:p1282). The case study protocol is also useful as it ensures uniformity in data collection and analysis (Yin, 1994).

The case study protocol not only shows the procedures to be taken, but it also contains the research instruments which will be used in order to collect data during the research project. The research design leads to the instruments to be used in the case study protocol (Mingers, 2001). In this case the research design is the Eisenhardt approach, discussed earlier in this chapter. The case study protocol used in this research exists out of five sections. The first section contains information on the purpose of the protocol and general data. The second section provides a brief overview of the research project and the case research method. Thirdly, a more detailed description of the procedures for conducting the cases is given. After the third section, the instruments to be used are mentioned. The last section will be the data analyses guideline, here a detailed guideline on how to analyze the cases will be shown and described (Maimbo, Pervan, 2005:p1287).

The case study protocol can be seen as an extension of the Eisenhardt approach and is therefore integrated to that model. The case study protocol has been made into detail, as the protocol is highly important in order to get most out of the case studies. The case study protocol which is used can be found in appendix 5.

2.5 Research design

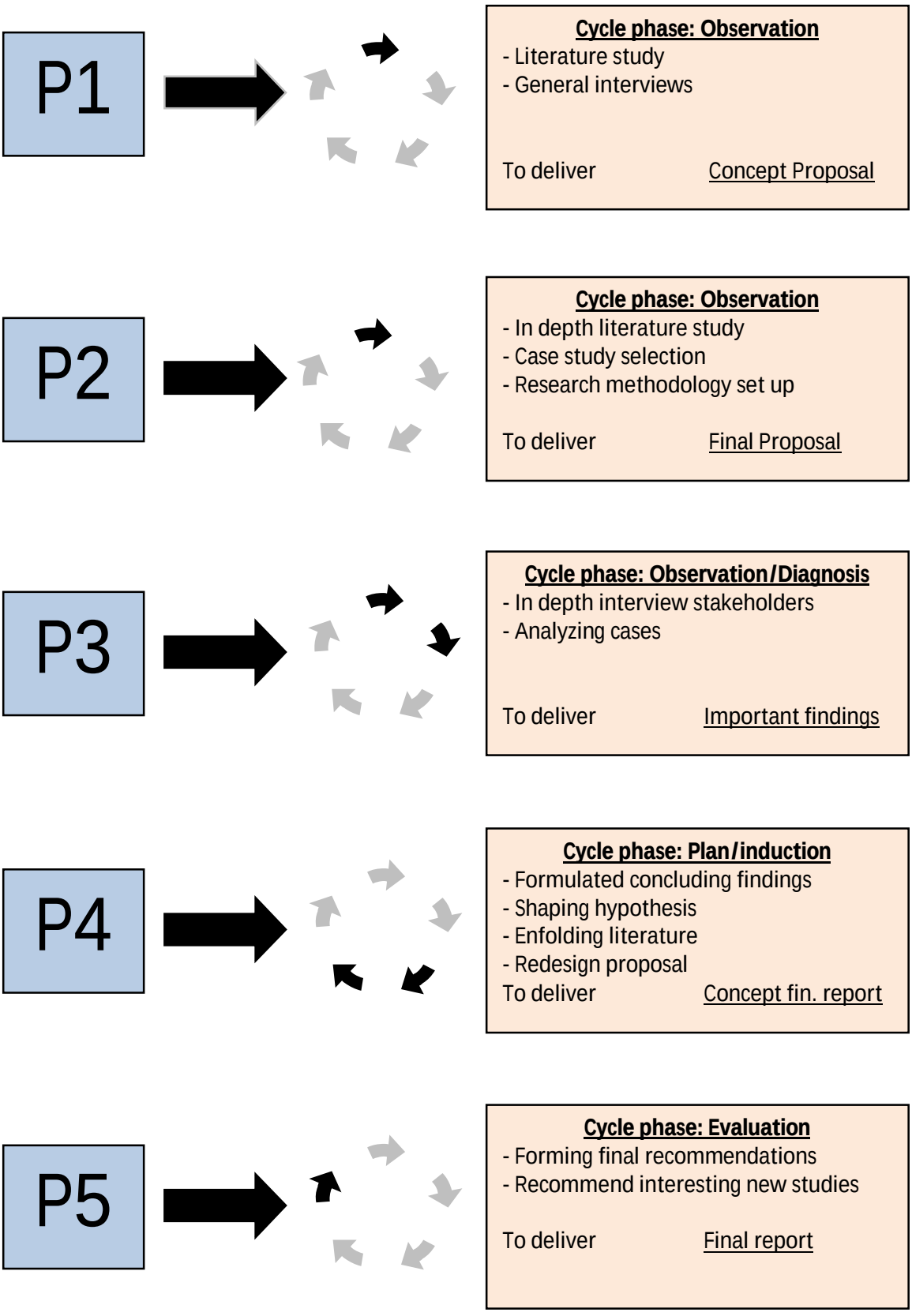


Figure 7- Research design

2.6 Limitations

The limitations of this research, meaning the aspects which will be handled and those which will not be handled, are important to discuss in order to prevent misinterpretation. This will be done in order to fully understand the priorities given in this research and to avoid misunderstandings.

Firstly, it is important to acknowledge that lean is a product and process based philosophy, meaning that this research is focused on the process between developer and facility management. This means that the priority is given on the process and not on physical building aspects. As physical aspects in the construction world tend to be interesting, a small amount of information in relation to physical building aspects will be handled.

As the research is focused on the four aspects: developer, facility manager, lean and flexibility; a clear view is given on the main topics. The research will use lean literature, by integrating the five principles, and by integrating lean between the processes of the two stakeholders. In respect to the flexibility aspect it is important to define the term as user requirements and or demands. Flexibility will therefore play a large role in the field of facility management as it is the added value of this stakeholder.

A mentioned problem in the building world, namely office vacancy, is seen as a consequence of various problems and seen as a result of years of mismatch between supply and demand. This research does mention the vacancy issue; however it does not handle building vacancy as a problem which will be dealt with in this research. Therefore the vacancy issue will not be solved by handling the research problem and thus it does not form the research objective. It is important to understand that the research looks at the mismatch between developer and facility management, leading to non-flexible buildings on the hand of the developer and thus making it extremely difficult for the developer to create buildings according to the wishes of building users. The vacancy issue is used at this stage as it creates an even larger problem for developers as their 'building' will be one of the thousands buildings in the current office supply. By defining the objective as creating a flexible building, the developer will have better chances on the market by developing flexible buildings and will have more chances of 'winning' tenders. This is the core of the research and is therefore essential for the reader to understand.

The end result of this research will consist of a process framework, implementing the five principles of lean in the process between developer and facility management based on two case studies. The framework will not be a guarantee of success for the developer to create the ideal building which will be sold. Instead, it will provide the developer with essential information on the usage of various processes with the facility manager to create a flexible building which meets a great deal of demands in a market were the demand is small and supply large, thus creating an even larger emphasis on satisfying users demands.

To sum up, this research will not solve the vacancy issue which plays a dominant role in the Dutch commercial real estate market. The research will also not physical building aspects as main aspect, but will be mainly focused on the processes between developer and facility management. This research will however try to create an efficient process between developer and facility management based on lean thinking with the objective to create flexible buildings and thus trying to satisfy building user's demands.

Conclusion

This chapter has showed that the usage of interviews will form an important aspect in this research. By making use of interviews the research will collect data by means of reliable and up to information. In order to conduct the research based on case studies efficiently, the Eisenhardt theory is of essential importance. By using this approach, reliable outcomes and hypotheses will be achievable. It is therefore important to follow all steps of the Eisenhardt methodology. The coding list used has filtered out the most important information gathered from the interviews and the case study protocol has been followed in order to analyze this information.

It is also important to keep the research limitations in mind. An important aspect here is that the vacancy issue in the market will not be handled and thus will not be solved by means of this research. Another important aspect here is that the lean philosophy in this research is process based, meaning that priority is given on the process and not the product (in terms of the physical building).

Part 2

Theoretical framework

3 Chapter three
Lean

Figure III – A car plant, referring to the roots of lean in the car industry

"The most dangerous waste, is the waste we do not recognize"
- Shigeo Shingo

Introduction

In the previous chapter the research methodology was discussed. In this chapter the theoretical approach of this research will be discussed by means of a literature study. In the first paragraph the history of lean will be handled. A look will be given at the founders of lean and the beginning of lean in the production world. In the second paragraph lean construction will be handled. Here a clear insight on the transition of lean production to lean construction will be given by means of literature examples. The next paragraph will be a rather detailed one, describing the lean principles used in this theory. Firstly the value principle will be discussed, followed by the value stream principle. After the discussion of the first two principles, the third namely; flow will be discussed. By means of examples, a clear insight of the principles will be given. After the flow principle the pull principle will be handled, which is focused on pull planning. The last principle will be perfection; this will be discussed and elaborated on. Overall, this chapter will provide a theoretical framework on lean by using various types of examples of different literature.

In the next chapter a literature study on facility management will be conducted. Here all important aspects related to this stakeholder and this research will be handled from theoretical perspective.

3.1 Lean history

Henry Ford and mass production

When looking at production methods in general, an important breakthrough began with Henry Ford (Ballard, Howell, 2004:p43) , who achieved great objectives with the model T, namely; 1) he had a car which was designed for manufacture, 2) almost anyone could drive and repair it. Henry Ford knew that the key to efficient manufacturing would be to create easy attachable parts by means of the assembly line (Womack et al, 1990:p26). In 1913, Henry Ford realized the continuous flow assembly line, as he noticed the great waste of time by employees walking from one department to another. This would be the start of mass production in the car manufacturing world and would spread to other businesses and is still of importance nowadays (Womack et al, 1990:p28). However, a shift can be seen to a new production method called: Lean production. It cannot be doubted that Henry Ford had a great influence in the (car) production world and that he was the initiator of mass production, however it is interesting to see that the mass production method would also be the start of lean.

Toyota and the beginning of lean

The 50's would be an important year for Toyota as their production method would quickly improve. The person responsible for this was Ohno (Toyota's top manager), as he eliminated the need for specialists in the fabric and reduced time required for changing dies from three days to three minutes. Another important breakthrough he made was done by using small batches of stampings instead of enormous lots. This would result into two advantages; no need for inventory and mistakes would be quickly discovered, resulting in high quality as waste would be eliminated (Womack et al, 1990:p53). Thus, lean can be seen as a process where waste is eliminated and only added value processes are being implemented. Interesting enough, Ohno saw that it were the assembly workers who added value and therefore placed them on a high rank, instead of the low status assembly workers gained in the western world. As these workers gained in hierarchy they would have the chance to stop the whole assembly line, when they would see a mistake. This would be impossible for assembly workers in the western world (Womack et al, 1990:p57). An essential part of the Toyota approach, would be their relationship with the suppliers. As Toyota would avoid inventory, the supplies would have to be arranged in a highly efficient way. Toyota would therefore make the suppliers an integral part of their organization (Womack et al, 1990:p57). This new and more effective approach would be called the Toyota Production System (TPS), also known as Lean. An important part of the lean method would also be the lean culture in Toyota. Ohno wanted to integrate lean in every aspect of the organization and wanted to make the employees part of the Toyota family. This great emphasis on the lean culture would be visible when looking at the workers dedication. The employees have a greater purpose than getting their paycheck. (Liker, 2004:p73). The following quote by Womack shows his vision on lean and emphasis the importance of added value:

"The truly lean plant has two key organizational features: It transfers the maximum number of tasks and responsibilities to those workers actually adding value to the car on the line, and it has in place a system for detecting defects that quickly traces every problem, once discovered, to its ultimate cause"
- (Womack et al, 1990:p99)

3.2 Lean construction

In order to understand the lean construction origins, the Lean Construction Institute can be consulted. They are the most well-known lean construction institute and provide information concerning this topic. According to them, lean construction is: *"A production management-based approach to project delivery -- a new way to design and build capital facilities"* (Leanconstruction, 2011: online)

Lean construction has caused a change in manufacturing design, supply and assembly. In the construction world lean has changed the way work is done throughout the delivery process. As waste is put to a minimum and value increased, the facility and its delivery process are designed together to better support the customer (Leanconstruction, 2011: online). Another interesting quote from the LCI showing its usefulness:

"Lean Construction is particularly useful on complex, uncertain and quick projects. It challenges the belief that there must always be a trade between time, cost, and quality" (Leanconstruction,2011 :online)

When looking at Womack, he believed that the definition of lean construction consists of the following aspects: teamwork, efficient use of resources, continuous improvement, communication and elimination of waste (Alcaron, 1997:p33). The waste methodology applied in construction in respect to lean is of great importance according to Alcaron. First, training in lean construction is needed for employees of the construction organization. Secondly, a brainstorm session is held among those employees and the rest of the staff to define the waste categories. Moreover, a second workshop is held to define the causes of waste. When the first three steps are completed, the survey is prepared followed by the improvement of action identification. When these improvements are identified, they are implemented by means of the last step to be taken (Alcaron, 1997:p393). According to the lean construction philosophy, several types of work can be identified as waste and one type of work can be identified as value adding. These categories can be broken down according to three categories (Alcaron, 1997:p393):

1. **Effective work**; activities directly adding progress to a unit being constructed such as placing bricks, painting walls, placing concrete, etc.
2. **Contributory work**; activities not directly adding but required to finish the unit such as ready plans, receiving instructions, moving outside the work position, etc.
3. **Non contributory or idle**; all other activities

There are however, misconceptions on the non contributory work category, as some perceive this as non-waste. Therefore Orbeta (1995) has further broken-down work into five categories (Alcaron, 1997:p393):

1. **Obviously valued effective work**; activities directly adding a characteristic valued and generally accepted by the customer, e.g. painting walls
2. **Competitively valued effective work**; activities adding a characteristic valued by the customer, which differentiate the product from others adding competitiveness, e.g. special wall finishing's
3. **Non-value adding effective work**; activities producing a transformation in the product which is not valued by the customer. E.g. extra activities which are not rework but are required because of poor quality internal processes
4. **Contributory work**
5. **Non contributory or idle**

3.3 Lean principles

3.3.1 Value

Lean thinking must start with precisely defining value in terms of specific products with specific capabilities offered at specific prices through a dialogue with specific customers (Womack, Jones, 2003:p19).

Value however is often difficult to define for producers as they want to produce those products which they are already producing and because customers are used to those products. Then the problem that both customers and producers make is that they re-define value in terms of lower costs instead of analyzing value and determine what is really needed (Womack, Jones, 2003:p31). In order to create value the customer must be treated as an integral part of the organization. Again, Toyota can be taken as example. Instead of producing cars based on assumptions and general market data, they have actually sold cars door to door. First, a profile of households within a certain area was made. Periodically, each of these households were visited and during these visits the sales representatives updated their profile by asking questions such as: age, care specifications, parking data, nr of children. After gathering this data, team members systematically fed this information back to the development team. This data could then be used by the sales representatives to suggest the most appropriate specifications for a new vehicle. During the sale of the car, a whole service package would be included, from insurance till the trade in of the old car. This shows two aspects, firstly that the customer is included in the car specifications and thus seen as an integral part of the organization. Secondly, the fact that the insurance and trade in is included shows the high level of service, leading to customer commitment (Womack et al, 1990:p182). In order to graphically display this process, the figure underneath can be used.

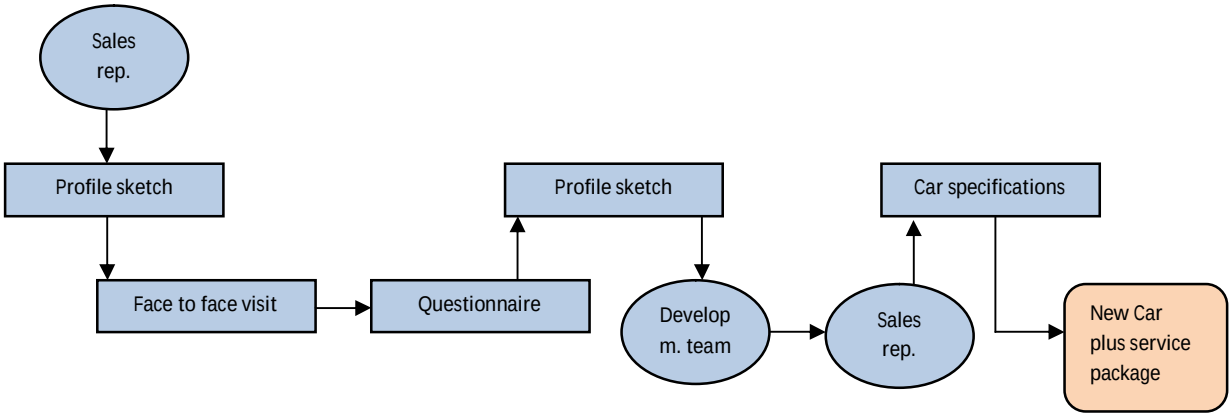


Figure 8- Gaining customer information by Toyota

When looking at the chart, it is noticeable that the real value is created at the face to face visit stage. By visiting the (potential) customer and asking them the correct questions, the profile sketch can be made accurately. The fact that a specific development team is present to analyze the profile sketch and to hand over the info to the sales representatives for a car specification list shows that the customers are taken seriously and do form an integral part of the organization.

3.3.2 Value stream

Identifying the value stream is the next step in lean thinking. The value stream is the set of all specific actions required to bring a specific product through the three critical management tasks of any businesses (Womack, Jones, 2003:p19):

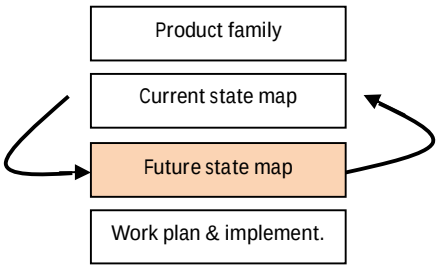
1. **The problem solving task**; from concept to detailed design
2. **The information management task**; from order taking through detailed scheduling to delivery
3. **The physical transformation task**; from raw material to finished product in the hands of the customer

In value stream you can look at value stream mapping; this assumes that an organization consists of a series of activities which are all designed to add value to the customer (Tid et al, 2005:p1). It can be said that value stream mapping is an essential tool because (Rother, Shook, 1999:p2):1) It helps you to visualize the whole process, 2) It helps you to see more than waste, 3) It provides a common language, 4) It makes decisions about the flow apparent, 5) It forms the basis of an implementation plan, 6) It shows the linkage between information flow and material flow, 7) It is a qualitative tool.

In order to create a value stream, the value stream mapping approach can be used. In order to make the value stream map, you need to identify three actions according to the following three categories (Womack, Jones, 2003:p38):

1. Those which actually **create value** as perceived by the customer
2. Those which create **no value** but are currently required by the product development, order filling, or production systems and so can't be eliminated yet
3. Those actions which **don't create value** as perceived by the customer and therefore can be eliminated immediately

Thus, by value stream mapping the following is meant: follow a products production path from customer to supplier and carefully draw a visual representation of every process in the material and information flow (Rother, Shook, 1999:p2).When making a value stream map it is essential that there is one person responsible for the value stream; making him responsible for the whole information and material flow. This person should be called: the value stream manager (Rother, Shook, 1999:p5). After the selection of the value stream manager, the value mapping process consists out of the steps shown in the illustration. First, the product family is chosen. Than a current state map is made, showing the current state of the current value map. Then, the future state value map is made, which is the perfect case scenario without all the non-value adding activities. If this is done, a work plan is drawn up and the implementation can begin (Rother, Shook, 1999:p7).



Initial value stream mapping steps

Figure 9- Value stream mapping steps

The current state map

In order to be specific and reliable on the current state map, it is important that certain steps are followed. Firstly, current state information needs to be collected. Secondly, a quick walk along the entire value stream needs to be done. Thirdly, it is important that the work is done upstream. Moreover, the time needs to be measured at various process stages to record times and see whether there are flaws. It is then important that the whole value stream is mapped by one person. (Rother, Shook, 1999:p10).

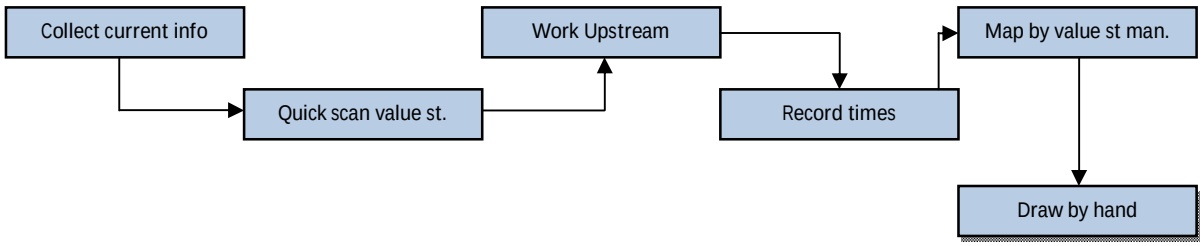


Figure 10- Steps to be taken in the current state map

The future state map

The goal of a future state map is to build a chain of production where the individual processes are linked to their customers either by continuous flow or pull. Each process gets as close as possible to producing only what its customer need when they need it (Rother, Shook, 1999:p49).

3.3.3 Flow

After the value stream mapping stage, the non-value adding items are eliminated and the focus can be set on creating continuous flow. The following statement is an interesting view on continuous flow, made by the former president of Toyota.

"If some problem occurs in one piece flow manufacturing then the whole production line stops. In this sense it is a very bad system of manufacturing. But when production stops everyone is forced to solve the problem immediately."– Teruyuki Minoura, (Liker, 2004:p87).

The statement shows both the danger and the strength of continues flow. It is logical that manufacturers lose capital when their production line stops, but the benefit of finding problems immediately is much greater than finding large problems too late (Liker, 2004:p87). In order to make value flow the following steps need to be followed (Womack, Jones, 2003:p52):

1. Focus on the actual object, the specific design, the specific order and the product itself
2. Ignore the traditional boundaries of jobs, careers, functions, often organized according to departments and form a lean enterprise
3. Rethink specific work practices and tools to eliminate backflows, scraps and stoppages of all sorts to that the design, order and production of the specific product can precede continuously

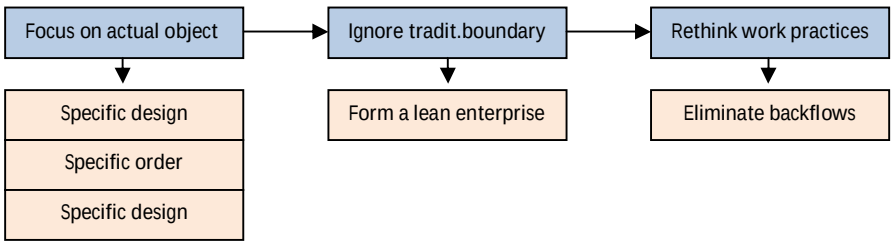


Figure 11- Steps to be followed in order to make value flow

In a continuous flow layout the production steps are arranged in a sequence, whereas the product moves from one step to another without any buffers. To establish and keep continuous flow it is important that work processes are standardized. Another requirement is that workers and thus the production team must be crossed skilled in every case, this is needed in cases when employees are absent (Womack, Jones, 2003:p60). By combining the standardization with cross skilled workers, the value flow steps will be optimal and will result into the figure underneath.

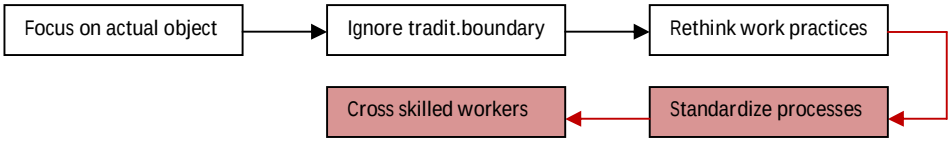


Figure 12- Flow steps extended

3.3.4 Pull

"Don't make anything until it is needed; then make it very quickly"
- (Womack, Jones, 2003:p71)

After establishing continuous flow the next step is to create a pull system to avoid overproduction and to be able to add what the customer wants when needed. In order to provide a good example of pull systems important lessons can be learned from supermarkets. Their pull system can be seen as material replenishment which is initiated by consumption, as step one in the process (replenishment) triggers step two (next process) (Liker, 2004:p23). An important element of the TPS is Kanban, which is a Japanese word and stands for: Card, ticket or sign and is a tool for managing the flow and production of materials in a Toyota style pull production system (Liker, 2004:p35). Pull can also be seen as no upstream should produce a good or service until the customer downstream asks for it (Womack, Jones, 2003:p67). This can be seen when looking at the illustration (taken from Toyota) underneath.

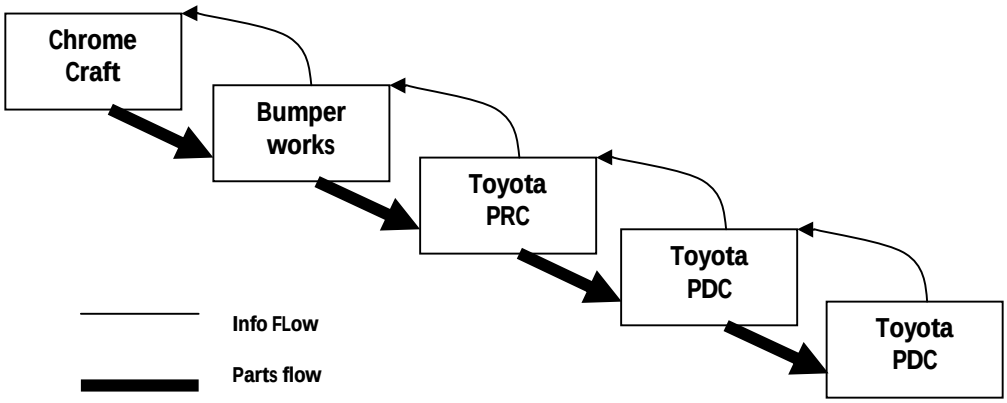


Figure 13- Establishing pull though loops

Pull planning is an important element in this principle. This system enables the planner to start planning the finished products and work backwards; this is also noticeable when looking at the illustration above. Pull planning consists out of four stages: 1) Pre-work, here the conditions and project milestones are set, also the right people are selected. 2) Facilitate the conversation, here the interaction of people is emphasized on and the training of them. 3) Follow-up, here the documentation of the meetings takes place. 4) Measuring and evaluating, here the planner identifies unplanned work and develops a backlog (Projectrealign, 2011: onine).

3.3.5Perfection

"We view errors as opportunities for learning. Rather than blaming individuals, the organization takes corrective actions and distributes knowledge about each experience broadly. "

- The Toyota way document 2001, Toyota Motor Corporation

The quote above shows the importance of learning and refers to the last step: perfection. By continuous improvement, called *Kaizen* in Japanese, a lean organization can reach its optimum. The four mentioned steps are in direct contact with each other and the value stream can always show hidden waste. By implementing perfection as ongoing process the lean aspects can be optimized (Womack, Jones, 2003:p25). It is important that the four previous steps are applied by the value stream manager. After this is done, he/she can decide on what source of waste to attack first (Womack, Jones, 2003:p94).The illustration underneath shows the five steps and the influence of perfection in the cycle.

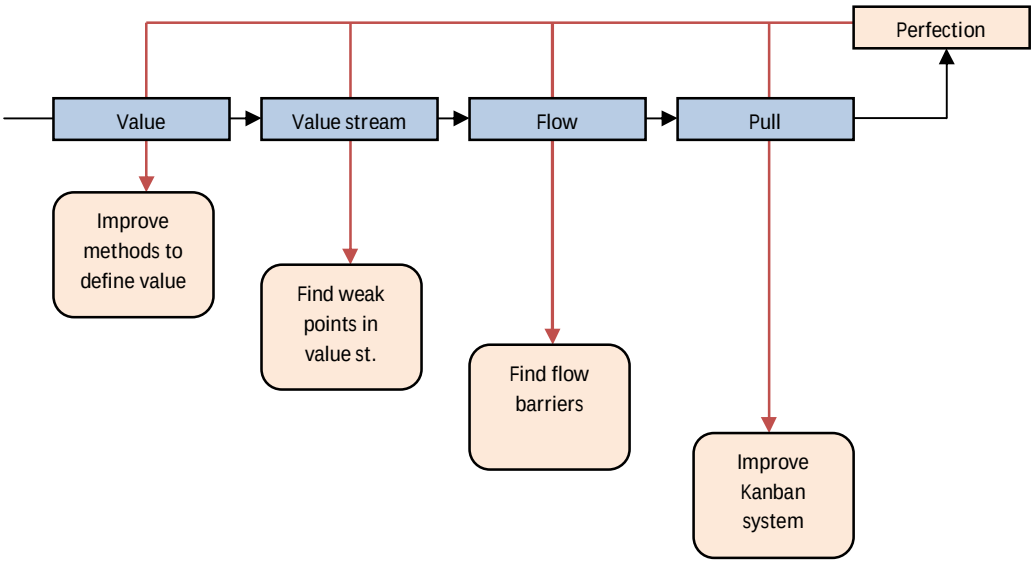


Figure 14- The five phases and the influence of adding perfection

The illustration shows that perfection is implemented after the pull phase, as this is the last implementing phase and gives time for reflection. Each phase needs to be reflected on, beginning with the value phase. Defining value is important, and thus the steps taken to define value are crucial. These steps can be evaluated and improved each single time. When looking at the value stream phase, value adding activities can be improved and there can always be hidden non-value adding activities. In order to create continues flow; it is important to always look whether there are barriers to be removed to increase this flow. And the pull phase can be evaluated to see whether the Kanban system can be improved (Kerper, 2006:p3).

In order to optimize the perfection process, the feed forward approach should also be considered. By passing information on to the next stage or next department, errors can be resolved during the process. The difference with feedback is that evaluations are made when processes are finished, meaning that errors cannot be resolved in the current process but in the next process (Winter, 2003:p5). By taking these steps into account, lean can be successfully integrated in processes.

Conclusion

This literature study has showed the great history and developments within Lean. The fact that Henry Ford was an important initiator for this philosophy is an interesting finding. An important outcome of this chapter was the fact that a large deal of lean involves Lean production and a small segmentation is made on lean construction. The Lean construction theory available however, shows the lack of focus on this specific research field. It is however important to understand the history of lean, in order to be able to work with the philosophy. When looking at the lean principles discussed, the theoretic data entails important information which will be used in the practical part of this research. By using and applying these principles in this research, a Lean theory can be developed, making this theoretical study highly important.

4 Chapter four
Facility management

Figure IV – Building users on their way to work

"Forget logistics, you loose"
- Fredrick Franks

Introduction

The literature study has started in the previous chapter by handling the Lean literature. In this chapter the emphasis will be put on facility management in theoretical perspective. The first paragraph focuses on defining facility management as a profession. Their responsibilities will be handled in order to give a clear insight on the profession. In the second paragraph the history of facility management will be discussed. This will be done by means of a timeline created, which can be found in the appendix. The following chapter will discuss the services provided by the facility manager, in order to look at the package of services provided by this stakeholder. Moreover, the trends in the field of facility management will be handled. Trends such as the new flexible workplaces are of great importance for facility management and will therefore be discussed. Also trends such as the influence of the old building stock and the emphasis on sustainability will be handled. The next paragraph will deal with FMIS (Facilities Management Information System). As digitalization in the building world is of importance, the FMIS will be elaborated on in this paragraph. The chapter will end with a part on flexibility, as it is highly related to facility management and needs to be defined.

As this chapter describes the facility management, the next chapter will provide a literature study on the other important stakeholder: The project developer.

4.1 Defining facility management

Facilities relate to all the physical conditions that enable an organization to conduct its primary activities. This includes the buildings, general installations, equipment, and their related services, but excludes human resources and all manufacturing equipment. Facilities management can therefore be described as the management and realization of housing and accommodation, the services related to these and other means in order to enable the organization to realize its mission. It includes activities such as building and technical maintenance, security, catering, travel, reception, transportation and distribution, warehousing and inventory. The task of facilities managers is to provide their services at a competitive cost and with quality level (Woude, 2007:p322).

The normal housing costs for organizations are on average 15% of the personnel costs. In housing, the employees are central, it is therefore important to look at their work processes in order to create optimal housing (Bijering, Hoogh, 2010:p2).The most important question for the facility manager is: what does the work environment need to facilitate? It is crucial that the work environment enhances communication and cooperation. It needs to be appealing for employees to come to work. It does occur in great deals of organizations that they have a low occupancy rate. This is bad for the work environment as the attractiveness is less appealing in those situations. Research has shown that a minimum of 65% occupancy rate is needed to create an attractive work environment, these are aspects where the facility manager has to deal with (Bijering, Hoogh, 2010:p2). When looking at defining facility management, it is important to look at their skills, which are divided into hard and soft skills. When looking at some of these skills, they can be listed as (Miller, 2007:p1):

Table 2- FM general hard and soft skills

Hard skills	Soft skills
Electrical wiring & power distribution	Customer relations
Carpentry	Contractor coordination and support
Plumbing and water works	Team building
Operation& maintenance HVAC	Technical judgment
Spatial planning	Time & Financial management
Civil and structural planning principles	Business continuity

It is interesting to see the variety of skills and the difference between hard and soft skills. When looking at the facility management strategy within an organization or during projects, the FM value map can be used. The value map provides a conceptual framework to understand and explain the different ways that facility management can create value for a core business as well as the surroundings for the benefits of multiple stakeholders: Owners, staff customers and society (Jensen et al, 2010:p2). The value map maps uses facility management as inputs into the internal processes to produce outputs according to the four elements: space, services, development and relations. After creating these outputs, they have their impacts on the surroundings and on the core business (Jensen et al, 2010:p2). The value map can be seen in appendix 8. During planning proposals, the facility manager can have an important role, as he will be able to advice the board of directors in respect of any proposed expansion or refurbishment plans. Relevant information such as budget and time schedule can then be adjusted accordingly. When applying for planning permission, a planning consultant will guide the facility manager through the application process. When formulating the application, aspects such as the maps and plans are important (Booty, 2009:p164).

4.2 The history of facility management

In order to illustrate the most important developments, the timeline in appendix 9 can be used. This timeline shows the different and most important developments throughout the history of facility management and can be used as a guide for this paragraph.

Facilities management can be seen as a relative new profession with its roots in the US. An important event leading to the recognition of facility management as a profession took place in the 70's, as the use of dividing screens and personal computers in offices challenged management for wiring issues. This emphasized the need for facilities management. The first step towards the formation of an organization occurred in 1978 where the seminar: "Facility influence on productivity" took place. This conference would be the leading aspect for establishing the Facility Management Association in the US. In 1981, this organization would have an international network, as facility management became more popular worldwide, leading to the new name: IFMA, International Facility Management Association (Ifma, 2011 :online).

In the UK, facility management would be seen as a profession in 1985, as it was seen as a needed profession in the work environment (Facilities-center, 2011: online). 85 Was also an important year for the Netherlands, as the ISM was established, which was the main facility management institution at that time in the Netherlands, the main focus would be on: education, maintenance, security, building services and management & organization. (Ytsma, 2005:p126). In 88 the ISM would determine the strategic course of facility management in the Netherlands followed by promotional tactics determined a year later by NEFMA. This showed the rapid increase in the importance of facility management. In the 90's the main facility management example would be seen in the educational world; the concierge. The 90's was also the period were organizations got larger and more complex, leading to a greater need of facility management, as these complex institutions needed to be managed in terms of housing and logistics. This was therefore a leap towards the outsourcing of facility management, as organizations were not able to manage it themselves, they needed facility management as operational management line in the organization (Ytsma, 2005:p127). In 95'the various facility management unions would be fused, resulting into Facility Management Nederland, which would represent the Dutch union (Ytsma, 2005:p133). In the end of the 90's, organizations would grow rapidly in all branches, due to great economic developments and forecasts. Organizations would outsource their canteen and building maintenance in the facility management branch. From 2005 an important new development would be introduced in the world of facility management, namely the flexible office concepts. The facility manager would be an important player in the commercial building industry and would be responsible for integrating flexible workplaces in offices around the world (Mooij, 2010:p14). In 2010, projects from the government would involve interesting shifts in the work field of facility management, as it would no longer be used in the building usage stage, but also in the pre usage stage, in terms of planning, designing and programming.

The timeline has showed a great shift in the development of facilities management, starting from the US and shifting to Europe. It is remarkable to see that the concierge of educational institutions were the main representatives of facility management in the 90's, leading to a discipline which would even be involved in the pre usage stage of the building industry and thus extending its responsibilities. The flexible movements in commercial buildings is a current development and will be introduced more in order to cut costs, here the facility manager plays a crucial role.

4.3 Services provided by facility management

When looking at the scope of services provided by the facility management, a subdivision can be made (Booty, 2009:p199):

1. A single service (cleaning, catering, porterage, etc)
2. A group or bundle of services (fabric services and maintenance services bundle e.g.)
3. A 'total facilities management 'package, whereby services across the three main facilities management sub classifications are supplied by one provider under a single contract

The figure underneath gives a graphical illustration of the three services

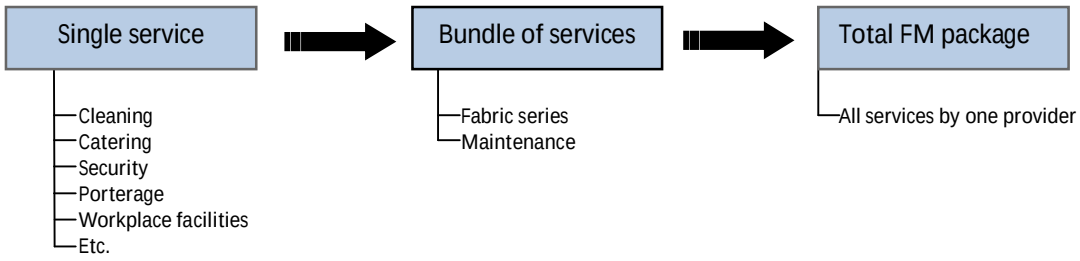


Figure 15- FM services

In facility management a separation has to be made according to in- house facility management (where the FM department is internal) or an outsourcing facility management department (external). To outsource facility management is becoming more popular, as total FM packages are provided, thus relieving the organization from a great deal of duties. When facility management is outsourced however, a Service Level Agreement needs to be drawn up. The service level agreement (SLA) is a detailed memorandum specifying the outcomes from many elements of the outsourced function. The SLA needs to be defined in detail, as they are an important way of measuring an outsourcing supplier's performance (Booty, 2009:p263). A SLA includes the criteria's seen underneath.

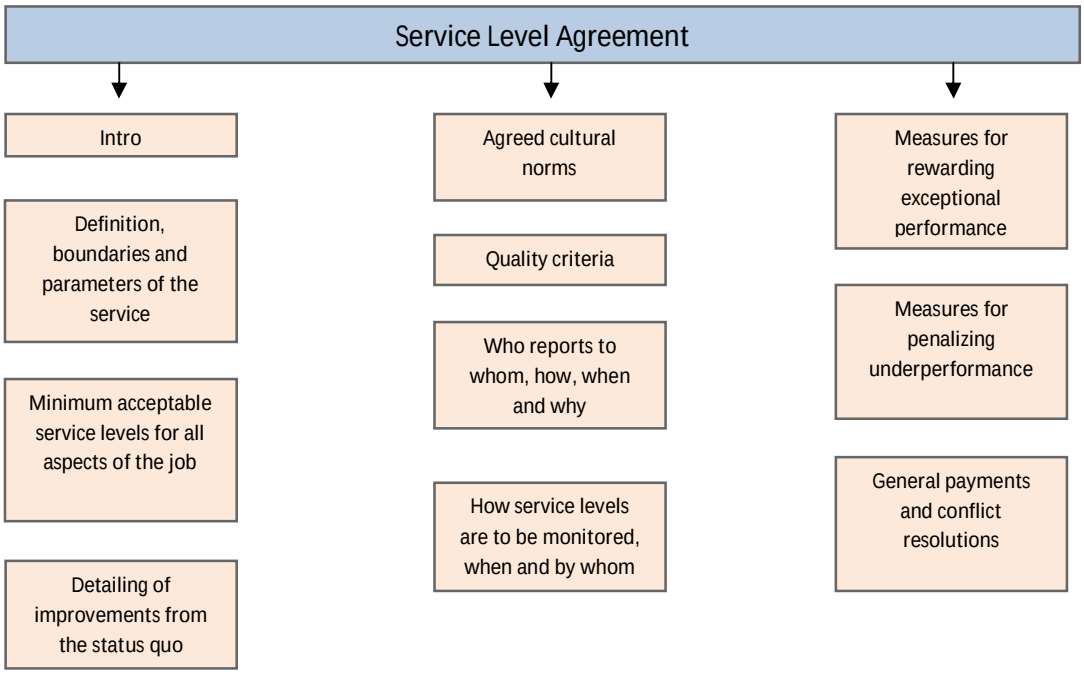


Figure 16- SLA items (Booty, 2009:p264)

4.4 Trends in facility management

Facilities management has gone through rapid changes the last couple of years. An important aspect of facility management is the new office concept: *"Het Nieuwe Werken"*, which was introduced in 2005 as office innovation concept (Mooij, 2010:p20). This concept was adapted due to the shorter working times; the increase in part time workers and the decrease in m2 would reduce facility costs. The fact that ICT tools enabled better communication, all contributed to the new concept (Mooij, 2010:p20). The concept enables workers to work at home or work on different places. The fact that employees can choose their own workplace means that a large change will take place; not only the management style of superiors, but also the whole workplace concept. As buildings are being demanded to be more flexible and commercial real estate will need less m2, buildings will need to be adapted. Also the old interior concepts where high lines of hierarchy were visible is changing towards a non hierarchy office layout, where shared service centers are established, creating a whole new concept. When looking at statistical data, it also becomes obvious that the new work concept is used more frequently in organizations. A survey conducted in 2011 showed that 58% of the responders have the possibility to work at home. From those who did not have that opportunity, 30% responded that they were interested to have this opportunity in the future. All the data show that the office flexibility concepts will increase in the future (Integron, 2011:p41). When looking at the trends and forecast important to facility management an interesting research report from the IFMA has been released in the beginning of 2011;*' Exploring the current trends and future outlook for facility management'*. This report has described some interesting trends effecting facilities management (Keane, 2011:p8):

- **Sustainability,** continuous to grow in importance worldwide and the emphasis has shifted from new to old buildings. Sustainability presents an opportunity for facility management
- **Complex building technology,** the increasing building technology in the building industry continuous to develop and forms a challenge and opportunity for facility management
- **Aging building stock,** both facilities and mechanical systems reach and exceed their expected operating lives, therefore issues such as repair or replace take place. The worldwide recession has also influenced the deferred maintenance issue
- **Preparedness,** Facility management plays a crucial role in business continuity after a disrupting event, this is done by crafting and implementing the response plan and by serving as role model for the organization in such times
- **Quantity and complexity of FM data,** the increasing amount of data available to facility management professionals challenges them to process this data into meaningful information
- **Finding top talent and evaluating the profession,** It is of great importance to find top talent, especially as the facility management work field is not students' first choice. There is a growing desire to elevate the profession
- **Evolving skill set and business acumen,** facility management should accumulate on technical and business issues and emphasis should be placed on strategic facility management
- **Enhancing workplace productivity,** Facility management has a positive influence on the productivity and health of employees and the usage of LEAN should be emphasized on
- **Changing work plans,** the different working hours and occupancy rates challenges facility management

The above mentioned aspects show that there are great deals of new developments taking place, which will influence and challenge the facility management branch. It also shows the growing importance of the stakeholder as they can contribute significantly to these developments (Keane, 2011:p27).

4.5 Facility Management Information System

FMIS is an abbreviation for Facility Management Information System and is used by facility management organizations in order to simplify the process and to translate them into of management information (Rouw, Jager, 2006:p16). The FMIS was defined two decades ago by Willemse (1990) as:

"An FMIS is the combination of procedures which are aimed on managing and providing information needed for integral planning, realization and managing the facilities of an organization" (Willemse, Veeke, 1999)

Organizations often make use of FMIS from financial perspective, as they can reduce costs or to review all processes within an organization. Different type of reports can be entered in the system, making the FMIS a reporting station (Haan, 2009:p34).
FMIS systems provide great advantages (Haan, 2009:p34):

- There is one central input system for clients
- Reports, complaints are directly visible at the correct department
- The service desk can be minimal
- No more ad hoc jobs which are not reported
- The service provided by facility management is more transparent
- All activities are measurable; e.g. how long does cleaning take? Who was responsible for the cleaning process? Etc.

When looking at how the FMIS system works, practical situations need to be described. First a report comes in through the service desk. This is entered in the system, where all data is entered. With help of standard applications in the system, the report is categorized. The FMIS than provides the info on location and the person information (FMResource, 2011: online). Functions which are available in general can be seen in the figure underneath.

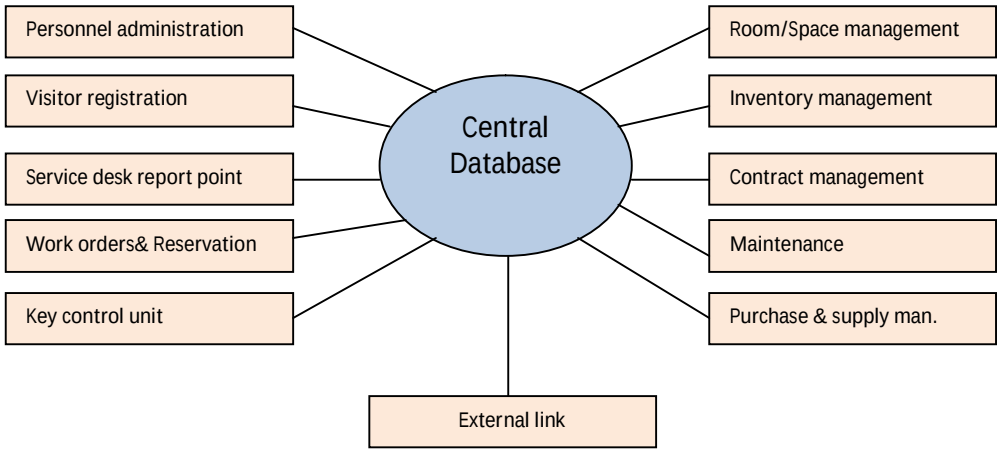


Figure 17- FMIS general functions

It is noticeable that FMIS has a great deal of functions. By means of the FMIS system the organizational processes go through great changes, as less personnel is needed and more information on work processes is available (Haan, 2009:p34). FMIS can be seen as an important breakthrough in facilities management and is a system which can add great value to organizations and should therefore be focused on.

4.6 Flexibility

Facilities management focuses on the office building and its users, currently the flexible trends in office buildings is one of the most important developments in this field (Integron, 2011:p41). As flexibility is a wide term and can be used in different perspectives, it is important to define the term. When looking at the Oxford dictionary, flexible means: "*Able to change to suit new conditions or situations" (Hornby, 2000:P488*). When analyzing this definition, it can be seen that flexibility adapts itself to the current or new condition required. This means that flexibility enables one to stay up to date with the new requirements.

Flexibility can be seen as a must for any building project which wants to focus on a long lifecycle and thus flexibility is becoming increasingly important (Plagaro. Cowee, Schwehr, 2009:p1). When looking at the flexible building related literature; flexibility is linked to the building user. As long as there is a match between the building and the needs of its user, no change is needed (Plagaro, Cowee, Schwehr, 2009:p3). However when the needs of the building user changes, the need to adapt the building arises (Plagaro, Cowee, Schwehr,2009:p3). The building industry is also aiming on the flexibility issue and examples in organizations such as BAM can be seen in their company reports, such as seen in the illustration.

Flexible means taking your needs and wishes into account, as well as social norms and values, and aspects of sustainability and particular circumstances. However, it all starts with your request.

Figure 18- Defining flexibility in commercial sector

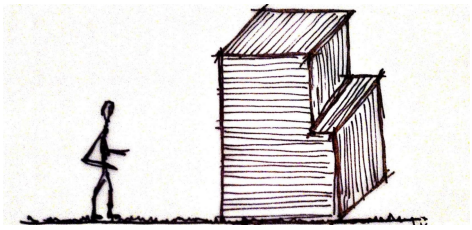


Figure 19- Building according to users wishes

When looking at research conducted by companies such as Arcades, the flexibility issue is also emphasized on. One of the articles shows an interesting quote: *"Building in shrinking Holland requires flexibility. When thinking on the changing building functions, the end user should be involved"* (Arcadis, 2008:p8). Here a clear link is made with the end user and integration of end user in order to accomplish flexibility.

When summarizing the most important elements concerning flexibility, it can be said that there is a clear link between the end user and flexibility. By creating a building which matches the user's needs, the flexibility objective can be reached and in that respect, a building can be seen as flexible. Flexibility is therefore also the key aspect for facility management. When looking at current developments in facility management, it can be seen that flexible demands are increasing, as building users need less m2 due to new flexible work concepts. This new demand plays an important role in the mismatch between the supply and demand of office buildings (Voordt, 2007:p38). Flexibility in the supply of the Dutch real estate market is limited (Lemmens, 2009:p18). This is an indication that flexibility does not have a high priority on the supply side of the market. The need for flexibility however has been increasing in the last couple of years (Lemmens, 2009:p18). An example can be seen when looking at the fact that building users put emphasis on flexible contracts, showing a small aspect of their flexible demands. This also means that facility management is increasing in priority in strategic aspects for building users (Lemmens, 2009:p18).

This research will focus on flexibility in the mentioned form: "building which matches the needs of the building user ". By defining flexibility, room is made to analyze flexibility in the current building industry and to see whether and where opportunities lie.

Conclusion

When summing up this chapter, it is noticeable that facility management is a rather new profession. It is however also noticeable that facility management plays an important role in the building industry and is gaining territory. As the service packages provided by this stakeholder is increasing, building users are relying on facility management. The trends in the field of facility management clearly indicate their importance, as aspects such as sustainability are emphasized on. Also developments of digital tools such as FMIS play a larger role in the field of facility management. By looking at these factors facility management can be defined and can be analyzed by means of their portfolio. It was also important to look at the definition of flexibility, which is interrelated with facility management. As flexibility does deal with the user's requirement, facility management and flexibility are closely linked.

5 Chapter five
Project development

Figure V – High rise buildings, influences of project development in booming times

"Well, real estate is always good, as far as I am concerned"
- Donald Trump

Introduction

The previous chapter provided a theoretical insight on facility management. This chapter will provide a theoretical insight on project development. First a paragraph on project development in the domestic market will be provided. Here the largest Dutch developers are analyzed and current developments in the real estate market are handled. In the second chapter the responsibilities of project developers In terms of managerial issues will be discussed. This is a rather detailed paragraph starting with project management in the inception and feasibility phase. This will be followed by a part on the strategy and pre-construction phase. Also responsibilities in the construction phase will be handled; this is done from a project manager's point of view. The completion and project close out phase will also be discussed and will conclude this chapter.

The next chapter will provide a theoretical model, placing the information of the theoretical framework into a practical model.

5.1 Project development in the Netherlands

The office market is essential for developers; this can be seen when looking at the last couple of years where an annual rate of between 500.000m2 and 1 million m2 of office space has been developed. This large rate represents 2, 5 billion Euros of production value and shows the importance of the office market (ABNAmro, 2011:p9).

The build volume of offices in the Netherlands cannot be seen as extremely high the last couple of years. This can be confirmed by looking at the chart underneath. This shows that 2000 was a year with far more projects than the last couple of years (ABNAmro, 2011:p37).

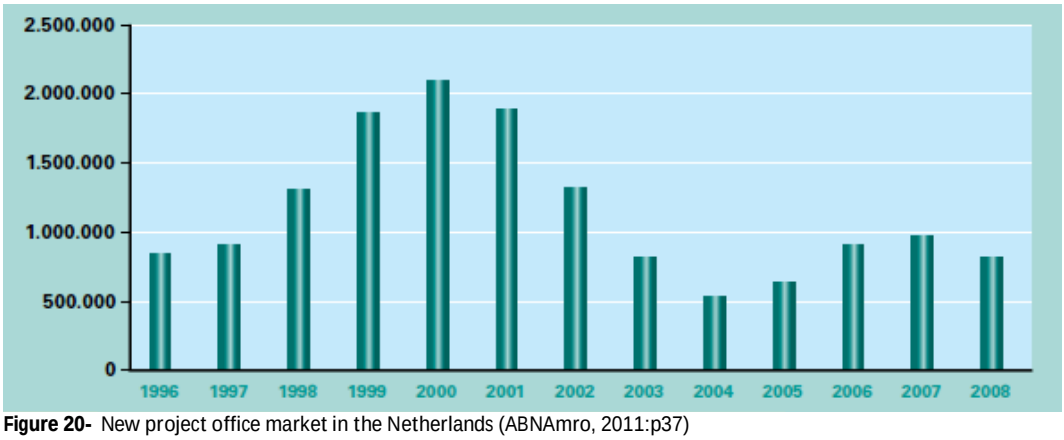


Figure 20- New project office market in the Netherlands (ABNAmro, 2011:p37)

The above chart shows that the development volume has been greatly reduced as it is more difficult for developers to realize projects. This has to do with two aspects, firstly investors have a more passive attitude in relation to new projects, secondly and most importantly, the end users also have this passive attitude(ABNAmro,2011:p37). These aspects have led to less risk full investment of project developers; this can be seen when looking at the majority of single and multi-tenant projects.

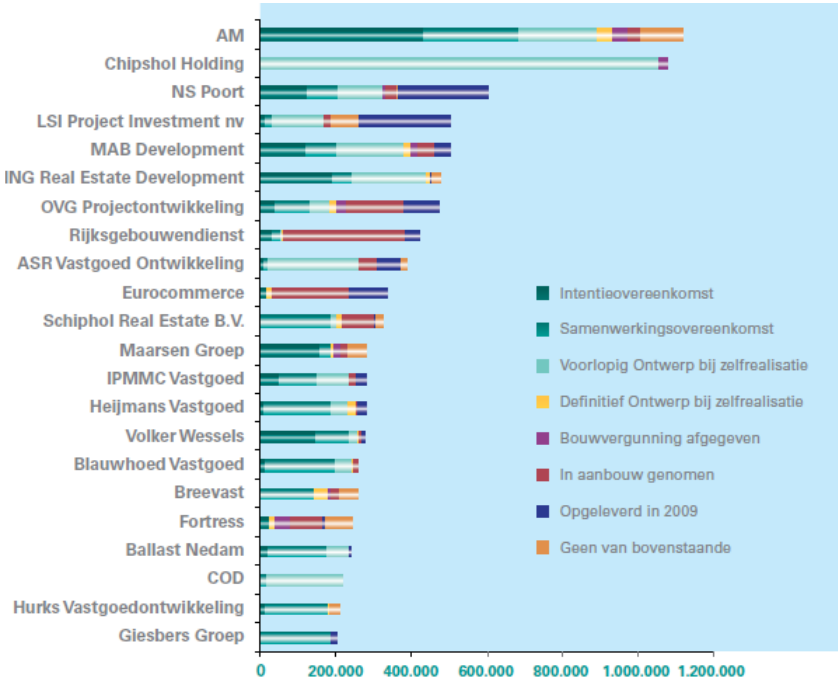


Figure 21- Developments among developers (ABNAmro, 2011:p38)

In single tenant projects the building users are contracted before the start of the actual building process and in multi-tenant buildings a substantial part of the (new) tenants have been contracted. (ABNAmro, 2011:p37).

The developments in the building market have led to a more feasibility oriented approach in the development world. Developers are changing their strategies, which can be seen in the chart. AM has put a great deal of focus in creating intention agreements between them and other parties. And when looking at projects which have been in realization phase, the state (RGD) has a noticeable position (ABNAmro, 2011:p38).

The chart clearly shows the emphasis put on agreements between parties before realizing projects and that not a great deal of developers have completed a great deal of projects in 2009. An important assumption to be made is that project developers are opportunistic, as they put emphasis on reacting on chances and with these difficult economic times, it is essential for them to react efficiently on the scares chances (ABNAmro,2011:p38).

When looking at the development plans which have been made for the Dutch office market, noticeable developments have taken place. In The Hague the need for new office space is decreasing, especially due to the fact that the government is decreasing (nr of employees and space). However, The Hague has a great deal of new plans for the development of projects; this is also the case for Almere and Zwolle. A contrast can be seen when looking at Zoetermeer, Amstelveen and Cappele. Here there are relatively no plans for new projects, whereas the expectation for growth is present at these areas (ABNAmro, 2011:p39).

The coming years will lead to a decrease of new projects, however a full stop of projects will not be the case. This has to do with the demand of users, as the (old) stock does not match with the new demands of users and thus leads to vacancy in the current stock (ABNAmro,2011:p40). The building users are important and the most essential stakeholders for the realization of new projects. It is therefore important to look at trends among these stakeholders. The current trend is flexibility, meaning that (new) buildings need to fulfill these flexible demands and that buildings need to be adapted in all times according to the wishes of the building users. These are important considerations for developers, as they have to react on these demands (ABNAmro, 2011:p47).

When looking at the NEPROM, which is the Dutch project development association which has been established in 1974 and has 65 members of large development organizations, they also see the problems in the market. They see that great deals of development plans have been cancelled and that only new plans with high qualitative potential make the transition to the realization phase (ABNAmro, 2011:p47). With high qualitative projects a link can be made with multi-functionality, which can be seen as important demands of end users. These developments mean that the development processes of developers are changing as more focus has to be set on the design aspects and the flexibility demands of the building users. The demands of the next generation of building users are also important and need to be translated in flexible buildings (ABNAmro, 2011:p47).

The new demands on the development market need to be reacted on as these demands are formed by a scares group of essential stakeholders, namely the building users. All parties recognize the problems in the building world, even the NEPROM, it is therefore important to react on these issues, as the forecast in the development world seems pessimistic.

5.2 Project management in project development

5.2.1 Inception and feasibility phase

Inception phase

Project developers deal with project management during and before their projects. The beginning of projects starts with the inception phase. In modern times key questions in assessing the need for construction include (Wiley, 2010:p3):

1. Why is the project needed?
2. How to incorporate sustainability and is the clients corporate responsibility defined?
3. What is a reasonable budget cost?
4. What is a reasonable time from inception to completion?
5. What are the investment and funding options?
6. What benefits are expected as a result of the project?

When these questions are positive and show that the project is feasible, then the project can be continued. A key role here is for the project manager. According to the author of the book: A code of practice for project management (2010), the duty of a project manager is to:

'Providing a cost-effective and independent service, selecting, correlating, integrating and managing different disciplines and expertise, to satisfy the objectives and provisions of the project brief from inception to completion. The service provided must be to the client's satisfaction, safeguard his interest at all times, and, where possible, give consideration to the needs of the eventual user of the facility'- (Wiley, 2010:p3)

Feasibility phase

At the feasibility stage, the main objectives for the client include identifying the project objectives, outlining the possible options, looking at value and risk assessments (Wiley, 2010:p10). At this phase the project brief is drawn up. The brief consists of the background of the project, followed by a project definition. Than an outline of the business case is set up. Moreover, a customer quality expectation form is filled in, followed by the acceptance criteria. Finally, a risk assessment is made. The figure gives a graphical view on these steps (Wiley, 2010:p19).

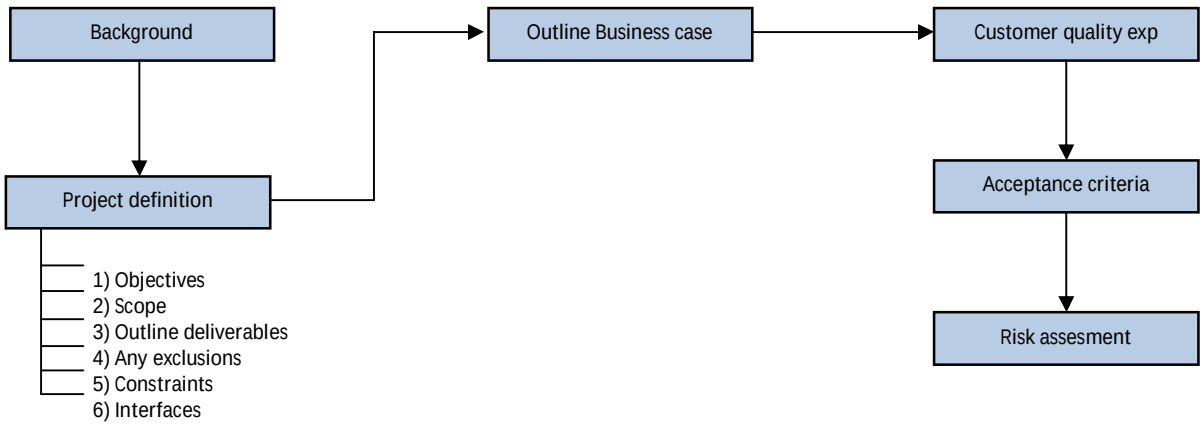


Figure 22- Contents for the project brief (Wiley, 2010:p19)

5.2.2 Strategy and pre-construction phase

Strategy phase

The main aims at this point include setting up the project organization, establishing the strategies for procurement, delivery and commissioning issues by identifying project targets, assessing and managing risks and establishing the project plan (Wiley, 2010:p24).

Pre-construction phase

At this stage the client expects to finalize the project brief for the project team, identify and agree the solution that gives optimum value, and to ensure a technical design which can be efficiently delivered with predictability of cost, time and quality (Wiley, 2010:p42). At this stage it is interesting to look at the design team activities, coordinated by the project developer. The illustration underneath gives an overview of design and quality activities.

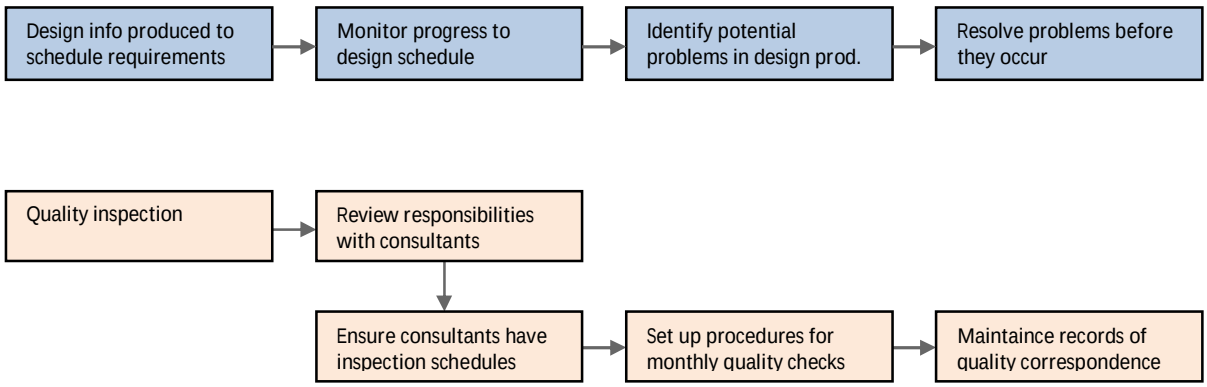


Figure 23- Design team activities (Wiley, 2010:p46)

5.2.3 Construction phase

At the construction phase, it is the project manager who is on site and needs to coordinate the building process correctly. Some of the main responsibilities for the project manager at this stage are (Wiley, 2010:p67):

1. Ensuring the contracts are signed
2. Reviewing the contractors construction schedule and method statements
3. Ensuring the contractors resources are adequate and suitable
4. Reviewing progress with the contractor
5. Monitoring performance of the contractor
6. Ensuring that the construction phase health and safety file is being maintained
7. Ensuring design information required by contractor is supplied by consultants
8. Establishing control systems for environmental sustainability, time cost and quality
9. Ensuring site inspections are taking place
10. Managing introduction of changes
11. Reporting to client
12. Review construction risks
13. Establish mechanisms for dealing with any claims
14. Monitor for potential problems and resolve before they develop

5.2.4 Completion and project close out phase

Completion, handover and occupation phase

At this stage the building is completed and can be handed over. The project developer can decide to cooperate with the (if the building is already sold) client for the move. Than it can be decided how the move is organized, to look at time constraints and to identify risk areas. The schedule underneath can be used as graphical illustration (Wiley, 2010:p97).

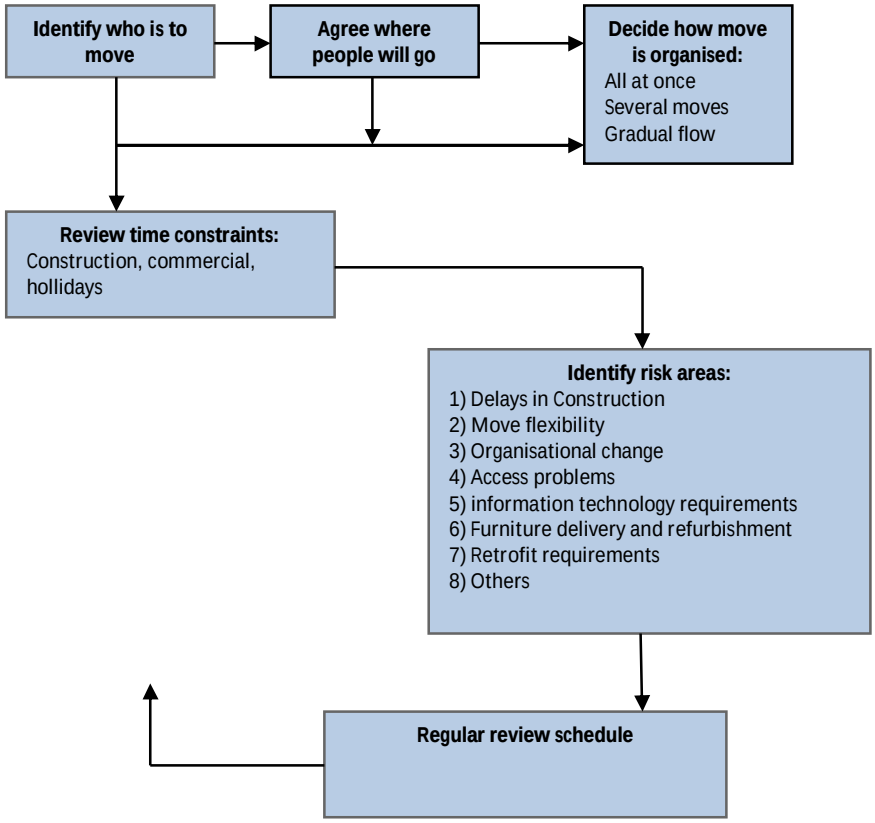


Figure 23- Occupation, scope and objectives (Wiley, 2010:p97)

Project close out phase

The developers' objective at the closing stage of a project should include (Wiley, 2010:p101):

1. To measure performance of all aspects of the project and ensure that the value of the knowledge gained can be carried forward to future projects
2. To undertake an initial assessment of the new facility so as to establish its fitness for purpose and satisfaction of requirements

After completion of the project, the project feedback is important (Wiley, 2010:p103).

All these steps can be seen as a general guideline used in project management and thus applicable to project developers. When going through all the different stages, it can be said that each project is unique, but should involve all the mentioned steps. It is therefore important that these steps are described, as it gives a practice view on the profession.

Conclusion

The developments in project development in the Netherlands show the great uncertainty in the market and the need for developers to react on the situation. As the build volume decreases the last couple of years, developers will be forced to be more innovative and need to react on the situation. By looking at managerial aspects in project development, a better understanding of a deal of their responsibilities is shown. By looking at these aspects it is possible to compare and find links with facility managerial practices and to try to match the needs of both stakeholders.

6 Chapter six

From theory to practice: Analytical model

Figure VI – Balancing stones, the first step towards practical implementations

"In theory there is no difference between theory and practice. In practice there is"
- Yogi Berra

Introduction

The previous chapter provided theoretical information on the specific subjects, providing important data on the research theme. In this chapter the transition of the theoretical content into a practical content takes place by means of an analytical model. The essence of this chapter is the implementation of all lean principles in the research. Each paragraph will discuss a lean principle and will look at the research question to be answered. Examples from lean used in the car industry will be provided.

In the first paragraph the value principle will be discussed. The second paragraph will discuss the value stream principle, followed by the flow principle. In the last two paragraphs the pull and perfection principle will be discussed. As all these principles are handled, a framework will be made showing the different stages of the research. The framework will show the research questions, the mentioned lean principles and the stages where hypotheses will be formulated, followed by a possible end product.

This chapter will be the transition chapter to the practical part of this research. In the next chapter the first case; namely the ministry of finance in The Hague, will be analyzed.

6.1 Integrating value into practice

In order to analyze the first principle: value, the Toyota way can be used. As mentioned in the value chapter, Toyota visited their customers in order to define what they prefer in terms of car specifications (Womack, Jones, 2003:p19). In the building industry, where (in this case) the facility manager is considered to be the customer, they have to be approached by the developer in order to define value. In order to implement the value principle in this research, it is important to understand what the customer wants.

A key aspect of this question is the way the needs of the client (facility manager) is determined. This will also be an important factor in order to determine the intensity of the cooperation between developer and facility manager. An example from Toyota can be used, showing their approach (which is sometimes used in Japan) towards gaining customer data. Toyota uses the way which can be seen in the illustration underneath:

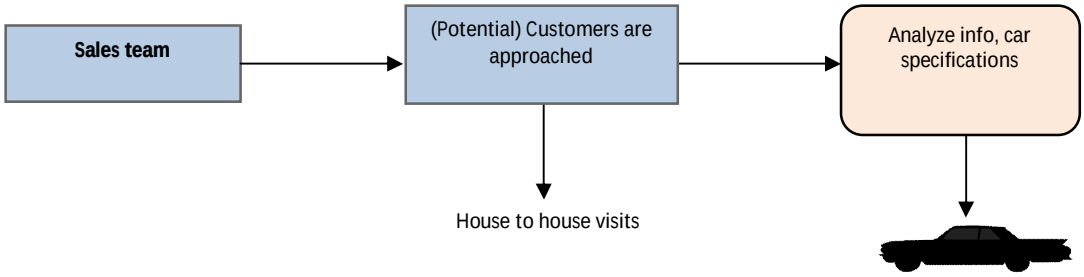


Figure 24- How car information is gathered by Toyota

From the above information handled it is noticeable that Toyota does take the customer demands very seriously; leading to their intense approach of actually visiting their customers. By asking previous Toyota vehicle owners on their feedback of a specific vehicle they try to gather data in order to create future cars for their customers (Womack, Jones, 2003:p19). By showing this example the lean principle: value, can be seen in a practical situation used by Toyota. By putting the value principle in practice in the building industry, it is important to look at the following aspects: The client (facility manager), the developer, the needs of the facility manager and how these needs are identified by the developer. By identifying these three aspects, data on value will be generated. This will be done in the field research, generating practical data. The figure underneath shows that the red circle is the missing link and needs to be identified by asking two main questions: How are the facility managers needs determined and how intense was the cooperation with this stakeholder in order to determine the value.

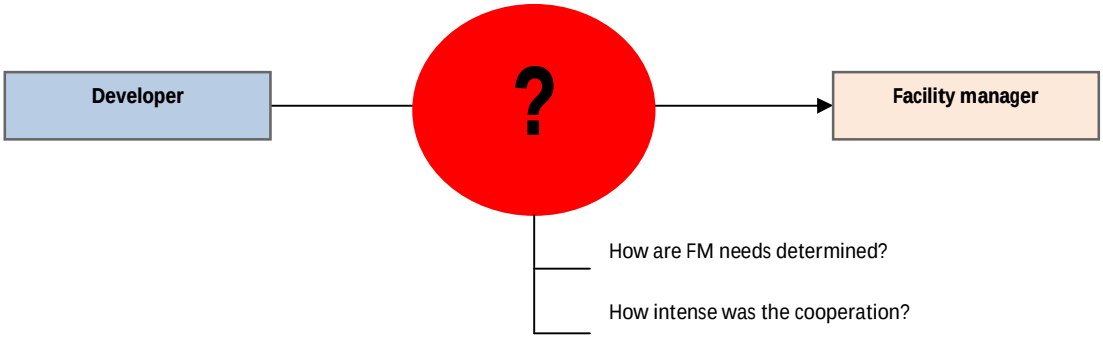


Figure 25- Gathering practical value data

6.2 Integrating value stream into practice

The second lean principle: value stream (mapping), looks at all actions in the production process which: add value, do not add value but are needed and don't add value (Womack, Jones, 2003:p38). In a production company this should be easier to analyze, as a clear time indication for each step in the product cycle can be taken. In this research however, there needs to be a clear transition from product to process, as processes are reviewed between the developer and facility manager. This can be done by defining the value adding processes by means of asking the following question: do they lead to the desired end product? The main question to be answered in order to implement successfully this second principle should be: *Which processes add value and which do not?* A value stream map used in a production company can be seen in the illustration underneath.

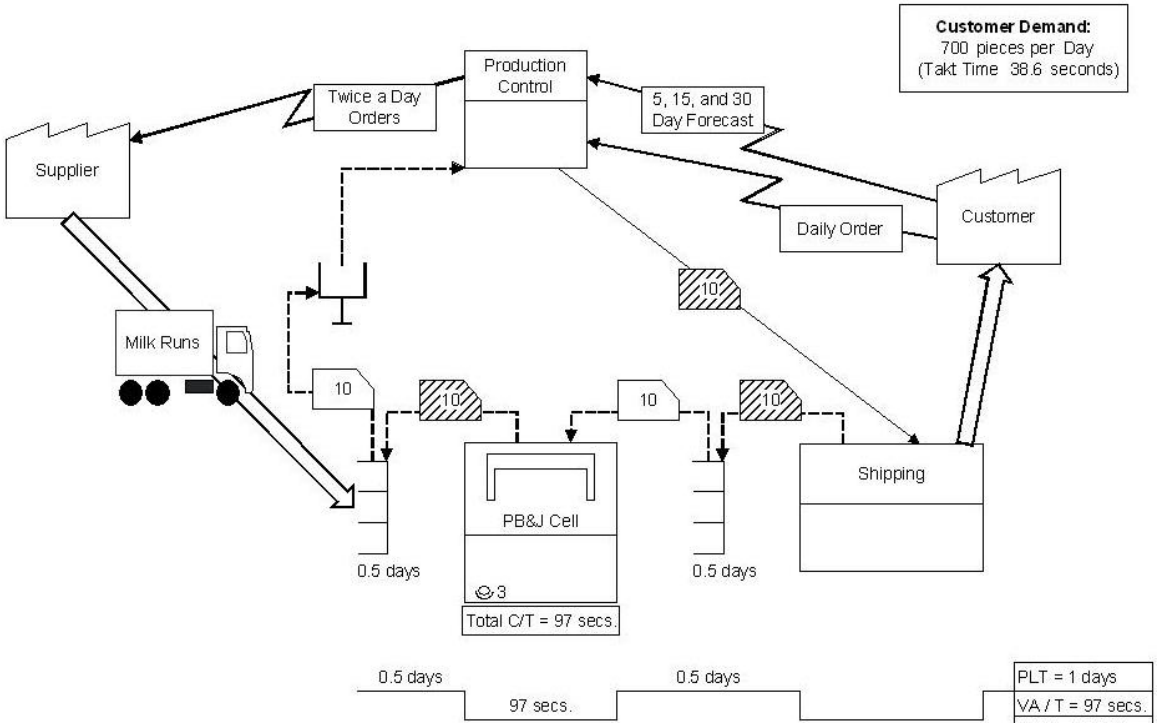


Figure 26- Value stream map example (beyond lean, 2011:online)

When putting the value stream into practice for this research theme, it is important to look at the value and non-value adding processes in the various building stages between developer and facility manager. This can be done by using the steps shown underneath. By looking at the various processes in starting from initial till usage phase, a value stream can be generated. This can be done as all non-value adding steps can be filtered, leading to the possibility of creating a value stream map.

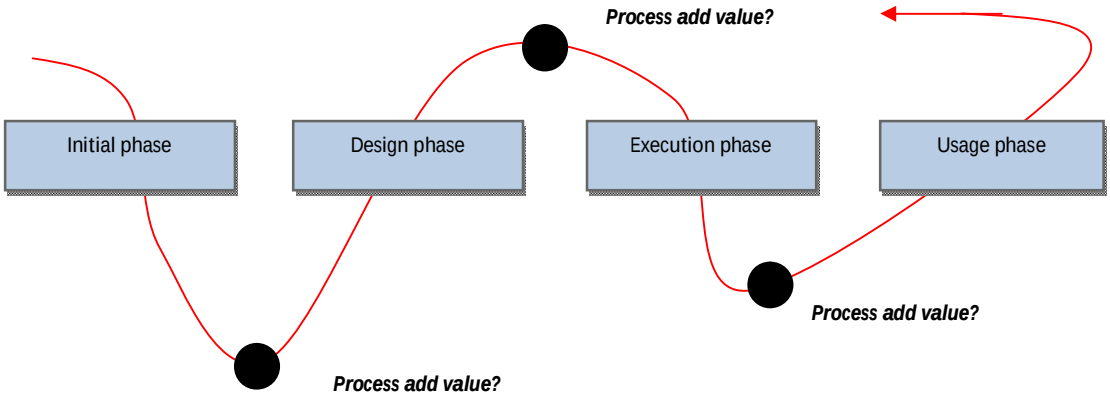


Figure 27- Value stream map example (beyond lean, 2011: online)

6.3 Integrating flow into practice

The third lean principle: flow, focuses on creating a continuous flow by eliminating all barriers in the product/process cycle (Liker, 2004:p87). In the Toyota Company flow is essential as they work with a production line; meaning that each barrier slows down the whole process. The figures underneath illustrates the transition from traditional flow to lean flow. The question to be asked in this principle should be: How to create continuous flow?

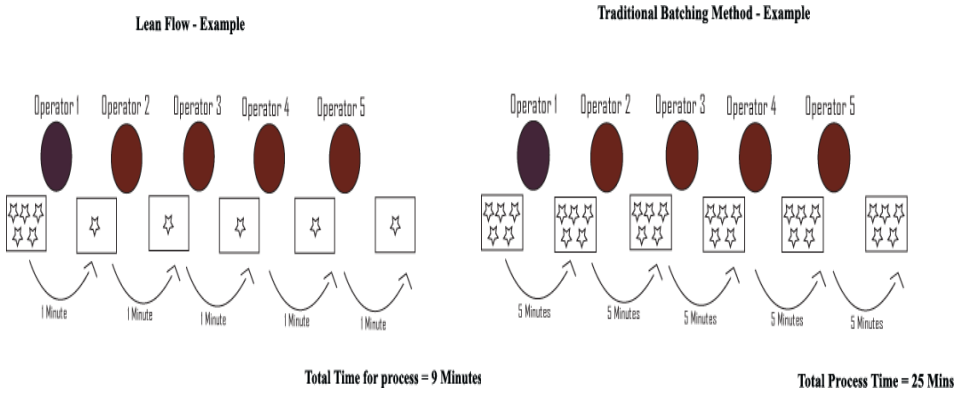


Figure 28- Lean flow (lean flow, 2011: online)

In order to create continuous flow the actual object should first be analyzed, which is done after creating a value stream map. The traditional boundaries should be eliminated in order to create continuity. The last aspect should be to rethink work practices (Womack, Jones, 2003:p52). In order to create the continuity priority should be given to identify and eliminate barriers. By looking at the processes between developer and facility manager and by identifying these barriers, continuous flow can be established. The figure underneath shows the effect barriers have on the flow line. The first part of the illustration shows various barriers, causing delays, capital and other negative aspects affecting the flow line. By filtering out these barriers, a stable straight flow line can be established and thus avoiding issues such as delays and extra costs.

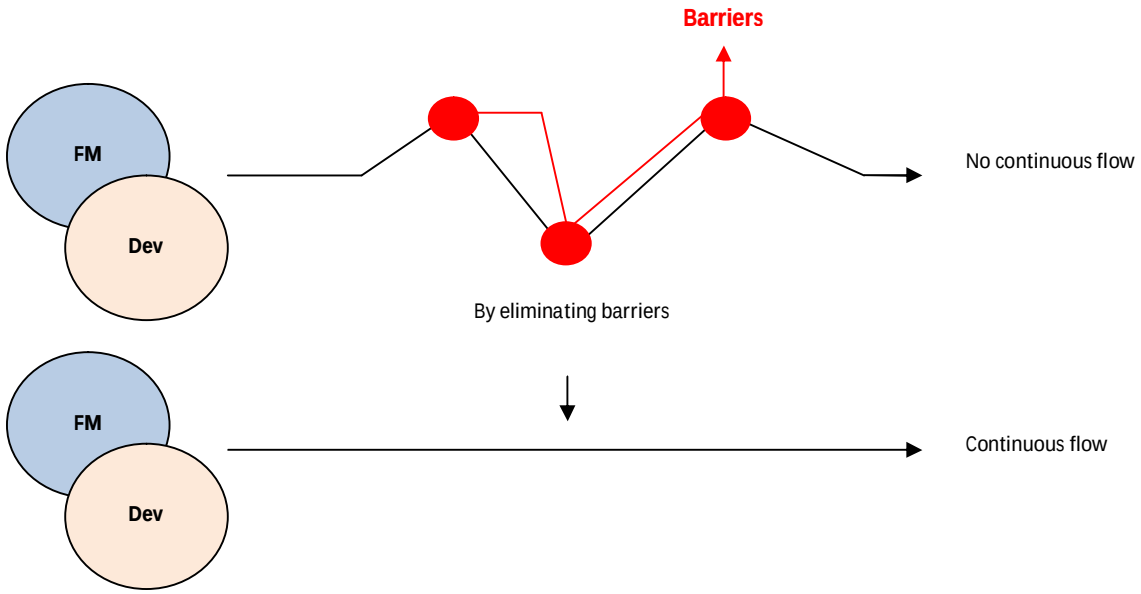


Figure 29- Lean flow (lean flow, 2011: online)

6.4 Integrating pull into practice

Principle number four: pull reflects to providing an item until the customer asks for it (Liker, 2004:p23). Toyota emphasizes on this aspect by means of pull planning. When the car specifications are known, Toyota first looks at how the car should look like, and then looks at all processes on how it should be assembled, this can be seen as backwards planning (Projectrealign,2011:online), see the illustration. The question to be asked at this stage is: how to provide a service on customer demand?

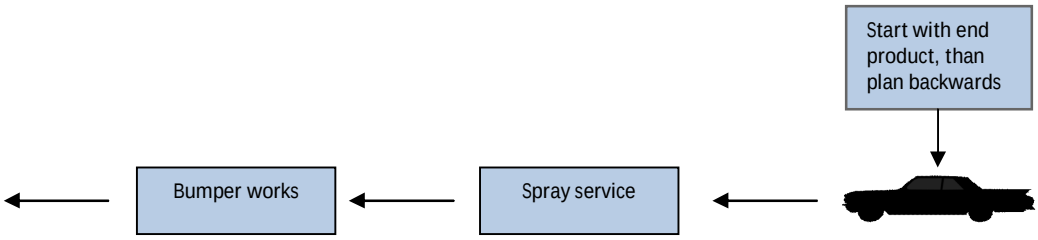


Figure 30- Pull planning

The illustration shows that the emphasis of pull planning is put on the end product. By starting at the end, all needed steps to accomplish the car can be staged. As the customer wants a predefined end product in the car industry the steps to accomplish that type of car are needed to be categorized. When placing this pull planning principle into the building world, it is important to look at the influence of the client (facility manager) in the planning process. This can be done by reviewing all stages where facility management was involved and by looking at their contribution in the planning process.

The figure underneath shows the various building stages linked to the planning schedule. By identifying whether facility management is involved in the planning process, a sense of pull can be identified in terms of planning. Then, pull planning can be implemented. This can be done by starting at defining the desired end product by the facility manager, and staging all the needed steps (planning) in order to achieve the pull planning aspect.

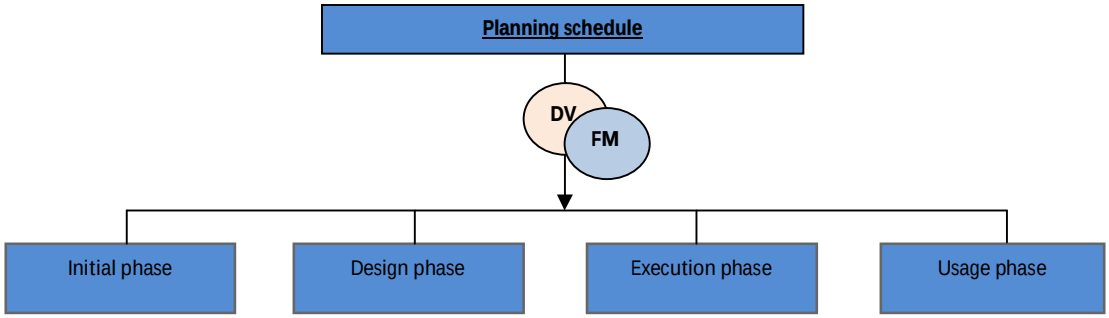


Figure 31- Planning schedule

6.5 Integrating perfection into practice

The last principle: perfection makes the whole lean philosophy complete and refers to creating continuous improvement (Womack, Jones, 2003:p25). By creating continuous improvement, Toyota is able to create high quality cars annually. This should also be the goal in all other industries, especially the building industry, as you strive for perfection to decrease waste and thus costs. The question to be asked at the last stage: How to create continuous improvement?

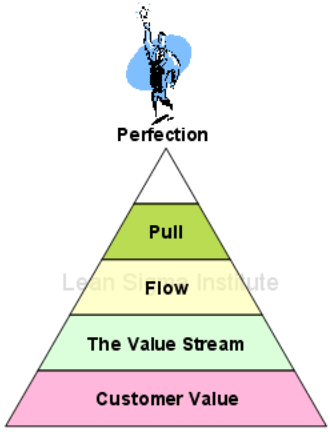


Figure 32- Lean Principles (6sigma)

In the ideal situation all these questions are answered. When all principles are applied in practice, by means of the case study, the questions are dealt with and will lead to the formation of the hypotheses as discussed in the methodology chapter. When the hypotheses are formed, it is possible that the end product will follow in the form of a framework. A conceptual model of the transition from theory to practice can be seen on the next page

The illustration shows the conceptual model of this research. Stage one shows the research questions /objective which need to be answered in order to complete the research. This stage has already been done as all research questions are already formulated at this point. The second stage show the research principles which have also been defined. It can be said that stage one and two are handled in the first part of this research. Stage two is also part of the initial phase of the case study, as interviews and other data collection methods need to lead to the findings in respect to the principles. The third stage: hypothesis takes place in the stage after the data collection part, as the hypotheses can only be formed after the case and cross case studies have been conducted. The last stage is stage four where (when possible) frameworks are worked out.

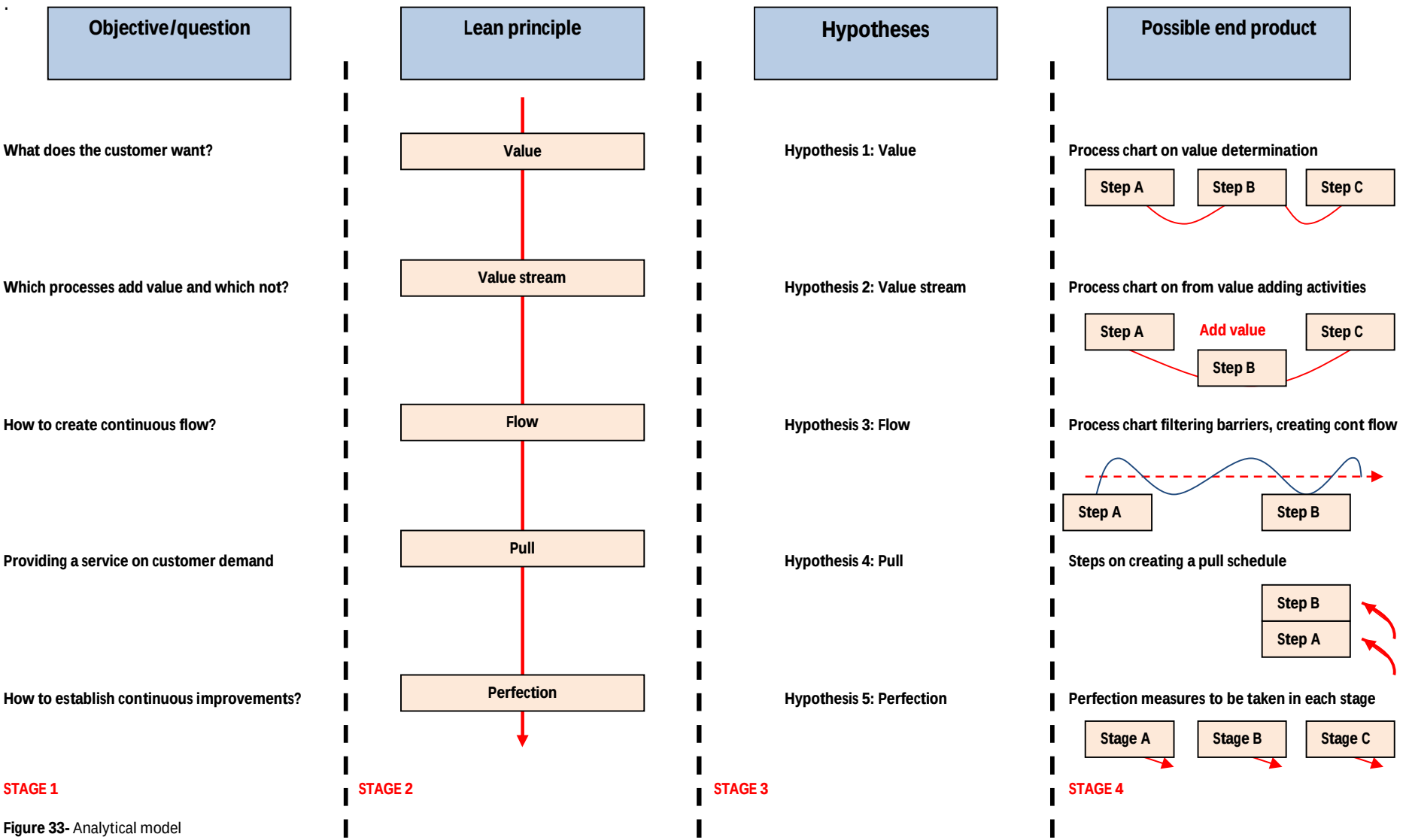


Figure 33- Analytical model

Conclusion

When concluding this chapter, it can be said that it is important to answer the research questions in order to get a fully lean functioning research process. By defining value as: what does the customer want? The link is made with facility management and the emphasis is put on how to define the facility manager's wishes in the case studies. When looking at the value stream principle the focus is put on identifying the added value and the non-added value processes in the process between developer and facility manager. The third principle: flow looks at creating continuous flow; here it is important on eliminating barriers between the process of developer and facility manager. The pull principle refers to pull scheduling and here the role of facility management in the planning process should be analyzed. The last principle: perfection looks at continuous improvement, in this case between the process of developer and facility manager. By focusing on all these aspects in the case study, the theory can be applied into practice, leading to the creation of five different hypotheses and possibly to various frameworks as seen in the previous page.

Part 3

Field research

7 Chapter seven
Description case studies

Figure VII – The top picture is the DUO building, the bottom refers to the ministry of finance(Strukton.com)

"Architecture should speak of its time and place, but yearn for timelessness"
- Frank Gehry

Introduction

In the previous chapter the analytical model of this research was discussed and the first step was made from theory to practice. This chapter can be seen as the first chapter discussing the practical field by means of case studies. Two case studies will be globally handled in this chapter. First the renovation of the ministry of finance in The Hague will be briefly reviewed. The various stakeholders involved in the project will be mentioned and a brief project description will be given. This will be followed by an organizational chart, showing the most interesting relations between the stakeholders active in the field. Also the developer and facility manager will be identified, this is done in order to view the most relevant stakeholders in respect to this research. The second paragraph highlights the most interesting aspects in the DUO building project in Groningen. Here also the start will be made with the focus on the various stakeholders involved in the project. Furthermore, project relevant information will be given, followed by the organizational chart and the identification of the developer and facility manager in the project.

The aim of this project is to introduce both cases by means of general information on the project and by identifying the most interesting stakeholders. This is needed in order to start with the detailed analysis of both cases, which will be done in chapter eight.

7.1 Case 1: Renovation ministry of finance

The cliënt:	Rijksgebouwendienst, ministerie van financiën
Consortium:	The building team consists out of a consortium, this consortium is called: Safire and exists out of: ABN amro, Burgers Ergon, GTI, ISS Nederland and Strukton (Strukton was the developer and investor, and ISS the facility management firm)
Architect:	Meyer en van Schooten architecten
Project form:	Public Private Partnership (PPP)
Contract form:	DBMFO
Project start:	Beginning of 2007
Project completion:	End of 2008
M2:	66000m2 BVO, parking 10000m2 BVO
Costs:	The DBMFO contract has a net value of €173 million
Interesting aspect:	This project was the first PPP project for governmental buildings in the Netherlands. In 2009, the building has been awarded with the BNA building of the year.

Project description

The project included the renovation of the existing building of the ministry of finance. This building had 66000m2 and due to the DBMFO contract included the operation and maintenance of the building by the project party for a period of 25 years (Strukton, 2011:online)

The motivation for the renovation of the ministry of finance had to do with the fact that there were complaints concerning the old climate installations. As these needed to be replaced, the facades of the building also needed to be adapted. During these findings it was also concluded that the interior of the building was not flexible. All these flaws resulted into the complete renovation of the whole building. The RGD wanted to create a building which would fulfill current users demand (Strukton, 2011: online).

The original building was built in 1975. After the renovation the building would offer space for 1750 workplaces on seven floors. The building also has meeting rooms, a library, a restaurant, an underground parking garage, and sport facilities (Strukton, 2011: online).

The emphasis of the building was placed on its integration in the urban area by means of placing a central lobby and a more transparent character. A large atrium forms the 'hart' of the building. The ventilation installations have been replaced and use is made of a warm/cold water storage system and a double skin façade, these aspects lead to lower energy costs (Strukton, 2011: online).

Due to the fact that this project was a Public Private Partnership and a DMFMO contract was used it can be seen as highly integral. The exploitation period of the project is 25 years, and parties from exploitation and construction have worked together in order to create a good transition from execution phase till usage phase.

When looking at the next page, a project organization chart can be seen, this chart has been used in the actual project (Interview developer, 2011).

7.1.1 Project organization

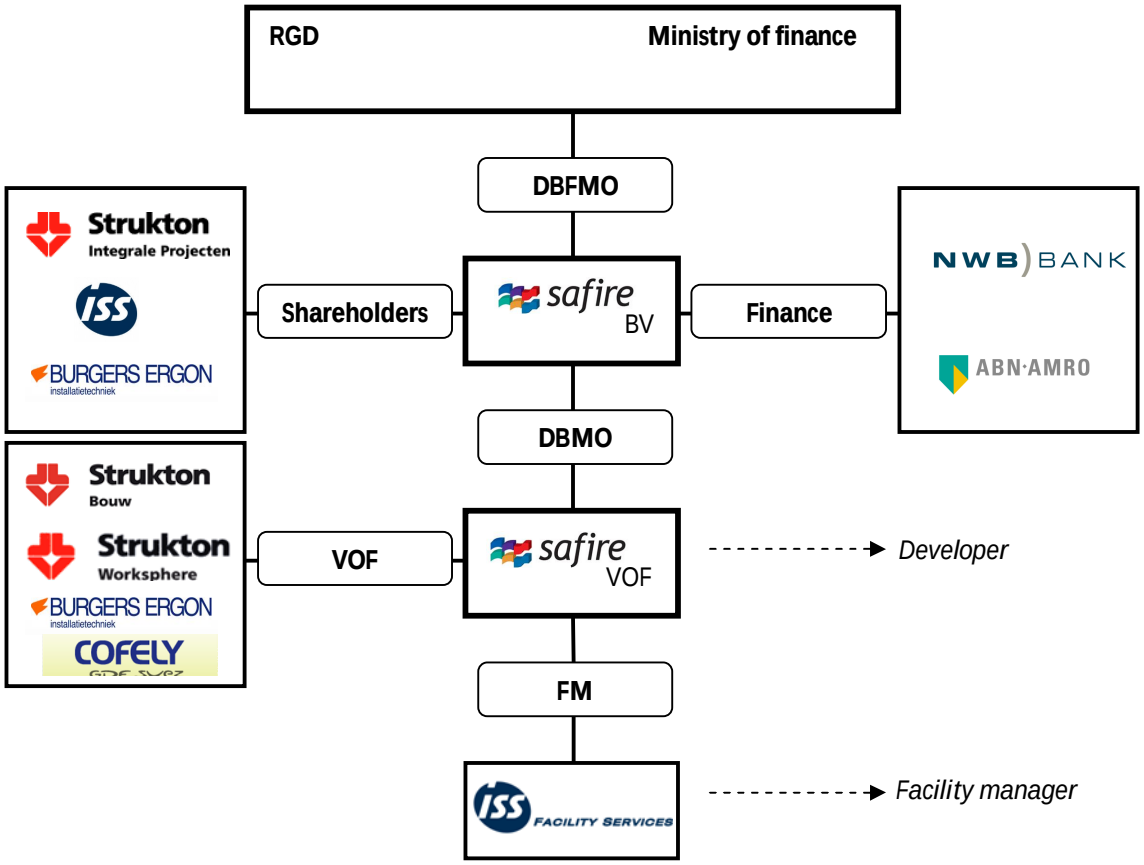


Figure 34- Organizational chart (Strukton,2011)

The project organizational chart above can be split into two; namely a BV side and a VOF (*Vennootschap Onder Firma)* side. The BV section on the above side includes all the shareholders of the project. Organizations such as Strukton, ISS and Burgers Ergon each have a share in the project. The BV is only focused on the financial aspect of the project and is not involved in the development team. The VOF section represents the development team and consists out of various organizations. These organizations form the VOF and are all partners and are equally liable. This means that Safire VOF represents the development team and is headed by Strukton. The client can be seen on top. In the BV part the DBFMO contract can be seen and in the VOF part this changes to the DBMO, leaving finance out. This has to do with the fact that the finance is done by the banks on the right side. Safire BV needs to report financing aspects to the financers. Safire VOF is able to communicate directly to the client, but their normal communication line is with the Safire BV (Interview developer, 2011). When looking at the interesting parties for this research, a look has to be made to the developer and the facility manager. As mentioned, Safire VOF was the developer. The head of this consortium was Strukton, making them an interesting party to analyze (only in the VOF). The facility manager in this case was ISS facility services, they can be found both on the shareholder side and the developer side, showing their presence throughout the whole project. ISS is therefore the second party to analyze as they lead the facility management in the project (Interview developer, 2011).

As both relevant parties are identified, both parties will be approached in order to successfully conduct this research. In order to gain some visual impressions, the illustrations on the next page can be seen.

Building impressions:

Figure 35- Ministry of finance in The Hague (Smaak, 2009)

Figure 36- Atrium (Smaak 2009)

Figure 37- Meeting room (Smaak 2009)

7.2 Case 2: Construction DUO Groningen

The client:	Rijksgebouwendienst representing DUO and tax office
Consortium:	The building team consists out of a consortium, this consortium is called: Consortium Duo2, existing of: Strukton, Ballast Nedam, John Laing
Most important sub-Contractors:	ISS Nederland, YNNO, Arup, Lodewijk Baljon landschaparchitecten, Studio Linse
Architect:	UN Studio
Project form:	Public Private Partnership (PPP)
Contract form:	DBMFO
Project start:	31/12/2008
Project completion:	01/04/2011
M2:	47000m2 BVO offices, parking 10000m2 BVO
Costs:	€100 million building costs, and €13, 2 million annually for exploitation
Interesting aspect:	This was one of the first newly build building according to the PPP contract form.

The buildings of the DUO and the Tax office were outdated as they were constructed in the 70's. Therefore they did not meet new user requirements, especially on interior level. Another problem was the fact that these two organizations were spread around regions and wanted to be placed in one location. This was the reason for the RGD, as owner of the ground, to start the tender procedure for a new office building.

The building had to become an important landmark in the Groningen region. The building can be considered as remarkable in terms of architecture and has a highly innovative façade. The façade has integrated sun blockage, wind regulation and construction in one element. Also a great deal of focus has been set on sustainability (NieuwbouwKempkensberg, 2011: online).

The building has common spaces such as an entrance with a common lobby, a company restaurant, a grand café and conference rooms. An interesting aspect of the building are the "boxes", where visitors can go with their enquiries to the reception employees.

After the completion of the building, a start has been made with the demolition of the old buildings, which consist out of two office blocks. The construction of an underground parking and a public garden will be finished in 2013 (NieuwbouwKempkensberg, 2011: online).

Due to the high integral aspect of the building project and the contract form, it can be seen as a highly integral project with intense cooperation of various parties. The DUO building can therefore be seen as one of the most integral projects at this moment in the Netherlands next to the renovation of the ministry of finance in The Hague. A key difference here in terms of architecture, is that the DUO building was a much more complex project than the renovation project, as a new building needed to be created with a great deal of new installations. This complexity together with the high integral focus of the project and focus on facility management makes it an interesting project to analyze. An organizational chart on the next page shows the intensity of the integral cooperation (Interview developer, 2011).

7.2.1 Project organization

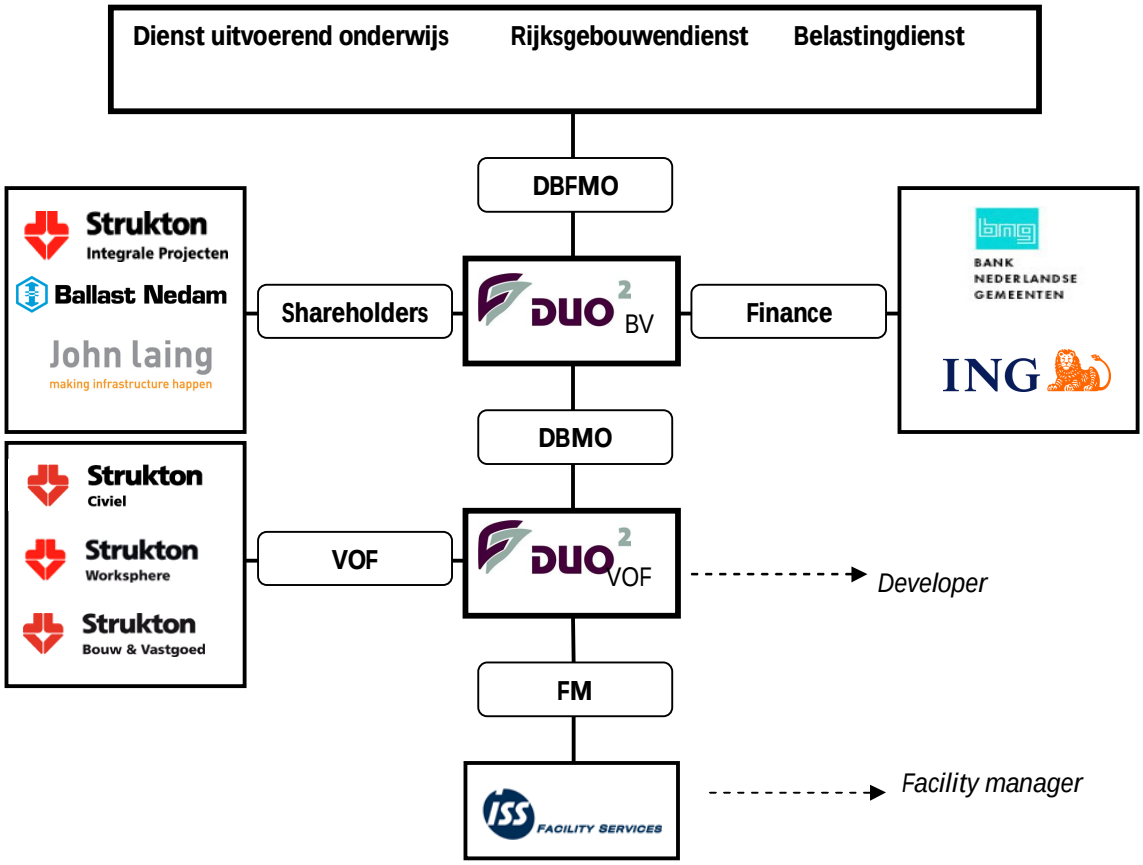


Figure 38- Organizational chart (Strukton,2011)

The project organizational chart above is similar to that from the first case. Here the chart can also be split into two; namely a shareholder side and a VOF (*Vennootschap Onder Firma)* side. The client can be seen on top. In the above part the DBFMO contract can be seen and in the second part this changes to the DBMO as in the previous case. DUOBV reports the financing aspects to the financers and all shareholders have a share in the BV. DUO VOF is the developer and communicates directly to the BV. As mentioned in the previous case the parties in the VOF all have their responsibility within the project and they are all liable and they all have their own capital (Interview developer,2011).

An interesting aspect in this project is that the VOF consists out of various departments from Strukton and thus, one company instead of various organizations forms the development team. When looking at the developer and facility manager it is obvious that Strukton (VOF) can be seen as the developer. ISS is the facility manager in this project. They are part of the VOF but are no shareholder. As these parties are identified (same as the parties in the previous project) they will be approached in order to analyze the work processes.

In order to view some interesting graphical aspects of the building, the impressions on the following page can be used.

Figure 39- DUO Building Groningen (Nieuwbouw Kemkensberg, 2011: online)

Figure 40- Receptions (Nieuwbouw Kemkensberg, 2011: online)

Figure 41- Central reception (Nieuwbouw Kemkensberg, 2011:online)

Conclusion

It is noticeable that both cases have their similarities due to the fact that the developer and facility management organizations were active in both cases. As this has been the case, it is interesting to see whether the stakeholders have used the same processes in both cases. It has to be emphasized that the first case involved a renovation, whereas the second case concerned a complete new building construction. Another interesting point is the fact that both projects involve integrated Design Build Maintain Finance and Operate (DBFMO) contracts. This aspect will be reviewed in the detailed analyzed conducted in the next chapters.

8 Chapter eight

Within case analysis: Ministry of finance The Hague

Figure VIII – The ministry of finance in The Hague (Smaak,2009)

"Architecture is a visual art, and buildings speak for themselves"
- Julia Morgan

Introduction

After describing both cases to be studied in the previous chapter, this chapter will provide a detailed within case analyses. The case to be analyzed in this chapter will be the renovation of the ministry of finance in The Hague. The within case analyses will be done by analyzing all lean principles in this chapter. The first paragraph will focus on the value determination and will see how value information was gained in this case. The second paragraph will focus on how the value stream can be determined by looking at both value adding and non-value adding processes between developer and facility manager. Moreover, the next chapter will handle flow and will look at the process barriers which have been identified. After identifying the barriers, the following chapter will discuss the pull principle. This will be done by reviewing the involvement of the facility manager in the planning phase and to determine whether they were part of the planning process. The last paragraph will focus on the steps which have been taken in relation to perfection. This includes aspects such as whether there were feedback sessions or other tools used to accomplish continuous improvements. The chapter will end with a descriptive case model, which is a table summarizing all aspects which have been handled in the analysis.

As this chapter conducts a within analyses on this specific case, chapter nine will focus on the second case: the construction of DUO Groningen. The same lean principles will be analyzed in the next chapter.

8.1 Determining value

"How are the facility managers' needs currently determined by the developer and how intense is the cooperation with the facility manager in order to gain the value knowledge?"

An important aspect in the determination of the needs of facility management was the creation of the output specification by the client. The output specification can be seen as a document which describes the desired result in terms of products and or performance (Vlaams kenniscentrum PPS, 2009:p27). The output specification was made on an abstract level, creating space for the development team to provide them with the necessary freedom in design terms. As the output specification was provided this meant that the facility manager would determine its need through analyzing and responding on this document in the tender phase (Interview FM, 2011). The output specification would be given to the consortium and thus the development team including the facility manager. This would lead to intense cooperation between the stakeholders as they needed to win the tender.

After the tender phase the project would start and the first step towards determining the needs of facility management by the developer would be through weekly meetings. These meetings would involve all parties in the consortium and were held in order to make agreements and to decide on the steps to be taken. During these meetings, facility management was able to provide their needed input and agreements between the various parties could be made. These meetings were held throughout the whole project cycle, starting from the initial phase (Interview FM, 2011).

In the design phase the needs of the various stakeholders were determined by means of dialogue sessions. These dialogue sessions would be formal meetings according to certain procedures. The dialogue sessions would be essential and would provide more specific data on the needs and agreements between all parties. In the design phase these dialogue sessions would lead to the creation of the layout plan and logistical plan of the facility manager. The dialogue sessions were intense as they would take long periods of time and would need to lead to agreements among all the stakeholders (Interview FM, 2011).

In the realization phase facility management largely shared their needs with the developer by means of an advisory role. This was done as all major aspects were agreed on in the design and initial phase, leading to the physical creation in the realization phase headed by the developer. An interesting aspect here is that facility management would, next to their advisory role, have a leading role in the creation of the garden and kitchen. This meant that facility management could control the physical output of their needs set in the previous phase, in the realization phase. The effect would be that the kitchen and garden were made according to their specific demands, leading to more efficient usage in terms of exploitation and logistics in the usage stage (Interview FM, 2011).

The intensity of the cooperation between facility management and developer would be emphasized by the leading role of the facility manager in the realization phase, as they needed to intensively cooperate with the developer in order to establish the physical kitchen and garden. This would mean the integration of exploitation and design in the usage phase. Also the fact that facility management was present in all stages of the project cycle can be seen as an indication of the intense cooperation between them and the developer. This was done as the facility management firm was shareholder in the BV and stakeholder in the VOF. The consequence of the facility management presence in all stages of the project cycle would be their large input and implementation of their needs in the various stages (Interview FM, 2011).

When looking at the usage phase, the intensity of the cooperation between facility management and developer would remain. This had to do with the usage of FMIS (Facility Management Information System). The FMIS provides information needed for integral planning, realization and managing the facilities of an organization. This tool enhanced the intensity as both the facility manager, responsible for soft FM issues (services) and developer, responsible for the hard FM issues (technical aspects), would be able to gather data through the FMIS. This data provides interesting information in relation to both soft and hard FM issues relevant for developer and facility manager. The effect of FMIS is that both developer and facility manager can react quickly on various issues, such as ventilation failures or difficulties in cleaning certain areas, and can collect data in order to optimize work processes (Interview FM, 2011).

When looking at the research question, it can be said that frequent interaction between facility management and developer has taken place in all stages of the project cycle, from initial till usage phase. This frequency shows a pattern of dialogues and weekly meetings. The frequency of the cooperation between facility manager and developer also gives an indication of the intensity of their cooperation. The reason for this frequent interaction and intense cooperation could do with the fact that both developer and facility manager would be in charge of the exploitation for a period of 25 years. This means that they needed to compromise and provide the best possible building in terms of maintenance, as an inefficient building (in terms of exploitation) would lead to high costs in the usage phase, these costs would be for account of both the developer and facility manager. Therefore one can say that developer and facility manager both had the highest priority of providing the highest quality of design in term of maintenance, as they would be responsible for the exploitation. Underneath the concluding findings are illustrated; the link between frequent interaction and the common objective is made.

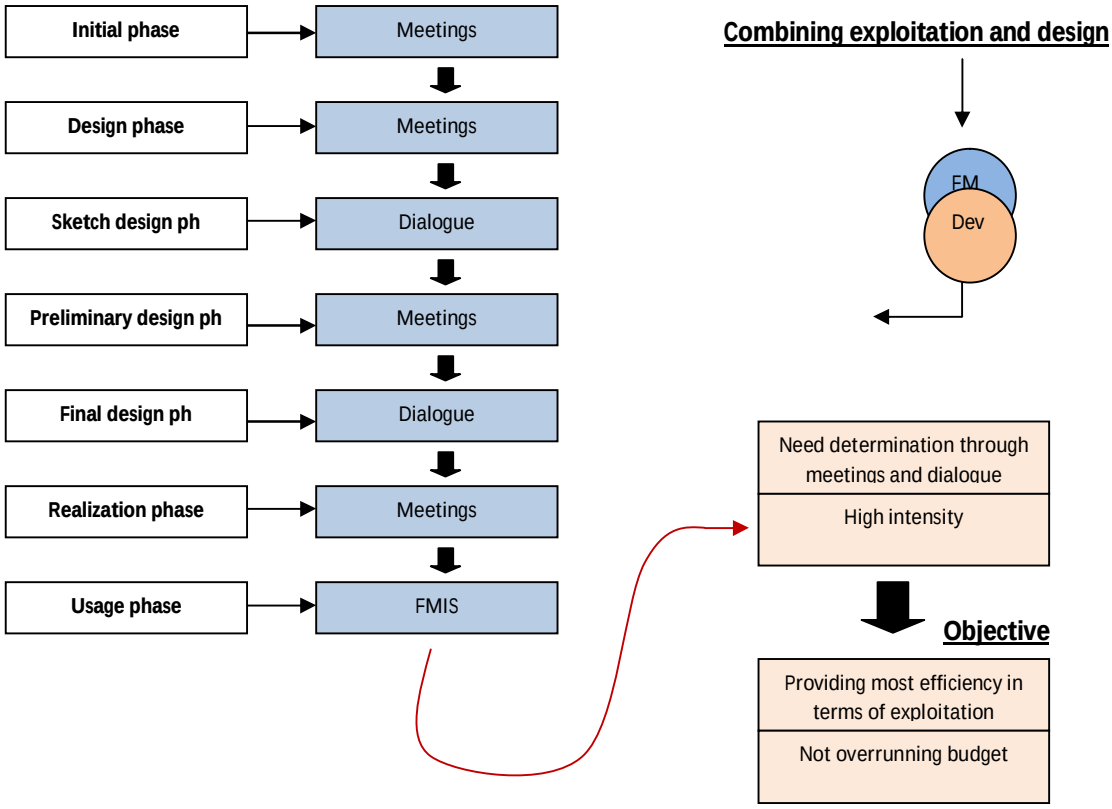


Figure 42- Concluding findings value case 1

8.2 Determining the value stream

"What are the roles and responsibilities of the facility manager and the developer in the real estate project cycle and which processes between these two stakeholders create value and which do not create value?"

When looking at the roles and responsibilities of the facility management department it has to be said that they were part of the consortium, both in Safire VOF and BV. As they were part of the consortium, this would mean that they would be present in all stages of the project, from financial (shareholder) till the development of the project (stakeholder). This would have the effect that facility management would have more responsibility, especially when comparing them in their traditional role of being active in the usage stage only (Interview FM, 2011).

Facility management was part of the exploitation team and concerned with soft services, this would mean that they would focus on logistic aspects, the relation between function and personnel and the layout/structure of the building. This would be a process which would be focused on from the initial till the execution phase of the building process. Facility management would also be present in all other departments of the VOF, meaning that they would also participate in the technical team. The effect of their presence in the technical team however, would not result into a great contribution in the overall design, as facility management is a service oriented discipline and not focused on technical aspects. This would mean that their input in terms of technical building orientation would be limited in this department and would be oriented on their initial task in relation to logistics and building structure/layout plans (Interview FM, 2011).

When looking at the roles and responsibilities of facility management in the various phases of the project cycle a separation can be made. In the initial phase they would focus on the output specification in terms of analyzing this document. This needed to be done in order to correctly match their needs to the requirements of the output specification. However, as the output specification was made on a rather abstract level, this would lead to more discussions between the development team, client and facility manager, as not all aspects were clear. In this phase the start of the optimization and creation of the layout plan and logistical issues would take place. As facility management was also a part of the building user in the usage phase, the logistical aspects would needed to be conducted efficiently, in order to prevent unnecessary exploitation costs in the future (Interview FM,2011).

In the design phase facility management would be involved in the preliminary design and the final design. In the sketch design phase, there was no clear presence of facility management. When looking at their contribution in the preliminary design phase, it is noticeable that facility management was not present from the beginning of this phase. That would have negative consequences as decisions in this phase would be made without consultation of facility management, leading to unwanted logistical aspects, which at that point could not or was difficult to be changed, as the design was in a mature phase (Interview FM, 2011).

In the realization phase facility management would focus on the detailing aspects, this would mean that they would focus on aspects such as locating electrical plug-ins and thus detailing aspects of the final design. This would mean that their role would be focused on detailing, resulting into focused responsibility in terms of facility management. In this phase an interesting development would take place, as facility management would be in charge of the creation of both the garden and the kitchen. As this is normally the responsibility of the builder and thus the developer, it is interesting to see that they were in charge of a certain item in the realization phase. This would mean that the role and

responsibility of them at this stage would change, from an advisory stakeholder to a stakeholder with a leading role, resulting into the creation of a garden and kitchen according to the wishes (in terms of detailing) of the facility manager and thus exploitation party. This is an indication of combining exploitation and development in both the design and realization phase (Interview FM, 2011).

When looking at the usage phase; facility management would be in charge of the soft services, such as cleaning, catering and security issues. This would be the traditional facility management activities, however as facility management was also involved in the pre usage stage, they contributed in the design. As usage of FMIS has been made in the usage phase, facility management would be able to react on performances in relation to exploitation and thus enabling them to better integrate their responsibility as exploitation firm in the usage phase (Interview FM, 2011).

When looking at the developer there was a development team present in the project. This would mean that several organizations were part of the development team. The developer in this case will be called Safire VOF. The developer was investor, shareholder and stakeholder of the project, creating a high financial interest in the project, leading to a great responsibility of staying within the budget of the project (interview developer, 2011).

When categorizing the main responsibilities of the developer in the various phases, a first look can be given at the initial phase. In this phase the developer was mainly concerned with analyzing the output specification and conducting feasibility studies. This would lead to close cooperation with the consortium and the facility manager as they needed to agree on the actions to be taken as a whole. Aspects such as the building form in respect to esthetics were focused on, but also the layout plan, building logistics and structure were important focus points. These issues led to the cooperation with facility management and therefore a deeper integration between developer and facility manager would be established (interview developer, 2011).

In the design phase it was the developer's responsibility to select an architect, who would be involved in the project as sub-contractor. The architect would design the main outlines in the sketch design phase, but would need to compromise in this phase with the developer, leading to form following function and thus emphasizing the importance of function. The design phase would also be a stage where the developer needed to compromise on issues with facility management, as the final logistical and layout aspects needed to be agreed on in this phase, resulting into an integral work approach (interview developer, 2011).

In the realization phase the developer would lead the translation from design till execution as they were also contractor of the project. As facility management also had a leading role on a part of the execution, their cooperation would be important as the whole realization process needed to be efficient (interview developer, 2011).

In the usage phase, the developer would be responsible for the hard FM issues. This is an interesting point as it traditionally occurs that the developer is not involved in the usage phase. As this was the case it meant that the developer had all interest in providing a building with high exploitation efficiency. This would lead to intense cooperation with facility management as their exploitation knowledge was essential in order to provide an efficient building (in terms of exploitation). This also had to do with the fact that the developer had signed a DBFMO (Design, Build, Finance, Maintain and Operate) contract, making them in charge of the exploitation together with the facility management organization (interview developer, 2011).

When looking briefly at the responsibility of the client, it was obvious that they would provide the output specification in the initial phase and would have an advisory role in the next phases. This advisory role would mean that the client had to give the complete responsibility to the developer making the developer fully liable. The client was intensely involved in the project. An important condition which was set for (on behalf of the client) both the developer and facility manager was the fact that the building character needed to be remained (interview FM, 2011).

Value creating processes

When looking at the processes creating value, a look can be given at some interesting aspects. Firstly, the process between developer and facility manager leading to the creation of a layout plan is an important value adding process. This has to do with the fact that the input of facility management can reach an optimum when they are involved in the layout plan due to their expertise in exploitation services. This is also the case for the logistical plan, leading to the avoidance of problems in the usage phase in terms of exploitation and leading to an efficient logistical layout for the building users (interview FM, 2011).

The dialogue sessions which have been held can also be seen as a process adding value. These dialogue sessions provided important compromises between parties and gave both developer and facility manager the opportunity to directly communicate and thus directly make compromises and decisions on aspects affecting both parties. These sessions also created the opportunity for the client to ask questions to both stakeholders and thus keeping the project on schedule (interview FM, 2011).

Another important aspect which can be seen as highly adding value is the fact that the DBFMO contract used in this project has led to the lifecycle focus of the building. As both developer and facility management focused on a period of 25 years, the long term focus would result into lifecycle costing (interview developer, 2011). Where e.g. decisions are made to use installations with a high purchase price, the consortium focuses on the long term feasibility instead of the short term purchase price. The lifecycle focus has also led to the integration of exploitation within an early stage, creating an optimal transition from realization phase to user phase and thus avoiding potential problems in the usage phase. E.g. if the kitchen would not be optimal and needed to be changed as the exploitation organization was not consulted. This connection with design and exploitation can be seen as one of the most important added value aspects, the best example is the role of facility management in the creation of the kitchen and garden (interview developer, 2011).

The usage of an FMIS can also be seen as an important value adding process, especially between developer and facility manager. As the system enables both parties to collect data on operational building issues in relation to both hard and soft FM, it enables both developer and facility manager to react on these issues and to create continuous improvement in future perspective (interview developer,2011).

Non-value creating processes

When looking at non-value creating processes it can be said that the presence of facility management in the technical building team was non-value creating, as these technical aspects are not part of the their competencies. Therefore meetings where technical details in terms of concrete structures and other aspects were provided did not provide the needed data to the facility manager and vice versa, thus these meetings did not add value for facility management. This is also the case with the communication between architect and facility manager, as both parties do not comprehend each other's discipline fully, leading to delays and communication barriers among the stakeholders (interview FM, 2011).

When looking at the fact that the project was rather integrated and involved a great deal of organizations in the development team, at first hand this can be seen as positive. However, as the development team existed out of various organizations, demarcation was created, leading to the separation of tasks among a number of parties. By dividing tasks and not integrating these tasks in the separate teams, demarcation was becoming a problem. This demarcation is opposite to integration and is therefore a non-value adding aspect (interview developer, 2011).

Underneath a value stream map can be seen, showing the most interesting processes between facility manager and developer. The blue boxes are the value adding activities; the two red boxes refer to non-value adding issues. (O.S is Output Specification). The value stream map is a current state map and thus shows the current situation from an external perspective. The current state map is the most efficient way to describe the current situation and it has shown the most interesting elements in terms of value and non-value creating stages. It is important that these aspects are focused on and that those aspects which do not create value are dealt with by means of future projects.

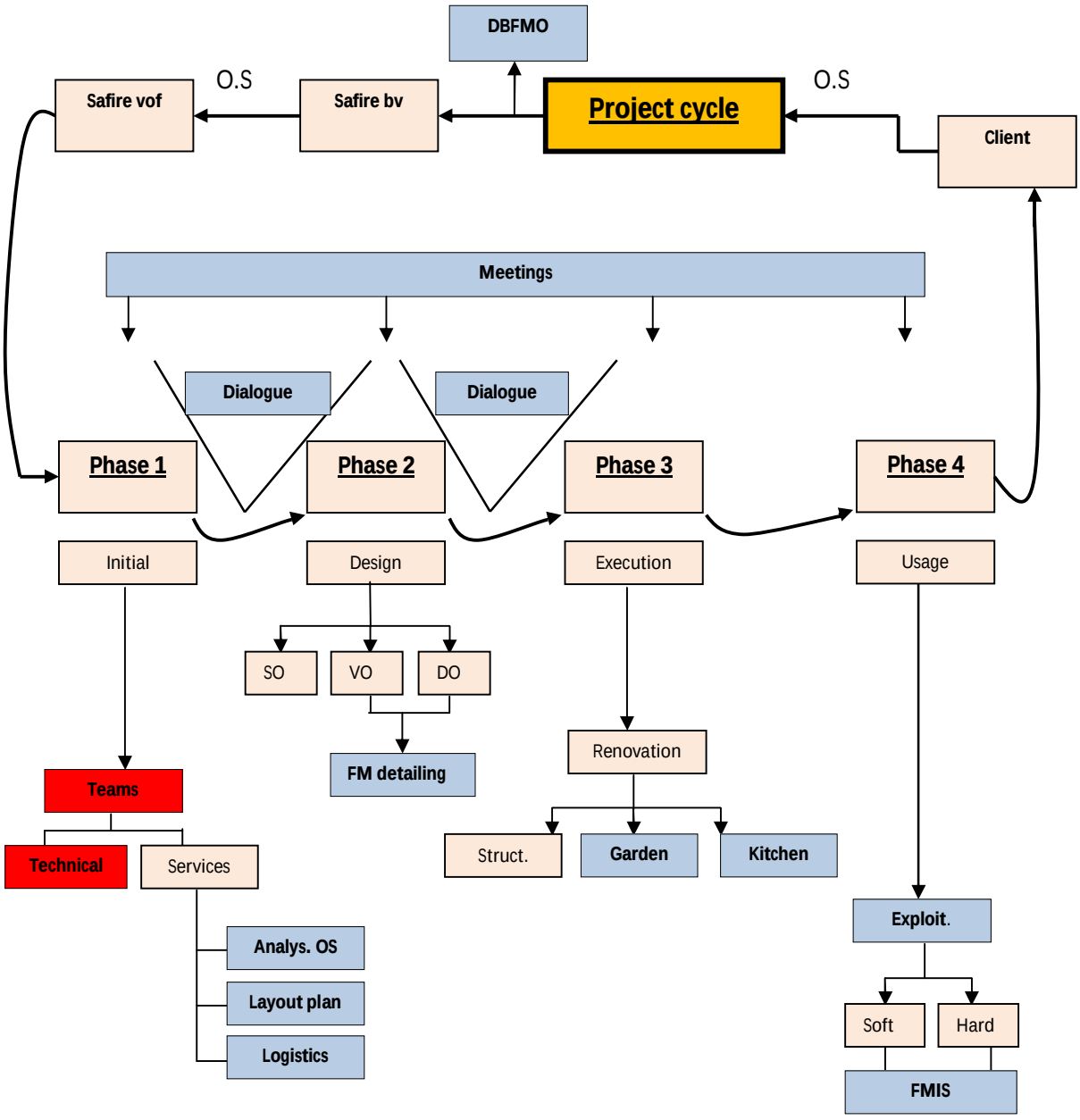


Figure 43- Value stream map case 1

When looking at the research question it can be said that facility management had a great deal of responsibilities in the project and shared this responsibility with the developer. The pattern which is noticeable is the emphasis on integral working, as both facility manager and developer needed to cooperate as they both were part of the exploitation team in the usage phase. Therefore it can be said that by giving the consortium the responsibility of the project in all stages by means of a DMFMO contract, the priority of creating a building of high quality standard in terms of exploitation, reaches an optimum. This priority and responsibility of both the developer and facility manager leads to aspects such as: lifecycle focus, lots of meetings, dialogue sessions and in this case even the leading role of facility management in the realization phase, which is far from traditional when looking at the traditional facility management discipline. The emphasis on the lifecycle focus has led to the creation of the roles and responsibilities in this project and therefore has a clear relation with each other. The integration of facility management in the project has however also led to non-value adding activities such as the communication with the technical department and the wide range of organizations in the development team with task divisions leading to demarcation. It is therefore important to work integral, but to know the limits. Underneath a graphical display of the concluding findings can be seen, showing the importance of the lifecycle focus.

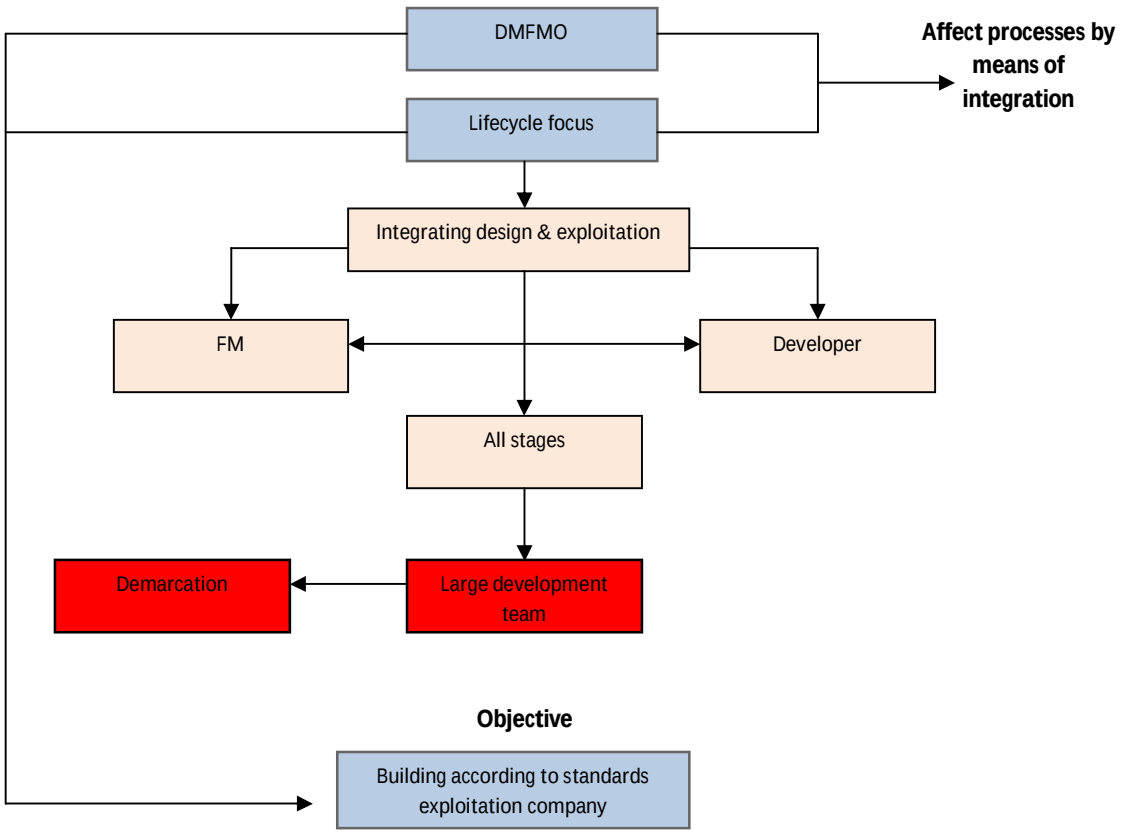


Figure 44- Concluding findings value stream case 1

8.3 Determining flow

"Which work practices between the developer and facility manager can be rethought and which barriers need to be eliminated in order to create continuous flow?"

The next step is to look at the flow principle, by means of defining the various barriers which could be seen in the case. A first barrier could be seen as the facility management communication line in relation to technical aspects. As mentioned in the previous paragraph, this did not add value as there is a lack of competency in terms of technical knowledge on behalf of the facility management (Interview developer, 2011). This means that the competency creates a barrier, which affects the communication lines as no valuable data is gained by the technical team and vice versa. The illustration underneath graphically displays this barrier.

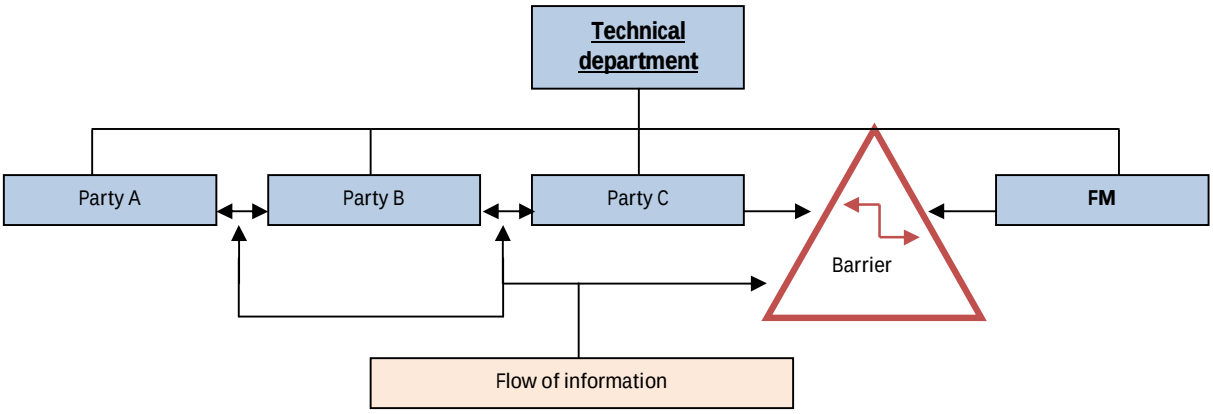


Figure 45- Communication barrier

Another important barrier, which can be seen as project specific, is the fact that facility management was involved relatively late in the preliminary design phase. This led to the situation that some design elements were already decided on, leading to a mismatch in the demand of facility management and the decisions taken by the development team. During such periods, it is difficult or even impossible to change these decisions. Leading to a barrier in the process, as changing such decisions leads to delays and implementing decisions without facility management consultant could lead to difficulties in the usage phase. The effect of this aspect has led to the creation of a storage room which was too large and placed under ground level, meaning that logistics, in terms of weekly supply delivered, will be done inefficiently (Interview FM, 2011).

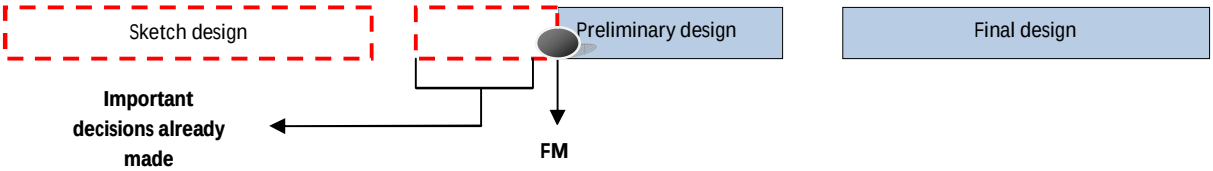


Figure 46- FM involvement

When looking at the abstract output specification used in the project, this can be seen as a barrier as specifications of the client were not detailed, leading to constant discussions with the client on gaining more information in relation to their demands as the output specification was simply not detailed enough. This abstract level of the output specification led to extra time needed in order to translate the document due to the extra discussions needed, resulting into a barrier in the continuous flow line (Interview FM,2011). The reason for the abstract level of the output specification was to create freedom for the designers (Interview client, 2011), but the misinterpretations causing delays did create a barrier.

When looking at the various parties involved in the project and in the development team, this variety of parties led to demarcation, as mentioned in the previous paragraph. Demarcation of tasks does not lead to value, but leads to barriers as the integral emphasis of the project disappears. The various stakeholders have assigned different tasks, leading to various groups focusing on their own specific task, instead of combining the task within the group. This demarcation cannot be seen as lean, but can be seen as a barrier, stopping full integration and effecting continuous flow (Interview developer, 2011). The illustration shows this process. It is noticeable that despite the intense meetings with all stakeholders and the dialogue sessions, that there is no full integration in such complex projects.

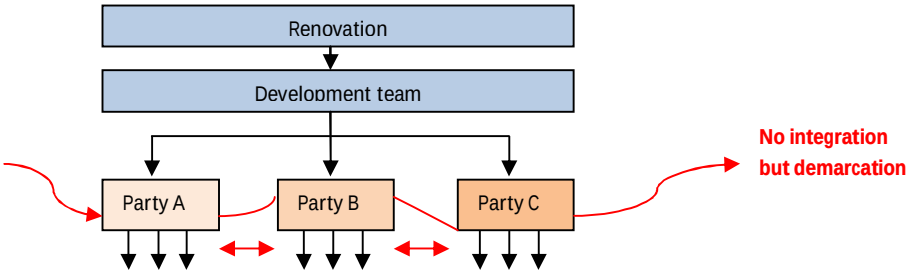


Figure 47- Division of tasks leading to demarcation

Another danger in these types of projects where multiple teams are involved can be seen when looking at the contracts. The usage of these strict contracts used in the project leads to inflexibility among stakeholders, because, in some cases, they are not able to be flexible as they are forced to constantly look at the tight agreements made in the contract. Inflexibility can create difficulty for all parties, also the facility manager and especially the developer, as this team is large and inflexibility can create barriers (Interview developer, 2011). The consequence of this issue is that the abstract level, due to the output specification, ideally leads to creativeness among parties, however this creativeness can be affected negatively as parties stick to their contract and do not want to be flexible in terms of various agreements leading to aspects such as; "*this is not my job according to the contract"* (Interview developer, 2011).

As this project involved a renovation, it meant that work needed to be done with the existing building. The building had a *brutalistic* character and a requirement of the client was to maintain this character; this would create a difficulty for the facility manager in respect to the creation of the garden. They had to create an indoor garden, surrounded by glass from the atrium. As the building character needed to be kept, the facility manager was forced to create a garden under the glass, in terms of maintenance this can be seen as a difficulty, as the maintenance does involve a great deal of work, leading to high maintenance costs. The fact that the building character needed to be kept, created a barrier in terms of maintenance, which is essential for facility management, therefore this issue is highlighted (Interview FM, 2011).

When looking at the experience and competency of facility management in the pre usage phase, it is rather limited as facility management is traditionally active in the usage field; this was noticeable in the literature study. It can therefore be said that the inexperience of facility management can be a barrier in such projects in terms of decision making, as they can lead to the wrong decisions; again the output specification plays an important role. As the abstract level is difficult to cope with for them, as they have a more visual approach towards aspects such as layout plans, it is difficult for facility management to make the translation into these layout plans. As they do not have experience in the decision making process in the pre usage phase. This inexperience could also lead to their presence in the technical teams and their late presence in the preliminary design. This had to be claimed by the facility manager (Interview FM, 2011).

Figure 48- The finance building 1975

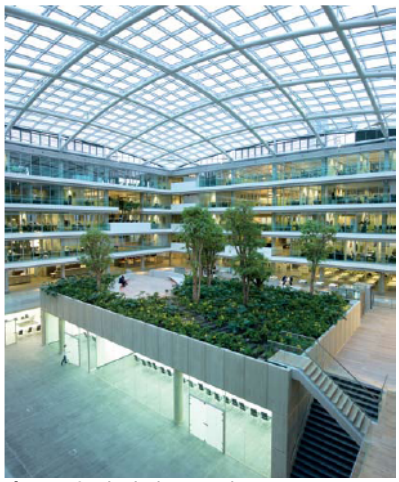


Figure 49- The indoor garden

When looking at the research question, it can be said that the various barriers exist as the project is relative complex in terms of the integral aspect and the number of organizations active in the development team. The number of organizations create demarcation and also create inflexibility in terms of the contracts used. The inexperience of facility management in the decision making process in the pre-usage phase leads to difficulties in translating the output specification and also leads to communication buffers as they are present in technical departments without technical knowledge. Their inexperience could also lead to their late presence in the preliminary design phase, if facility management would emphasize on their added value at the design phase, maybe this could be prevented. It is however interesting to see the connection between these barriers and these need to be reacted on in order to create continuous flow. Underneath the concluding findings are graphically displayed, emphasizing the demarcation and experience barriers.

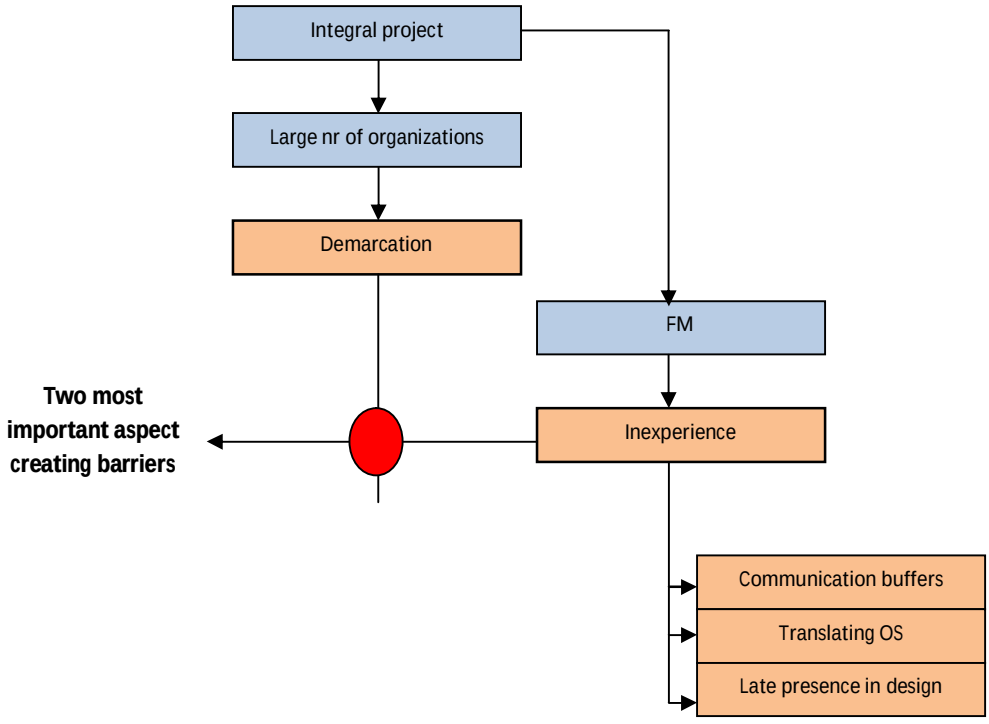


Figure 50- Concluding findings flow case 1

8.4 Determining pull

"What are the facility manager's influences on the schedule and in what way can the process between the facility manager and developer be made fully pull, leading to pull planning?"

When looking at the pull factor, in terms of the involvement of facility management in the planning schedule, it can be said that in this case the whole team was responsible for the planning (development team). The planning schedule was made by the head of the development team and it was the responsibility of the various stakeholders involved to meet the deadlines. When looking specifically at facility management, it is noticeable that they did not have an influence in the determination of the planning schedule, leading to a planning with no involvement of facility management. It can be said that facility management did and does not have the competency to be in charge or part of the planning schedule, creating a non pull schedule in this case, as this is the consequence of their lack in planning competencies in the building phase (Interview FM, 2011).

When looking at the various stages in the project cycle, it has been noticeable that there was space for pull planning in the pre execution phase between the design team and the head of the development team. As the dialogue sessions provided information on needed steps to be taken and thus various deadlines. It has to be said that facility management was part of the design team but also had no control on the planning aspect in this stage. The effect of this aspect was that facility management would always follow deadlines given and were not able to take concrete steps in creating a pull planning system (Interview FM, 2011).

In the realization phase there also was no room for pull planning for the various stakeholders involved. At this phase however, facility management did had an advisory role on planning processes related to the creation of the garden and the kitchen. This was the case as they would lead this building process, making it necessary for them to be active (Interview FM, 2011).

The fact that facility management did not have a clear say in the planning process could be a consequence of their lack of competency in terms of complex planning in a pre-usage stage. This automatically refers to their experience in this field, which was discussed in the previous chapter. As the core of facility management is not largely involved in planning before the usage phase, they do not have the needed competency in order to conduct the planning process; however it is important for them to be involved in the planning process (Interview FM, 2011). This can also be seen when looking at a quote of one of their managers:

"We should emphasize our conditions and demands in terms of planning. If we would have pilot sessions, we should be able to better communicate in a plan session" (Interview FM, 2011).

The fact that planning is highly important for all teams, including facility management can be seen when looking at the fines given for late delivery, as these fines are rather high (Interview FM,2011).

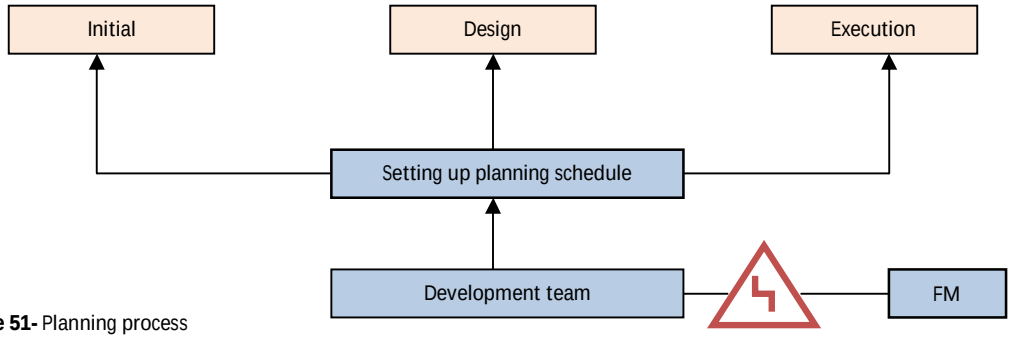


Figure 51- Planning process

When looking at the research question, it is clear that facility management does not have influence on the planning schedule in the various stages of the project cycles. This could be explained by two aspects, namely their lack of experience in the field of planning in the pre-execution phase and their lack of knowledge due to this consequence. In order to make a pull schedule, it is important for facility management to gain knowledge by using these experiences in an efficient way. It is in their best interest to react on this issue as all stakeholders, including the facility manager are subject to fines when delivery is not met before deadline. The graphical illustration underneath summarizes the main concluding findings, with the emphasis on experience.

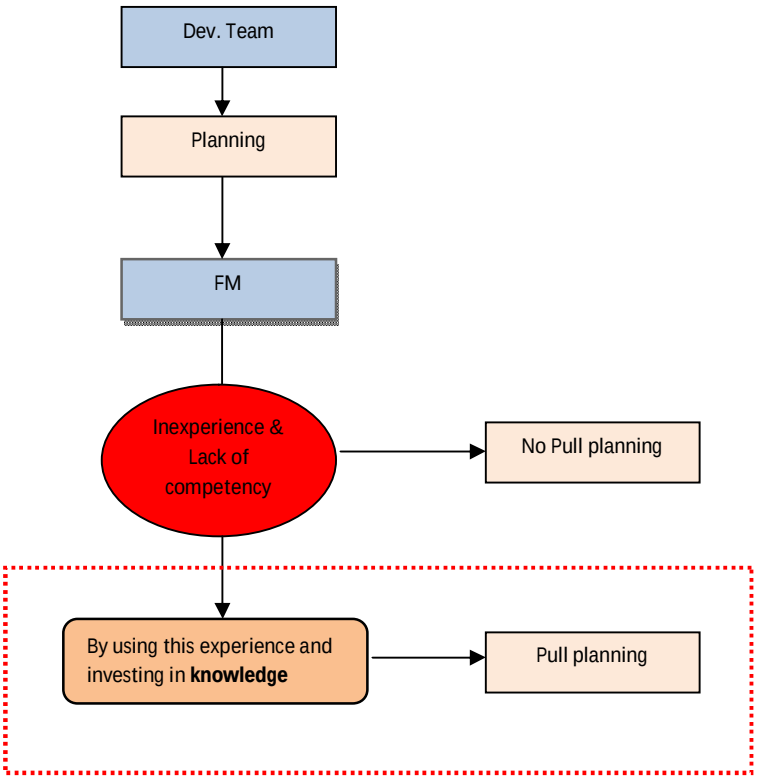


Figure 52- Concluding findings pull chapter case 1

8.5 Determining perfection

"How could continuous improvement be established and what does this mean for the relation between developer and facility manager?"

In terms of continuous improvement aspects which have been applied in this case, it can be said that there have been evaluations among members of the consortium and the client. These evaluations are used in order to look at the project difficulties and the project successes and the most important findings can be used to improve processes for future projects. The effect of these feedback sessions can only be visible in future projects of the various stakeholders (Interview FM, 2011).

Another important tool which provides essential data is the usage of the FMIS (Facility Management Information System) as this tool provides essential data on various aspects such as maintenance issues. This tool communicates information between facility management and the developer in the exploitation phase and provides both parties to quickly react on various aspects and work towards a continuously improving work process. The effect of this tool is that continuous improvement can be set throughout the usage phase of the building by both facility manager and the developer, and will enhance the goal towards perfection (Interview developer, 2011).

A future goal of the client in this project, which will largely impact the developer and also the facility manager in a positive way, is the use of BIM (Building Information System). As this provides the client with detailed information on the building by creating a 3D model with the building details in an early stage, faults can be seen before the realization phase and thus decreasing failure costs. The developer will be able to create buildings without mistakes and the facility management team will be able to plan logistics and other aspects in detail. Also a link with the BIM system and the FMIS system could be made, creating an ideal situation for both parties (Interview FM, 2011). This would mean that the relation between developer and facility manager would be made more integral in a more early stage and thus linking exploitation and development and improving future work processes. An example of a BIM model can be seen underneath

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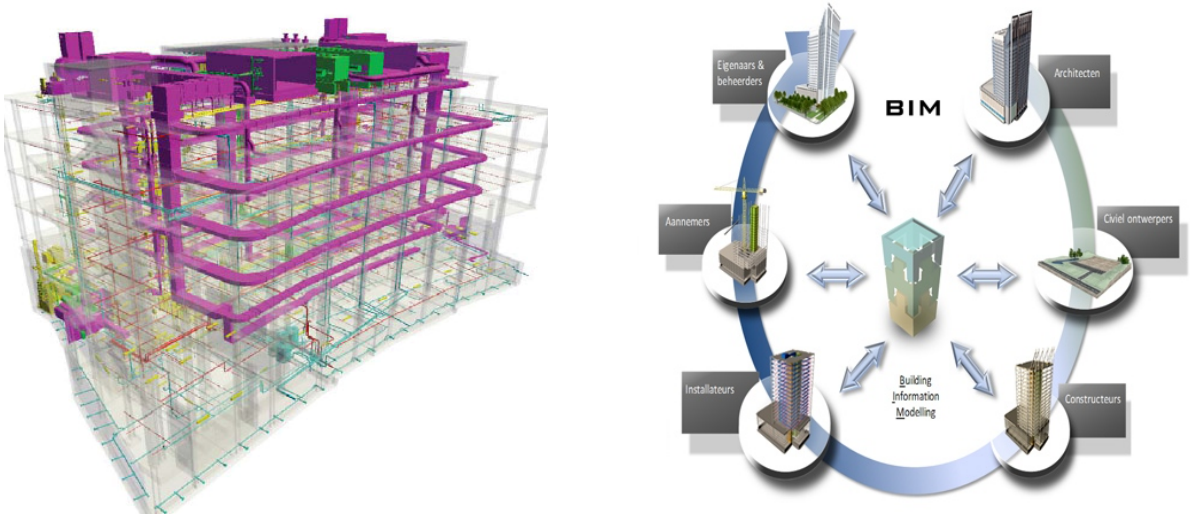


Figure 53- Random BIM model (Aecbytes & cadix,2011:online)

When looking at the research question it is noticeable that use of evaluation meetings has been made. The most important question here is whether the stakeholders are able to make use of their experience in other projects. An important breakthrough for both developer and facility manager is the use of digital systems as they will enable both stakeholders to easily react on data gathered. That will lead to more efficient usage of this data to implement continuous improvement. As the development is intense at this current moment, the future will bring more developments which will affect the implementation of perfection in a positive way. The illustration underneath provides the main concluding findings graphically, showing the importance of digital tools.

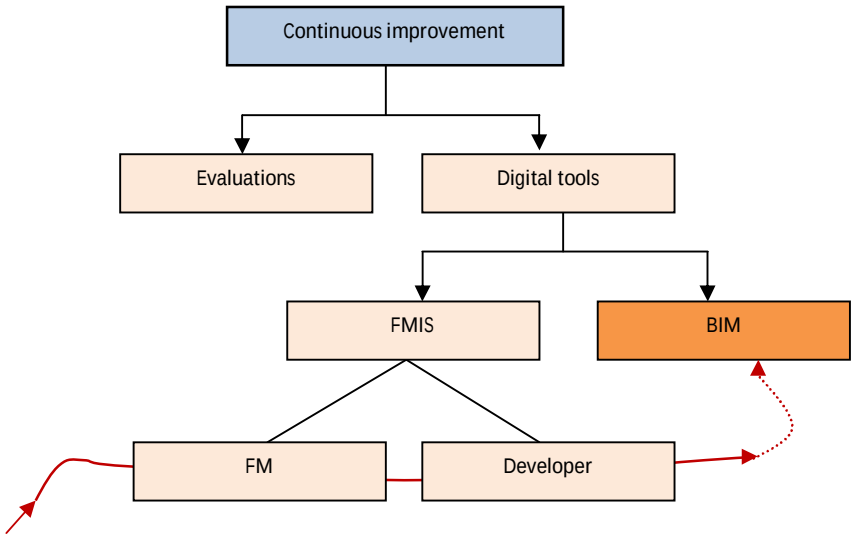


Figure 54- Concluding findings perfection case 1

Conclusion

In order to conclude this chapter, a descriptive table has been used which can be seen on the next page. The table is made in order to summarize the key findings and to determine the main conclusions. When having analyzed the value principle, the priority set on exploitation has been important, as this has led to intensive cooperation between developer and facility manager. It was important for the developer to determine the facility manager's value in order to create a building fulfilling the exploitation and users criteria. The value analyses has also showed a remarkable finding, namely the leading role of facility management in the realization phase, which can be seen as rather unique. When looking at the value stream, it was noticeable that this leading role had a positive effect and added value. However aspects such as the demarcation in this project can be seen as non-value adding, as the integral aspects is diminished due to the large number of organizations involved in the project. Overall, when determining the value stream, an important element is the shared responsibilities of both parties in terms of exploitation, enabling the long term focus of the project as a whole. When looking at the barriers, the lack of experience of facility management in the pre usage stage can be seen as an important element. An interesting aspect here is the fact that demarcation played a role. As the developer was represented by various organizations, tasks were divided instead of integrated, leading to a barrier in terms of demarcation. When having looked at the pull aspect, it has become clear that the inexperience would affect facility management in the planning phase, as their incompetency due to lack of experience has led to no input of them in the planning schedule. The last principle; perfection, has showed the importance of digital tools such as BIM and FMIS, creating great opportunities for both parties to implement perfection and to emphasize on continuous improvements. Overall it can be said that this project has showed the great possibilities there are when integrating facility management in the pre usage phase of a building project. It is however important to keep aspects such as the barriers and non-value adding items in mind in order to be more efficient in such projects.

Table 3- Descriptive model case 1

VALUE	VALUE STREAM	FLOW	PULL	PERFECTION
Weekly meetings between developer and facility manager	FM would be in charge of soft FM in the exploitation phase	The communication FM and technical department is a barrier	No influence FM in the planning process	Project evaluations among stakeholders have been set
Dialogue sessions in form of formal meetings	FM would mainly deal with the layout plan and logistics	The late presence of FM in the preliminary design formed a barrier	FM had no planning experience	The FMIS in realization phase enabled improvements
The usage of FMIS in the usage phase shows FM needs	The developer would be responsible for hard FM	The abstract level of the output specification did form a barrier	FM had no competency in pre usage planning	The usage of BIM is a future goal
The output specification would show the customer value	The developer and FM would have a long term focus adding value	Demarcation could be seen as a great barrier		The project provided enough parallels to be used in future projects
Realization phase: FM has an advisory role	The DBFMO contract would be of great added value	The contracts used led to inflexibility among stakeholders		
FM would be active in all stages, leading to intense cooperation	The FMIS would be a great added value	The building character needed to be remained, forming a barrier		
FM would also participate in all departments	The dialogue sessions provide great added value	The inexperience of FM in the pre usage stage formed a barrier		
FM would be in charge of both garden and kitchen	FM participation in garden and kitchen would add great value			
FM was shareholder in Safire BV and VOF	FM in the technical department would not add value			
FM and developer would be in charge of exploitation 25 yrs	The large nr of organizations would lead to demarcation			

Key findings	*Key findings*	*Key findings*	*Key findings*	*Key findings*
The intense cooperation between FM and developer has led to a strong value determination. It is remarkable to see FM in charge of the creation of the garden and kitchen	The shared responsibilities between FM and developer concerning exploitation is of great importance. Their long term focus is of great value, however FM presence in the technical department does not create value	An important barrier can be seen as the demarcation, blocking full integration among stakeholders. The inexperience of FM is also an important issue which has to be dealt with	In terms of pull, the case showed that FM did not have any responsibility in terms of planning, leading to no pull planning	The perfection measures are influenced by digital tools. The FMIS is of great usage of both developer and FM to improve aspects in the usage phase. Future usage of BIM will provide more possibilities in terms of perfection

9 Chapter nine
Within case analysis: DUO Groningen

Figure IX – The DUO building in Groningen (Panoramio.com)

"Buildings should serve people, not the other way around"
- John Portman

Introduction

The previous chapter had focused on the within analyses of the first case. In this chapter a within case analyses will also be conducted, however this will involve case two: the construction of DUO Groningen. The same analyses lines used in the first case will be applied. First the value determination will be handled in the first part. The second paragraph will review the determination of the value stream. Here all value and non-value adding processes will be handled. After determining the value stream, the flow principle will be determined. This will be done by analyzing the barriers which were noticeable in the project. The next part will concentrate on pull and whether pull planning was part of the project. This will be analyzed by looking at the involvement of facility management in respect to the planning schedule. The last part will concentrate on perfection and on which measures were taken in order to accomplish continuous improvement. The chapter will end with summarizing the main points and will describe these points by means of a descriptive case model.

This chapter will be followed by chapter ten, here a cross case analyses will be conducted in order to compare the main findings of both chapters and to analyze the main outcomes.

9.1 Determining value

"How are the facility managers' needs currently determined by the developer and how intense is the cooperation with the facility manager in order to gain the value knowledge?"

In this case the first step towards determining the facility manager's needs was by means of analyzing the output specification. The output specification was set up by the client and also the internal facility manager, which was part of the building users department and could contribute by setting their demands in the output specification. As the output specification was made by the same client as in the previous case, the abstract level was remained, meaning that the developer and facility manager would have the freedom in terms of design. This would mean that both stakeholders would need to analyze the document in order to adequately decide on their needs and thus this would mean intense cooperation between developer and facility manager and a more advisory involvement of the client (Interview FM, 2011).

In the initial phase the needs of internal facility manager was set by means of the output specification and the needs of the (external) facility manager would be set after analyzing this document. An important indicator of the determination of facility managers needs would be done by means of weekly meetings in this phase. These weekly meetings would involve the development team and the facility manager, leading to intense cooperation and a better determination of the needs of various parties. As facility management was involved in the whole project these meetings would continue in all phases of the project (Interview FM, 2011).

In the design phase the needs of the facility manager and other stakeholders were determined by means of dialogue sessions. One dialogue sessions would take place during the sketch design phase and one would take place after the preliminary design phase. The dialogue sessions would take approximately three weeks each and gave space for compromises and discussions between developer and facility manager, the client was also present during these dialogue sessions. As the dialogue sessions were held in order to discuss various items it also created room for discussion with the client. These dialogue sessions would intensify the relation between developer and facility manager as they would have constant discussions in a period of three weeks (Interview client, 2011).

In the realization phase the needs of the facility manager were largely determined in the previous phases, creating an advisory role for them in the realization phase. This would mean that the relation between developer and facility manager was based on a more advisory approach among both parties, as the developer leaded the project and the facility manager was sub-contractor. It was important for the facility manager to provide the right advice due to liability issues, as advice which would lead to inefficiencies would lead to their financial liability. Facility management was subcontractor as they were no shareholder in the DUOBV. However their position of subcontractor would not prevent their presence in the project, as they were present in all stages. But it is noticeable that they did not have a leading responsibility in the realization phase (Interview FM, 2011).

In the usage phase, the intensity of the cooperation between developer and facility manager would be noticeable by means of FMIS. Both stakeholders had access to this digital tool. The tool also enabled facility management to show their needs as the digital tool generated data on performances of both hard and soft FM issues.

The fact that the Dutch '*polderen'* was used among the stakeholders also showed the intensive cooperation between the various stakeholders. This would be the case in the meeting and dialogue sessions, as the opinion of all parties would be taken into account by the developer, leading to an integral process (Interview internal FM, 2011).

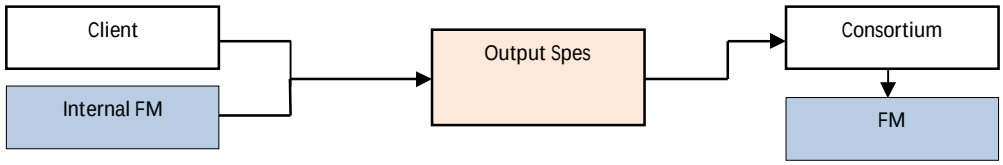


Figure 55- Internal and external FM link to the OS

When looking at the research question it is noticeable that there was intense interaction between facility management and developer in order to gain the value knowledge. The facility manager was present in all stages of the project. Value knowledge was gained through intense meetings and dialogue sessions. The facility manager however, was sub-contractor and no shareholder in the consortium, this could have a relation with their less intense role in the realization phase. The fact that both developer and facility manager would lead the exploitation by means of soft and hard services in the realization phase does however create the urge of the developer to generate value knowledge of facility management, as it is in their best interest to provide a building which is efficiently maintainable by this stakeholder. This is important as they do work according to a specific maintenance budget and therefore do not want to create more costs in the usage phase. The illustration underneath shows the main findings of this chapter by emphasizing on the exploitation objective.

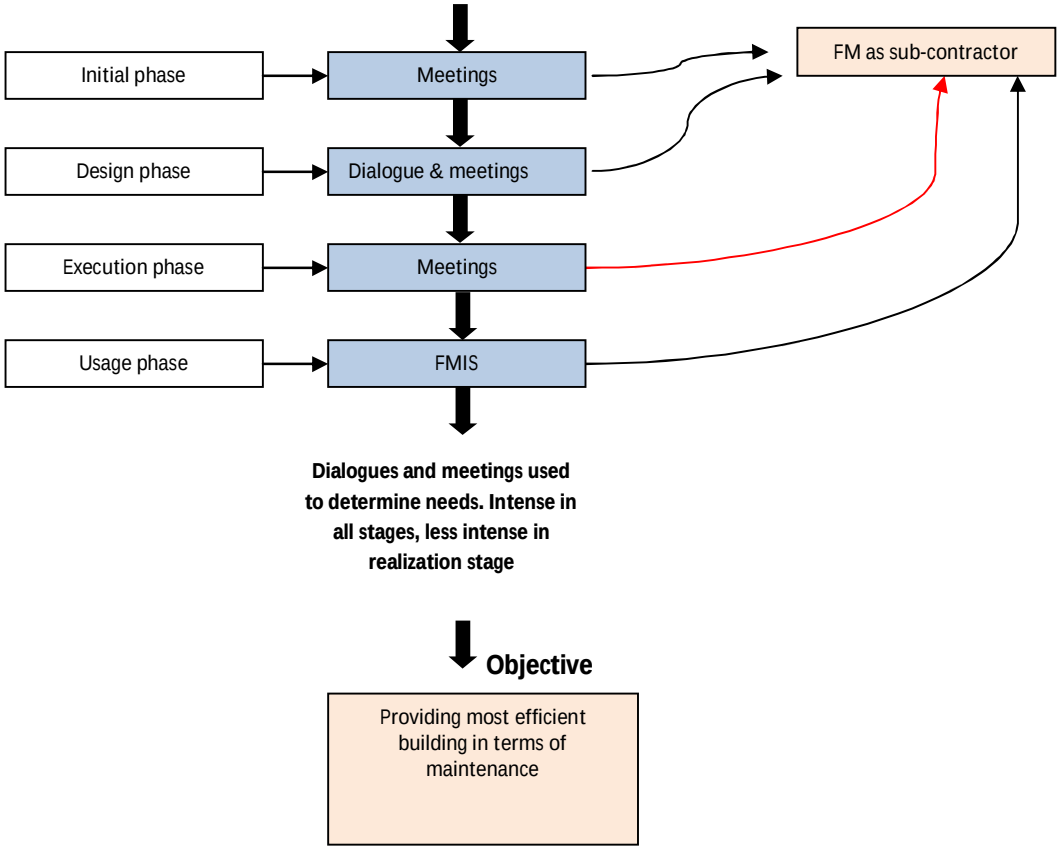


Figure 56- Concluding findings value case 1

9.2 Determining the value stream

"What are the roles and responsibilities of the facility manager and the developer in the real estate project cycle and which processes between these two stakeholders create value and which do not create value?"

When looking at the roles and responsibilities of both stakeholders, it can be said that the facility manager had the role of subcontractor in all stages of the real estate project cycle. The project consisted out of DUOBV, which were the shareholders and DUOVOF, which were the stakeholders and the development team. In the BV, all parties had a share in the project and in the VOF tasks were divided and agreements were made, all parties were 100% liable. As the facility manager was no shareholder, they would only be present in the VOF as sub-contractor. This due to the fact that they did not own shares in the project but were hired as external party for facility management (Interview developer, 2011).

The facility manager would be present in all stages of the project cycle and would focus on soft FM issues such as the creation of a layout plan and the determination of logistical aspects. This was needed as these aspects lied in the core of their competency and were one of their most important aspects. As facility management was part of the exploitation team, it was their responsibility to prepare the building in such a way that exploitation would be integrated in the pre-usage stage in order to have a building which would be efficiently maintainable by the building user. The facility manager was also present in meetings with all departments, including technical departments, resulting into discussion on organizational, technical and building security measures. As mentioned in the previous case, their technical input would be limited in these meetings as they are service oriented, however organizational aspects in relation to security would be more of their interest (Interview FM, 2011).

In the initial phase the internal facility manager would be focusing on creating the output specification together with the client; this would be analyzed by the (external) facility manager after completion. This means that the first important aspect for facility management in the initial phase would be the analyses of this document in order to determine their reaction in respect to their needs. In this project, the output specification was also made on abstract level, leading to more discussion with the client and consortium on the steps to be taken. This phase would also be the start of the set up on issues concerning the layout plan and the determination of logistical aspects (Interview internal FM, 2011). An important requirement of facility management was that they would provide market comfort by means of providing up to date data on logistical issues and thus following the trend in the market, leading to a user friendly logistical layout (Interview developer, 2011).

In the design phase the facility manager would be participating on the sketch design, preliminary design and final design. This would mean that they had a great input in all stages of the design phase, leading to a high contribution level in terms of decision making in relation to the facility management discipline. This would enable facility management to integrate their logistical plan into detail in this stage. It is interesting to see that their role as sub-contractor would not negatively affect their presence at the design phase (Interview client, 2011).

In the execution phase, the role of facility management would be mere an advisory role on detailing aspects. They would not have a leading role on physical building aspect, but their role was limited. They would be present in weekly meetings at this stage and would give their advice. Advice could not be given on structural aspects, as no structural adoptions were allowed to be made. It is important to

notice that wrong advice in this and the previous stage would lead to financial consequences for the facility manager, therefore all advice needed to be carefully thought trough (Interview FM,2011).

In the usage phase facility management would be responsible for the exploitation of soft services for a period of 20 years. In this usage stage the facility manager would also be responsible for cleaning, internal planting, the coffee machines and the press container, the normal operational issues which belongs to the traditional work core of facility management. It is important to notice that the transition from execution till usage phase went well as exploitation was part of the pre-usage phase and thus combing exploitation and design. In the usage phase the FMIS tool would also be important, as data could be gathered by both facility manager and developer on building soft and hard FM issues (Interview internal FM, 2011).

The developer in this project can be seen as DUOVOF, which was a team of various departments of one organization. This meant that one organization would be in charge of the development issues, leading to less demarcation and less inflexibility in terms of contractual issues in respect to the development team. The organization representing the developer was also key shareholder of the project and would therefore also lead DUOBV (Interview developer, 2011).

In the initial phase it would be the developers' responsibility to react on the output specification in terms of analyses and planning the global design aspects in relation to the output specification, as it needed to match the demands of the client. This would result into an integral approach by the developer and the stakeholders such as facility management, as the output specification showed the integral demands of the client (Interview developer, 2011).

In the design phase the developer would have the lead on all steps in the design. They would be in charge of hiring an architect as sub-contractor and on detailing the design together with the architect and the other stakeholders. The developer would therefore intensively cooperate with these parties and would be responsible for a good and efficient design with an important focus on the building lifecycle and thus integrating exploitation in the design. The developer would also be responsible of the building's interior (Interview developer, 2011).

In the realization phase the developer would be responsible to translate the design in a physical building, as they were also contractor of the project. Their focus would also be on detailing aspects, this was needed as it involved a highly complex project due to the integral approach (Interview internal FM, 2011).

In the last stage, the usage stage, the developer would be responsible for hard FM issues for a 20 year period. This due to the fact that usage of DMFMO was made, making the developer responsible for exploitation. Their responsibility would also mean cooperating with the facility management organization, as they both need to efficiently maintain the building. In this stage the developer would also make use of FMIS in order to gather data relevant on hard FM issues (Interview developer, 2011).

The client was responsible for creating the output specification which would be tendered to various parties. After the tender stage, the client would not have a leading role, but an advisory role, meaning that they were only allowed to give advice. It was not necessary for the developer to follow this advice, but it did occur that the developer consulted the client in order to create a building according to the client's wishes in detailed aspect (Interview client, 2011).

Processes creating value

The fact that the layout and logistical plan was made in cooperation between developer and facility manager can be seen as a value creating process. The facility manager had integrated his experience in a pre-usage stage leading to the creation of a building according to the user standards and thus it had a positive effect on the building in terms of exploitation and usage. The dialogue sessions and the weekly meetings can also be seen as value adding as they contributed to the efficient flow of information between developer and facility manager, leading to agreements and an integral approach towards the project (Interview client, 2011). The integration of facility management and development has led to the creation of the usage of internal steal walls, which can be replaced by means of magnets. This is an example of the effectiveness of the integral approach (Interview client, 2011). This integration has also led to the detailing of the building toilets, leading to easy maintenance in the future for the exploitation company.

The contract used in this project can also be seen of high value as it led to the lifecycle focus of the building. By giving the maintenance responsibility to the developer, the developer is forced to look at the whole lifecycle of the building and not only delivering the building. This long term focus creates an emphasis on the exploitation and thus on facility management, leading to intense cooperation between the two stakeholders (Interview developer, 2011).

The lifecycle focus has also led to an interesting development, namely the fact that the developer has looked to the period after 20 years. By looking at the long term, the building is made adaptable as it can be easily adapted into dwellings after the exploitation period, meaning that the property will have a function after its lifespan, this can be seen as the best example of a lifecycle focus and of thinking beyond the current project but also to future projects, making it more attractive for future investors (Interview client, 2011).

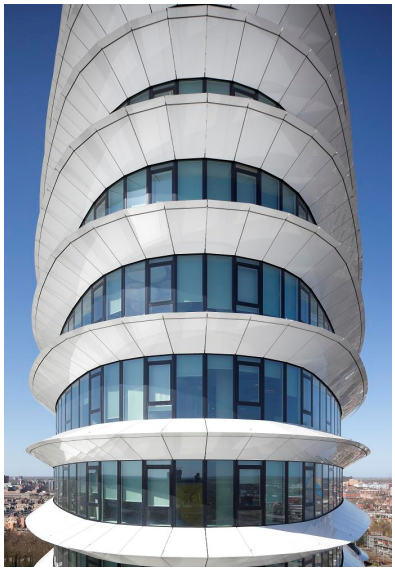


Figure 57- Building facade (Kempkensberg,2011:online)

The usage of the digital systems can also be seen as a highly value adding, especially when looking at FMIS. This system has enabled both facility manager and developer to gather soft and hard FM data and to react on critical aspects quickly and thus improving processes continuously. Another interesting tool is the usage of BIM in this project. BIM however has only been used by the architect, but it enabled the developer to prevent constructional mistakes from happening in the execution phase (Interview developer, 2011).

The fact that only one organization formed the development team can also be seen as an important aspect adding value. This has to do with the fact that less demarcation is created when dealing with one organization. In one organization consisting out of various departments it is easier to work integral, as work processes within organizations are uniform and the information flow within this organization will reach all departments relatively early (Interview developer, 2011).Usage of various control mechanism in the realization phase made sure that the end product would fulfill users demand and would also result into more control for the exploitation criteria, which is important for facility management; this can also be seen as value adding. The use of this control mechanism would also relieve the developer from stress, as the delivery would be more realizable. When looking at the application of FMIS in the usage phase, this can be seen as important tool as communication

between developer and facility manager would be optimized and thus creates value (Interview developer, 2011).

Processes not creating value

When looking at the communication between facility management and the technical department, it can be said that this is a non-value creating process. Here the lack of competency and the large difference in tasks of both parties create such a barrier that this can be seen as a non-value creating process (Interview FM, 2011).In order to graphically display the most important value stream aspects, a value stream map is made for this case showing the most interesting points. The current value stream map can be seen underneath. The blue boxes show the value adding activities and the single red box shows the non-value adding activity. The value stream map shows that the projects integral approach created a large range of value adding processes in relation to the developer and facility manager.

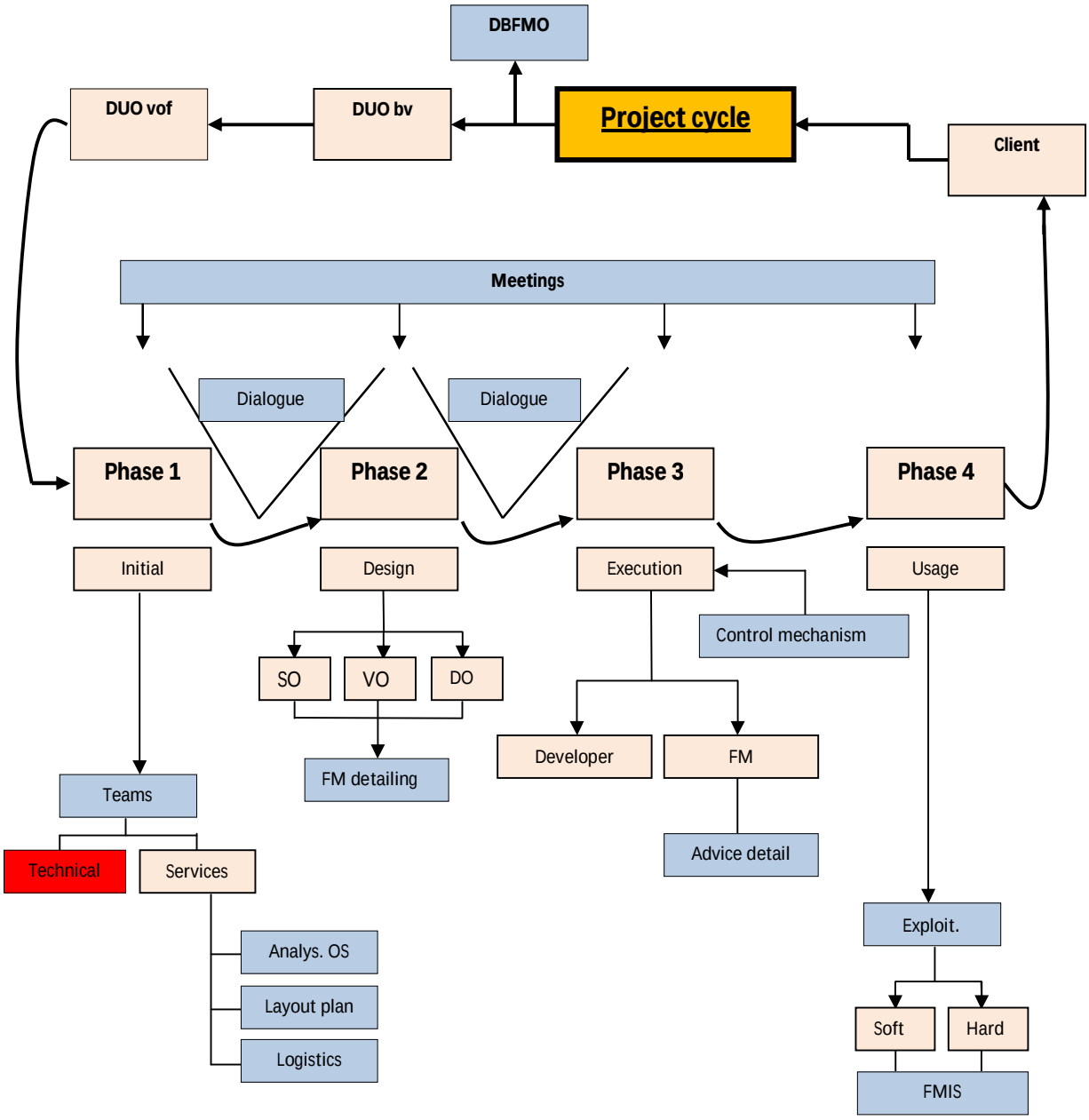


Figure 58- Current value stream map case 2

When looking at the research question it is noticeable that there are a lot of similarities between this project and the project discussed earlier. The facility manager had great responsibilities and was involved in all stages of the project; they however were no shareholder but completed their tasks as sub-contractor. The lifecycle focus has also played an important role in this project. By making the developer responsible for the building exploitation, the emphasis on integration with facility management increases, which was noticeable in this project. Also the fact that one organization represented the developer has had great influence on this project, as less demarcation was visible and a better integral approach could be set between the various departments of the development organization and the facility manager. Overall it can be said that the combination of exploitation and design has been established by means of the projects lifecycle focus and has influenced the project on a positive way. The illustration underneath summarizes these important findings.

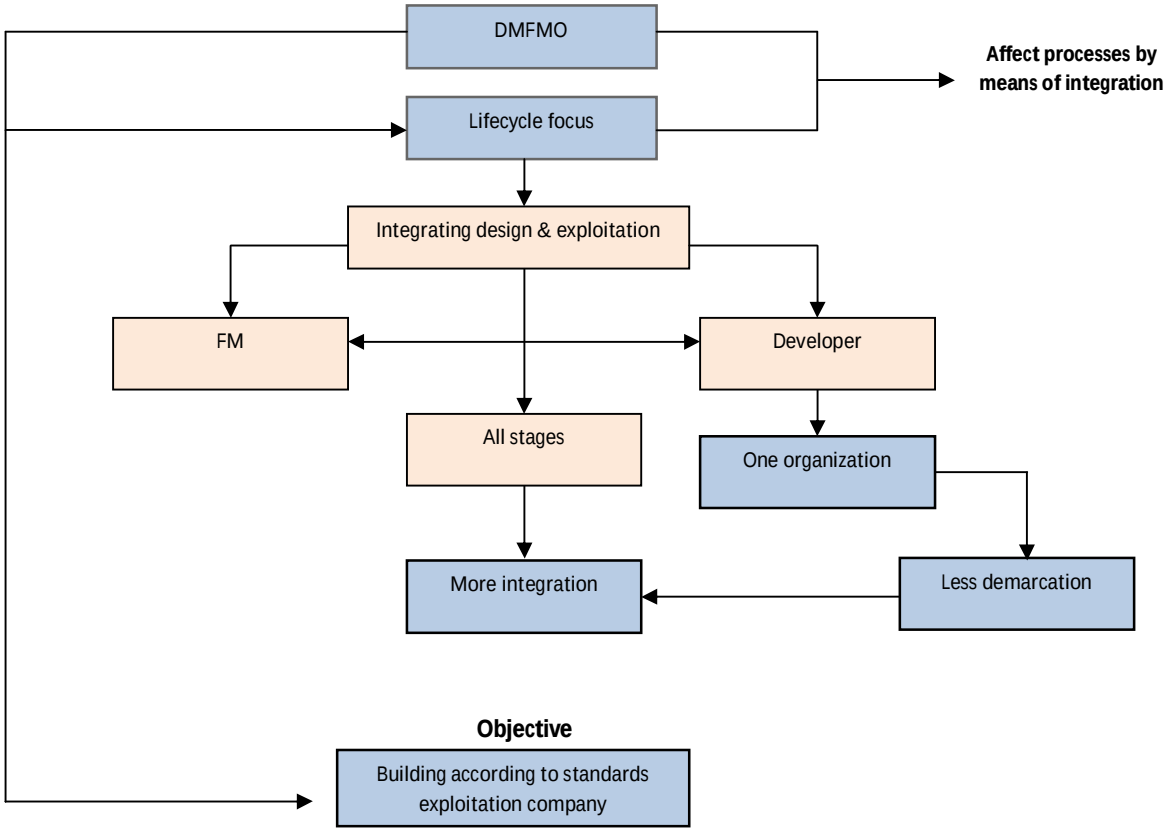


Figure 59- Concluding findings value stream case 2

9.3 Determining flow

"Which work practices between the developer and facility manager can be rethought and which barriers need to be eliminated in order to create continuous flow?"

When looking at the barriers a first notice point can be seen as the communication line with the technical department. Communication between facility management and technical department was needed in order to agree on organizational safety issues; however the presence of facility management in technical aspects did form a barrier due to their lack of knowledge and inexperience in technical building aspects. This means that the communication lines were not optimal and did create a barrier in the process flow.

When looking at the output specification, the client emphasized on the abstract character of the document in order to give the developer creative freedom in relation to the design of the building. The abstract level however, also created more time on translating these wishes into a product. This time consumption of constant negotiating in form of meetings and the dialogue sessions can be seen as a barrier (Interview FM, 2011).

In this project there was no demarcation as the development team existed out of one organization. However, as there were sub-contractors involved in the project in relation to the complexity level, contracts did play an important issue as parties did stick to their contract, creating inflexibility. As the project was complex, it would be important for parties to be flexible in relation to certain tasks, however parties did quickly refer to their contracts, creating a barrier (Interview developer, 2011).

As the project did not involve a renovation but a completely new construction, the complexity level was high, making it more difficult for the various shareholders and stakeholders to budget the project. This also meant a more complex approach for both the developer and the facility manager and a more integral focus (Interview developer, 2011). The difficulties due to this integral approach also resulted into internal walls which had great adaptable possibilities, but did not match the required acoustic levels, meaning that integration was difficult to achieve. When looking at the initial phase, where the output specification was made, a relatively long period of time was needed (approximately one year); this could be caused by the inexperience in such projects by the client and its members (internal FM), leading to the delay (Interview client, 2011). When looking at the experience of facility management in the pre-usage phase, it can be seen as rather limited, due to the fact that facility management is traditionally active in the usage phase (Interview client, 2011). As facility management needs to gain experience in making decisions in the relatively new field of decision making in the pre usage stage, mistakes can be made leading to various consequences. An example can be seen by looking at the rubber floor used in the building. The whole team decided on using this floor, however after implementation the floor turned out to be difficult to maintain (Interview internal FM).

Figure 60- Rubber Floor in the DUO building

When analyzing the most interesting barriers from this case, an important aspect could be seen as the continuity barrier, in terms of different people in different periods of time. During the various phases of the project, especially from the design phase till the realization phase, a great deal of people were not involved in the project any longer. This meant that people from the development team, who had gathered essential information in the design and initial phase, were not present in the execution phase, creating a continuity barrier and creating loss of important knowledge (Interview client, 2011).

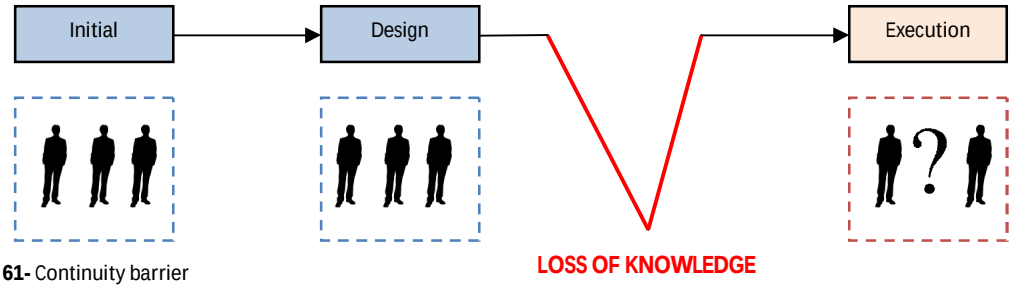


Figure 61- Continuity barrier

In building projects, esthetics always plays a large role and it is often difficult to find the right balance between esthetics and functionality in such integral projects. This can have various consequences, which can be seen in the building by looking at the façade. The illustration shows the façade and should be easily maintainable when looking at the illustration. However, it has proven to be difficult to maintain, leading to high maintenance cost for the windows (Interview internal FM, 2011). This does show that in the design phase, the choice has been made for esthetics meaning that functionality has not been fully integrated.

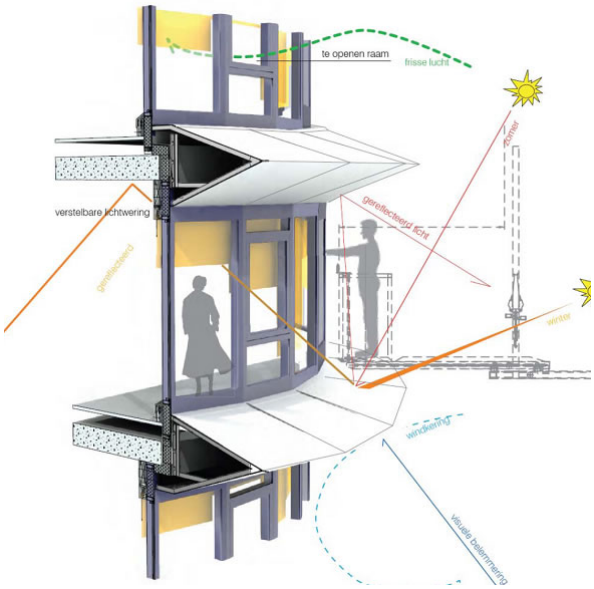


Figure 62- Building facade (Kempkensberg,2011: online)

When looking at external aspects impacting the work process, the weather has played an important role in this case. Due to two frost periods, the builders were unable to build, causing time pressure in the realization phase. This can be seen as a barrier stopping the whole process and disabling the development team, including the facility manager to continue working (Interview internal FM, 2011).

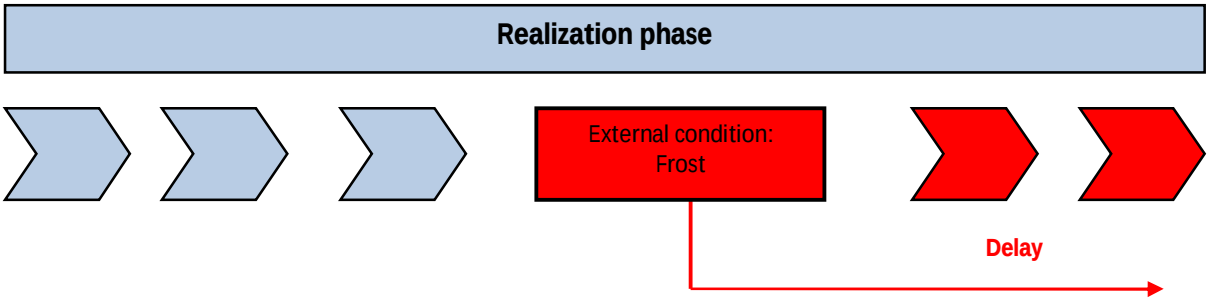


Figure 63- External conditions causing delay

When looking at the research question it can be said that the experience of facility management in the pre-usage phase did had an effect on various processes and thus did create barriers, especially on the decision making processes. Another important aspect was the fact that esthetics did have an important role, which is the case in most projects. However, esthetics should not dominate functionality aspects; this did happen when looking at the facade. Both aspects did have an influence in relation to the barriers and therefore are important aspects to be dealt with in order to establish continuous flow. The illustration underneath summarizes important findings of this paragraph.

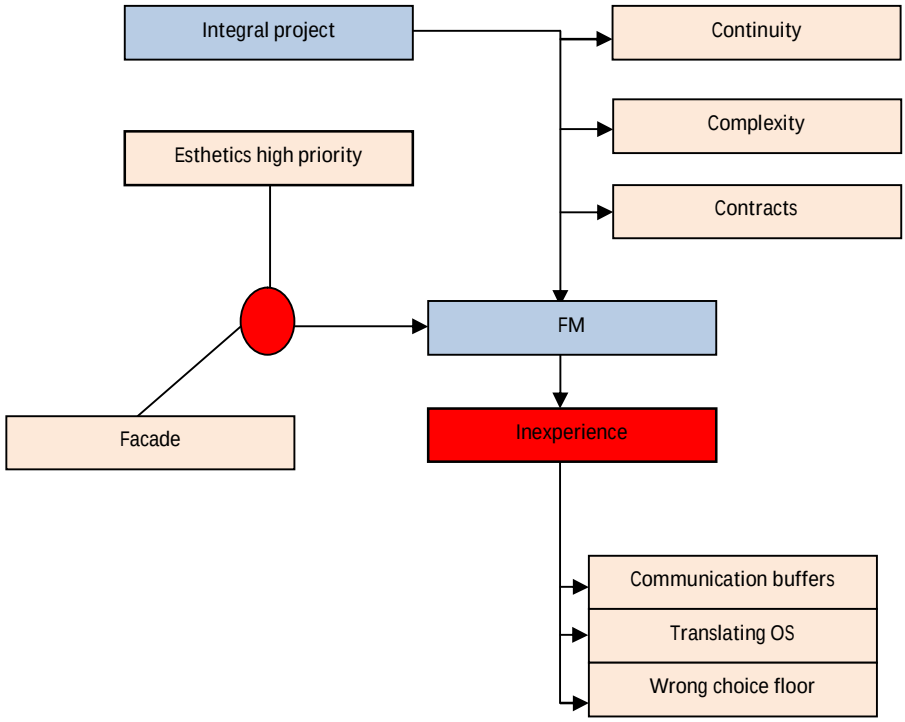


Figure 64- Concluding findings flow case 2

9.4 Determining pull

"What are the facility manager's influences on the schedule and in what way can the process between the facility manager and developer be made fully pull, leading to pull planning?"

When looking at the planning aspect, the planning schedule was set by the head of the contractor in the realization phase. This meant that they were in charge of the planning and determined the deadlines (Interview developer, 2011). It was the development team which needed to agree to the planning and they had to make agreements with the contractor, including facility management, in relation to various planning aspects. Internal facility management was not involved in the planning schedule at all (Interview internal FM, 2011).

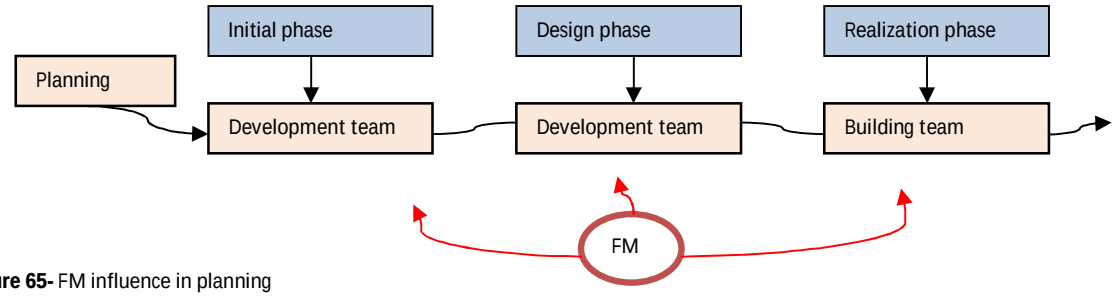


Figure 65- FM influence in planning

In the planning process all parties including facility management, needed to agree with the various planning aspects. If they agreed on meeting a certain deadline, this was signed in the planning form. However, some aspects were not agreed on due to certain aspects, these were than compromised with the contractor (Interview developer, 2011). In these forms all risks were assessed by the stakeholders; this was done with plusses and minuses.

An example of a planning adjustment in relation to facility management was the implementation of a roll container in the design phase. This was agreed upon, however in a later stage both parties discovered that such a container would be too small and would lead to high frequency cleaning periods and thus high maintenance costs. As this problem needed to be solved, the developer decided to increase the building volume and implement a press container. This would mean an adjustment in the planning schedule but was compromised on as both developer and facility manager would gain most efficiency (Interview developer, 2011). An important aspect which can show the limitation of facility management in planning and thus in pull planning can do with the limited experience and lack of knowledge of them in the pre usage phase. As they have no experience on decision making in these situations, it is also difficult for them to be involved in the planning process. It however must not be forgotten that all parties, including facility management are responsible for delays and thus will get fines in such situations. It is therefore important that they do represent itself strongly in the planning procedure in order to work more efficient and to integrate pull planning.

When looking at the research question, it is obvious that facility management did not have a leading role in the planning schedule, as they (as well as the development team) needed to make agreements on the deadlines given by the head of the development team and the contractor. They however did have the possibility to asses certain risks related to the planning procedure, creating input from the facility management side. This aspect is important to evaluate as there are possibilities to adjust this planning procedure and to make it lean by implementing pull planning headed by them.

9.5 Determining perfection

"How could continuous improvement be established and what does this mean for the relation between developer and facility manager? "

When looking at the involvement of facility management and internal facility management in this project, it can be said that they were involved relatively early. For the facility manager, they were also involved earlier in the design stage, leading to a better integration of facility management in the design compared to the renovation of the ministry of finance. Due to their previous experience they have gained more insight on such aspects, leading to improvements in later projects such as this specific project (Interview FM, 2011). A statement from one of the stakeholders shows the lessons learned from previous projects, leading to better integration:

"At the DUO project we were involved earlier in the preliminary design phase compared to the renovation project, this was a success, however there is always room for improvement" (Interview FM, 2011)

In order to draw lessons from this project, the stakeholders of the project had project evaluations in order to analyze the successes and failures of the project. One can say that it is difficult to apply previous experience into new project as each project is unique (Interview FM, 2011). And other parties can say that there are a lot of parallels which can be applied into new projects (Interview client, 2011). It has to be said that each project contains valuable information and should therefore always be analyzed by the involved stakeholders. However, when looking at possible new projects from this scale, it is a fact that the building world is facing difficult times, making it likely that such projects will not be realized in a short period of time, meaning that these experiences cannot be used unless new projects arise (Interview internal FM, 2011). However educational perspectives for the stakeholders do form an option.

When looking at digital systems, they have been important in this project as they contribute greatly to the improvement aspect of processes. The FMIS system has been of great use and is currently used in the exploitation phase by the various parties, leaded by the facility manager and the developer responsible for exploitation. The FMIS system enables the exploitation team to analyze performance failures in terms of maintenance aspects and thus generates important data on where to apply improvements (Internal FM, 2011).

When looking at the client, they have decided to make use of BIM in future projects in order to prevent building structural failures in the realization phase. In this specific project usage of BIM has been made by the architect, meaning that the first step towards complete digitalization has been set. By focusing on BIM and possible finding a link between BIM and FMIS, future improvements can be established, leading for benefits for the user and project stakeholders (Interview FM, 2011).

When looking at the research question, it can be said that improvement can be established by means of using previous experience and nowadays by means of digital systems in the field of development and facility management. As it is important to learn from experience, evaluations have and will take place among stakeholders of this project. The integral approach and the innovative digital systems create a closer relation between developer and facility management; this will likely be seen more in the future. The illustration on the next page graphically shows the main conclusions of this paragraph.

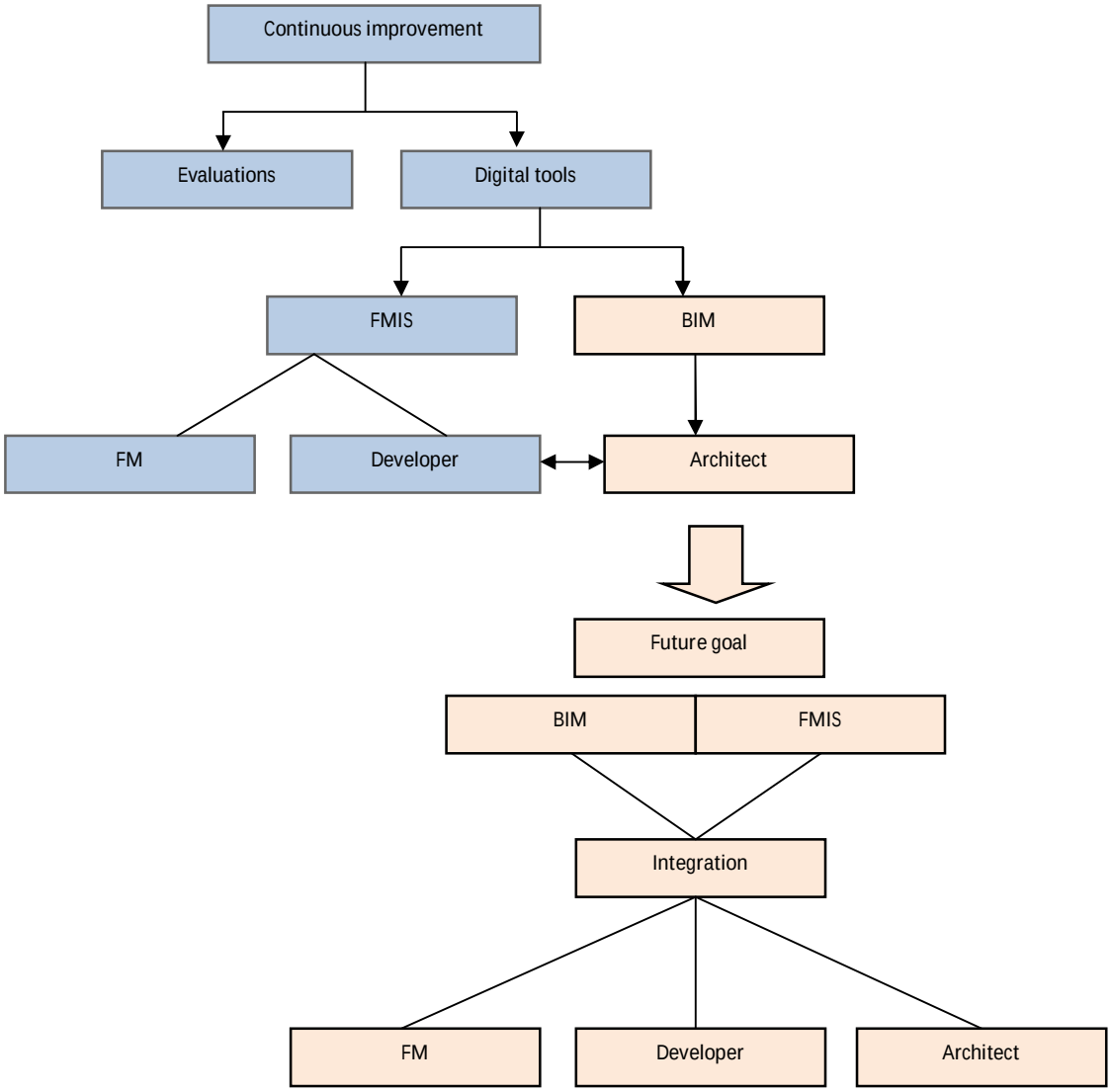


Figure 66- Concluding findings perfection case 2

Conclusion

When concluding this chapter the table on the next page can be used as it summarized the main findings. When looking at the value principle; it can be said that the cooperation between developer and facility manager was intensive. It was obvious that the emphasis on gaining value knowledge was conducted by means of weekly meetings and dialogue sessions. The cooperation between both developer and facility manager was intense. When looking at the value stream principle, it became clear that the communication lines between facility management and the technical department were non-value adding. It was also noticeable that the development organization existed out of one organization, preventing demarcation. An interesting aspect when looking at the flow principle was the lack of continuity in the project. This caused a great deal of important knowledge to be lost and is a point which needs to be reviewed in future projects. The fact that esthetics played such an important role in this project cannot be seen as a surprise, however the fact that this intervened with functional requirements can be seen as an important barrier. When looking at the pull aspect, it has become clear that facility management did not have a real input here, disabling them from implementing pull planning. The perfection aspect showed the great emphasis put on digital tools and showed a clear improvement when comparing this project with the renovation project in the first case.

Table 4- Descriptive model case **2**

VALUE	VALUE STREAM	FLOW	PULL	PERFECTION
Weekly meetings between developer and facility manager	FM would be in charge of soft FM in the exploitation phase	The communication FM and technical department is a barrier	No influence FM in the planning process	Project evaluations among stakeholders have been set
Dialogue sessions in form of formal meetings	FM would mainly deal with the layout plan and logistics	The abstract level of the output specification did form a barrier	FM had no planning experience	The FMIS in realization phase enabled improvements
The usage of FMIS in the usage phase shows FM needs	The developer would be responsible for hard FM	The contracts used led to inflexibility among stakeholders	FM had no competency in pre usage planning	The usage of BIM was made by the architect
The output specification would show the customer value	The developer and FM would have a long term focus adding value	The inexperience of FM in the pre usage stage formed a barrier		The project provided enough parallels to be used in future projects
Realization phase: FM has an advisory role	The DBFMO contract would be of great added value	The high complexity level of the project can be seen as a barrier		FM was involved earlier in the design phase due to experience
FM would be active in all stages, leading to intense cooperation	The FMIS would be a great added value	The continuity barrier led to loss of information		
FM would also participate in all departments	The dialogue sessions provide great added value	Esthetics had higher priority than functionality in some cs		
FM was sub-contractor	The developer consisted out of one organization, no demarcation	External conditions did form a barrier (weather)		
FM and developer would be in charge of exploitation 20 yrs	FM in the technical department would not add value			

Key findings	*Key findings*	*Key findings*	*Key findings*	*Key findings*
The intense cooperation between FM and developer has led to a strong value determination.	The long term focus is of great value and the fact that the developer exists out of one organization prevents demarcation. However the FM presence in the technical teams do not create value and should be eliminated	When looking at the continuity barrier, this had led to a great loss of important information. Also the inexperience of FM in the pre usage phase effected the project	In terms of pull, the case showed that FM did not have any responsibility in terms of planning, leading to no pull planning	The perfection measures are influenced by digital tools. Both FMIS and BIM have been used, preventing important problems. FM has made use of previous experience leading to their early role in the design phase

10 Chapter ten
Cross case analysis

Figure X – Looking through multiple lenses

"Think as you work, for in the final analysis, your worth to your company comes not only in solving problems, but also in anticipating them"
- Tom Lehrer

Introduction

As the previous two chapters involved a within case analyses of both cases, this chapter will review and analyze both cases by means of a cross case analysis. The cross case analysis will be conducted by means of analyzing the main outcomes of both cases according to the lean principles. In the first paragraph the outcomes in relation to the value principles will be handled. In the second chapter a look will be given to the value stream principles and the main conclusions of both cases will be compared and discussed. The third paragraph will deal with the flow principle and will look at the barriers compared from both cases. The fourth paragraph will handle the pull principle, followed by the perfection principle. In order to provide a clear understanding of the cross case analyses, an analytical cross case model will be used on page 123 to display the main findings.

This chapter will be followed by the last part of this report, namely the conclusions and recommendations. Here the main conclusions will be handled and recommendations based on the case researches will be given.

10.1 Value

When looking at the analytical cross case model on page 123 It is clear that in terms of intensity, that facility management in the construction of DUO is less present in the realization phase. This becomes clear as the facility manager had a leading role in the execution phase, whereas the facility manager in the DUO project had a limited responsibility in the form of an advisory role. When looking at the relation between responsibility and role, it is clear that the facility manager in the ministry of finance case was shareholder of the project. In the DUO case however, the facility manager would be subcontractor. This would not affect the presence of facility management in the project, but could be linked with their smaller role in the execution phase; this can be seen in the illustration underneath.

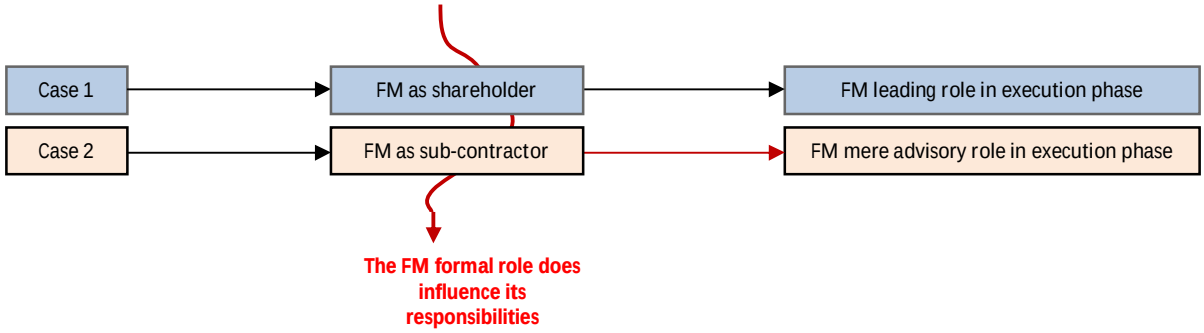


Figure 67- Reviewing the differences of the value principle of both cases

When looking at the similarities between both projects, it is obvious that the frequent interaction between developer and facility manager did occur in both cases. Interaction would occur by means of weekly meetings and dialogue sessions, showing the intensity of the cooperation. An important aspect for the developer to gain value information in both projects can be seen as the fact that exploitation would be the responsibility of the developer. As the facility management firm in both projects would also be an important part of the exploitation (soft FM), it would be of best interest for the developer to intensify the cooperation with facility management. The cooperation thus led to integral work processes between developer and facility management by means of the mentioned frequent interaction.

When a developer leads the exploitation in the usage phase for a long period it is of importance that the developer will create a building which leads to efficient maintenance in both hard and soft FM. This is important as the developer will be responsible for the maintenance costs and therefore has all priority to create a well maintainable building. In this respect the facility manager plays a great role as this party can provide the needed information to the developer in terms of exploitation by setting up the most efficient layout and logistical plans. Therefore intense cooperation between facility management and developer in an early stage is preferable for both parties.

From the above mentioned aspects, it can be concluded that frequent interaction between developer and facility manager by means of weekly meetings and dialogue sessions does provide the developer the needed value knowledge. Therefore it can be seen as an important step which has influenced both projects in terms of value determination positively. The fact that value knowledge is gained enables the developer to create an optimal building. By giving the facility manager the freedom to lead the creation of the kitchen and garden shown in the first case, the value aspect will reach its optimum, as the party representing the client is in full control.

As exploitation, integration and intensive cooperation are clearly linked to each other, they are displayed in the analytical model. The output created by these “variables” is the frequent interaction between both stakeholders.

10.2 Value stream

The analytical cross case model shows that the ministry of finance case dealt with demarcation, as the development team existed out of various organizations. This created a non-value adding aspect, creating problems in terms of integral working. The second case; DUO Groningen however, showed that the developer consisted out of one organization and thus did not deal with this non-value adding issue. This can be seen as an important difference when comparing the two cases in terms of the value stream. It can be said that there is a link with the number of organizations representing the developer and demarcation. Whereas the developer exists out of one organization, tasks can be done more integral as employees deal with their known organizational structure. When the development team is represented out of more organizations, the chances of dividing tasks among the organizations instead of integrating tasks increase. This is illustrated underneath.

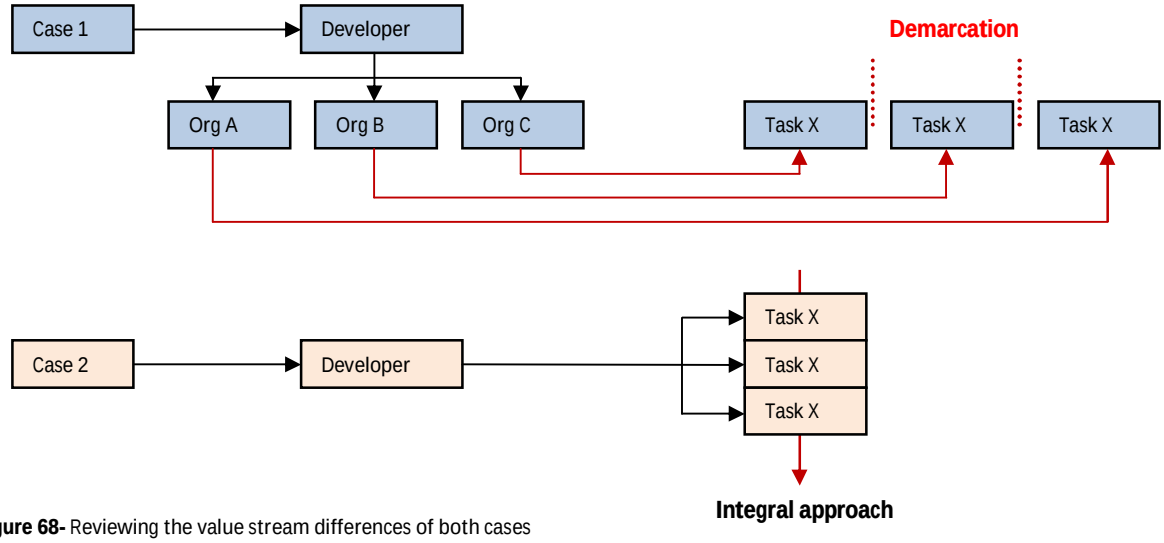


Figure 68- Reviewing the value stream differences of both cases

When looking at the similarities among both projects an essential aspect in creating the efficient value stream can be seen as the focus on the building lifecycle. Both projects had a strong lifecycle orientation. This would (again) emphasize the importance of integrating exploitation and design. And thus it can be said that both projects, in terms of value stream, link the buildings lifecycle focus with the importance of facility management. Therefore the lifecycle focus can be seen as an important added value aspect, leading to the involvement and thus responsibility of facility management in the pre usage phase. When looking at the tools used to enhance this lifecycle focus, the contract type used in both projects can be seen as great value adding aspects. By using the DBFMO contract, the developer has been forced to create an efficient building in terms of exploitation, as this party is responsible for the exploitation period. By making the developer responsible for this aspect, his interest in cooperating with facility management increases, as both parties priority lie in decreasing maintenance costs. This can be achieved by creating an efficient maintainable building in the pre usage stage, this enabling close cooperation between developer and facility manager.

When looking at the non-value adding aspect, a parallel between both cases can be found in terms of communication lines. It is noticeable that the presence of facility management in the technical departments does not add value, due to the different interests and the limited competencies of both parties. Where technical oriented organizations have a primarily technical interest, facility management has a service related interest. By placing the facility manager in communicational lines with the technical department, waste is generated as time and thus efficiency is lost. This parallel was noticeable in both projects.

10.3 Flow

When looking at the analytical cross case model the differences in the two cases can be seen as the demarcation barrier, as mentioned in the previous paragraph, and the continuity barrier. Where the ministry of finance project dealt with difficulties in terms of demarcation, the DUO case dealt with the loss of information in various phases of the project. This had to do with the fact that key people were not present in the various stages of the project cycle, leading to a continuity barrier. The continuity barrier can be seen as an important element, as important case information is lost when key figures are not part of the project any longer. This means that time is needed to regain that information by others, and in some cases it means that information is lost, leading to miscommunication and thus failures. It can therefore be said that the continuation of people in a project is linked with the gain or loss of knowledge valuable to a project. The illustration underneath illustrates this situation in the DUO Groningen case.

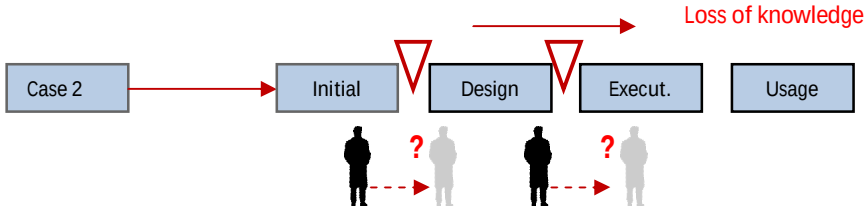


Figure 69- The continuity barrier in case 2

When looking at the parallels of both projects in terms of flow and thus barriers, these can be seen when looking at the experience of facility management. Due to the fact that facility management is a profession which is rarely involved in decision making in a pre-usage phase, it can be said that facility managers are inexperienced in the pre usage phase. This inexperience of facility management was noticeable in both projects and did have its consequences on both projects. An example could be seen when looking at the late presence of facility management in the preliminary design phase at the ministry of finance project. This led to functional failures in the design, which could not be revised due to their late presence. However the most important consequence of the inexperience of facility management in the pre usage phase is related to their decision making. As they do need to make important decisions in the pre usage phase, e.g. materialization, it does occur that their lack of knowledge leads to the wrong decision making. These aspects are important to be dealt with and are an important result of the cross case analysis. The inexperience of facility management in the pre usage phase can also be linked with communicational barriers. The fact that they were present in the technical department is an example of this aspect, showing their presence in the wrong department.

When looking at the contracts used in these complex projects, another barrier in terms of flexibility issues can be seen. As complex projects involve detailed and complex contracts, it creates a level of inflexibility. As this leads to stakeholders being rather passive, great problems can be encountered in such integral projects. The analytical model shows the following main aspects: Inexperience, communication, decisions and contracts. Here it is clear that they all are linked to each other due to the first point; inexperience, which can also be referred to as lack of competency.

Overall, it has to be said that the barriers encounter do slow down the process in projects, stopping the continuous flow line. Important aspects such as the continuity barrier and the inexperience of facility management in the pre usage phase do form a problem, but can be dealt with by taking the right measures.

10.4 Pull

When looking at the pull aspect on the analytical cross case model, it is obvious that there were no relevant differences between both projects in relation to the pull factor. An important reason for the fact that there were no differences here, deals with the fact that no use was made in relation to pull planning. When looking at the planning process in general at both projects, there was no clear input of the facility management organization.

An important link can be made when looking at the fact that facility management had no input concerning the planning aspect. The link can be made with experience that facility management has in the pre usage phase. This lack of experience between the cooperation of developers and facility managers creates a situation where facility managers have a lack of competency in pre usage planning. Here it is noticeable that the lack of experience leads to the lack of planning skills for the facility manager. This can be seen on the illustration underneath.

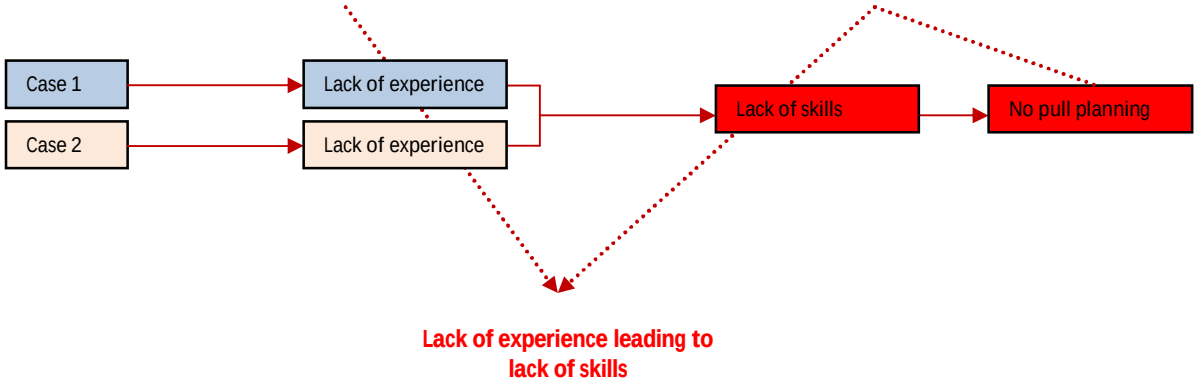


Figure 70- Experience barrier FM effecting pull

As the lack of experience on the part of facility manager influences both projects in relation to the limited planning input, it is important to acknowledge the fact that this is an issue. As pull planning helps integrating the client, in this case the facility manager, into the project by producing and creating on clients demands, it greatly adds to integrating developers and facility management's wishes. As inexperience on behalf of the facility manager disables this integration, it needs to be dealt with. It is not surprising that facility management has a lack of these skills, as the profession is used to operate in the usage phase of the building project. However in order to be active and to apply pull planning, this should be taken care of by means of educational purposes.

As the model shows, there is a clear link between the experience and lack of competency of facility management in the planning process of projects. As both cases did not deal with pull planning, rather limited information could be generated on pull planning between developer and facility management. It was however interesting to see that there was no space given to facility management in relation to planning. As both developer and facility management can benefit of integrating facility management in the planning process, it is important that both stakeholders realize this issue and try to adapt it in future projects.

10.5 Perfection

When looking at the analytical model of the last principle, it is noticeable that the differences between both projects in terms of perfection were limited. The differences which were found can be seen when looking at the digital tools; BIM. In the ministry of finance case, no use of BIM was made; there were however aims to use this tool in future projects. In the DUO case however, usage of BIM was made by the architect. The usage in this second case was limited, as only the architect made use of the tool, but it did proof important as mistakes were found and prevented.

Digital tools do proof to be important in such projects. In order to enhance facility management in the usage phase, usage has been made of FMIS (Facility Management Information System) in both cases. As this tool generates critical information for both facility manager and developer in the usage phase, data can be generated on operational building failures, enabling both stakeholders to react fast on them. Both cases therefore show the interesting possibilities and influences that digital tools have on such projects. They also form a step towards more integration in terms of digitalization. An interesting approach would be to take a close look on integrating BIM with FIMIS, such as the figure underneath shows.

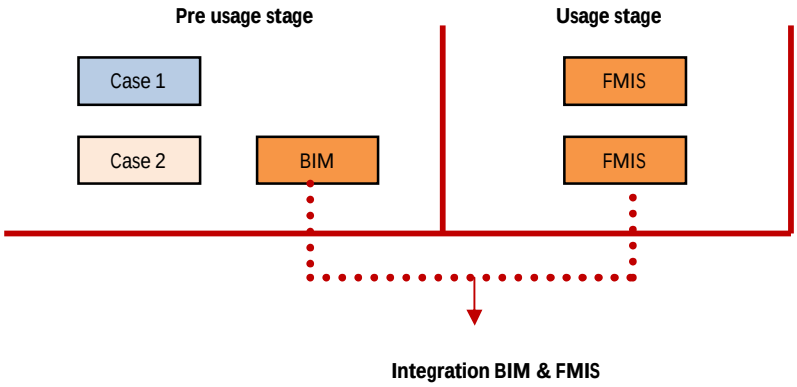


Figure 71- Integrating BIM and FMIS

When looking at the other aspects noticeable in both cases in terms of perfection, it can be said that use of evaluation meetings has taken place. These evaluation meetings give all stakeholders involved in the project the chance to discuss aspects which can improve, resulting into feedback sessions among the members. However it has to be seen whether these feedback sessions are successful, this can be done by looking at future projects of these consortia's.

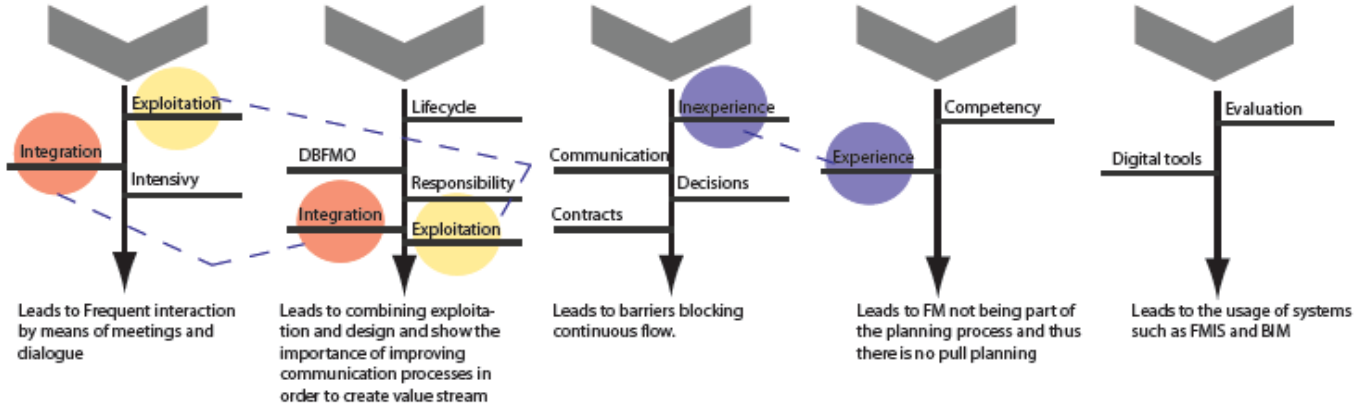
When looking at the analytical model on the next page, it is noticeable that the various principles do display links. The keywords can be seen as: exploitation, integration and experience. As these elements are broad and do effect the various lean principles, they need to be given attention, as they play an important role in handling the research questions. Therefore they are highlighted and will be discussed further on.

Analytical cross case model

Table 5-Analytical cross case model

Analytical

	Value	Value Stream	Flow	Pull	Perfection
Differences	The intensity of cooperation is in the second case less in the realisation phase, this could do with the fact that FM was sub contractor and not shareholder	Demarcation in the first case was present due to the various number of parties representing the development team. This would not enhance the integration. In the second case there was no demarcation as the development team existed out of one organisation, leading to better integral work processes	The main barrier in the first case was demarcation leading to the division of tasks, in the second case there was a barrier in the continuity leading to the loss of information. Also the fact that esthetics dominated, giving less priority to FM leading to the creation of the difficult maintainable facade		In the first case there was no usage made of BIM, in the second case BIM was actually used. BIM can be of significant importance for the developer and FM in order to establish improvement by preventing mistakes and/or by linking the system to FMIS
Similarities	Gathering value from FM is done according to frequent interaction by means of meetings and dialogue sessions.In both projects it is of high importance for the developer to integrate exploitation and thus intensivy their cooperation with FM as both parties want high efficiency in terms of exploitation due to the fact that they lead the exploitation in the usage phase	The roles and responsibilities were creatly influenced by the lifecycle focus, giving the FM party a great responsibility as design and exploitation would be integrated. The DBFMO contract used would enhance this focus. Issues in terms of the comminication line have to be looked at, as these do create non value adding processes.	The line of inepxerience of FM in the pre-usage stage can be seen as important barrier, influencing aspects such as the late presence of FM in certain design stages, communication, and specifically on their decision making aspects in terms of e.g. materialisation. Also the abstract level of the OS and parties sticking to their contract form barriers stolling the continuous flow	pull planning was not realised in both projects, leading to no responsibility of FM in the planning process. This could do with the lack of their competency on planning in the pre-usage stage. Also their limited experience creates a difficulty in establishing pull planning	Evaluation sessions have been established in both projects. Also the usage of digital tools such as FMIS generate critical information for both developer and FM as it provides data on hard and soft FM.



Conclusion

When concluding this chapter, it can be said that the data analyses has brought a great deal of information which will lead to the answering of the various research questions. It was important to put both cases next to each other by means of the cross case analyses, as this would generate information on the various similarities and differences of both projects. The value principle has showed the influence of the exploitation in the design which emphasized the importance of the facility managers needs in an initial phase. The value stream aspect showed the relation of a lifecycle focus and the responsibility of facility management and developer leading to integration of both disciplines. The flow aspect showed that the most important barrier is related with the inexperience and thus the competency of facility management in a pre-usage phase. The pull principle has showed again the lack of facility management competency in relation to planning in a pre-usage stage. The last lean principle: perfection has showed the great opportunities of digital tools such as FMIS, which could enhance perfection in the process between developer and facility manager.

Part 4

Conclusions

11 Chapter eleven
Conclusions & recommendations

Figure XI – The final piece of the puzzle

"Reasoning draws a conclusion, but does not make the conclusion certain, unless the mind discovers it by the path of experience"
- Roger Bacon

Introduction

The previous chapter gave insight on the most important results of the field research by means of a cross case analysis. This chapter will make use of those findings and will form conclusions on the handled data. First; all research questions which were set up initially in this report will be answered. This will start by answering the sub research questions first, followed by the main research question. After answering the research questions, hypotheses will be formed according to the Eisenhardt methodology. All lean principles will generate a hypothesis, formed from gathered theoretical and practical information. This will be followed by the recommendations paragraph, providing recommendations in relation to optimizing processes between developer and facility manager. In order to be specific on these recommendations illustrations will be used. The chapter will finish with reflecting on the initial problem statements in order to determine whether the problems (s) have been solved. Also recommendations on interesting future studies will be made in this chapter.

As handling the conclusion, this chapter will be followed by a brief reflection in terms of an epilogue, describing the research process from personal view.

11.1 Answering research questions

Main research question

How can Lean, when using its main principles in an early interaction, starting from the initial phase till the final phase of construction projects, between developer and facility manager, lead to an effective real estate project cycle and also result in an office building which fulfills the current demand of flexibility?

The above stated research question is the main research question. In order to answer this research question, the sub research questions need to be answered first, as they show how the lean principle can be used in the process between developer and facility manager.

Research question 1

"How are the facility managers' needs currently determined by the developer and how intense is the cooperation with the facility manager in order to gain the value knowledge?"

The first aspect towards implementing a lean framework is done by means of value and in this case by looking at the value determination of the facility manager by the project developer. It is essential that the needs of the facility manager are determined in order to optimize the cooperation between developer and facility management and therefore research has been done on the determination of value by the developer. The results showed that the facility manager's needs in the various stages of the real estate project cycle are determined by the developer through frequent interaction. Interaction by means of meetings and dialogue sessions. An important aspect which has led to intense cooperation between developer and facility manager was the fact that they both shared the common goal in terms of end product. They both aimed for the creation of a building fulfilling the exploitation criteria. This was important as both developer and facility manager would be responsible for the building exploitation, leading to their frequent interaction and the integration of facility management in the pre-usage stage. Overall, it can be said that the facility manager's needs are determined by means of frequent interaction in terms of meetings and dialogue sessions. Due to the common objective of both facility manager and developer (in terms of exploitation) the cooperation between these parties is intense.

When applying the value principle in a future project where facility management is involved in the pre-usage stage, it is important that the facility manager and developer both share the common objective in terms of the end product. As the objective is common and clear for these stakeholders, the developer will cooperate with the facility manager to gain the value knowledge of this stakeholder, leading to intense cooperation and resulting into an end product which fulfills the building user's standards. It is therefore essential that this first lean principle is well integrated as it is the needed step towards the second lean principle.

Research question 2

"What are the roles and responsibilities of the facility manager and the developer in the real estate project cycle and which processes between these two stakeholders create value and which do not create value?"

When looking at the roles and responsibilities of both stakeholders in the real estate project cycle, it is a fact that the developer performs his traditional role and is almost always leading the development team from initial phase till the execution phase, especially if the developer is also contractor of the project. It is interesting to see that there is a shift in their responsibility in DBFMO contractual projects, as they extend their responsibilities till the usage phase, making them the

leading party in terms of exploitation. This development is interesting and creates a great deal of links between developer and facility manager as they share the responsibility in terms of exploitation in the usage phase. When looking at the roles and responsibilities of the facility manager in the real estate project cycle it is noticeable that they, instead of their traditional role in just the usage phase, are present in all stages of the real estate project cycle in these DBFMO contracts which have been analyzed. The main responsibilities of facility management are to create layout and logistical plans in order to create optimal efficiency for the building users and for their exploitation needs in the usage phase. This also means that facility management is in some cases involved in the realization phase in a leading role. This gives them the opportunity to detail their actual needs in physical aspects and thus creating an even stronger link between facility management and project development. The building lifecycle focus emphasizes the importance of the cooperation between these stakeholders and gives space to the facility manager to conduct their tasks and increase their responsibility. The fact that a DBFMO contract is used in these integral projects can be seen as an added value process as they lead to integral work processes between the stakeholders and also to lifecycle focuses. As it also leads to the presence of developer in the usage stage in relation to exploitation which also creates added value for the cooperation between developer and facility manager. The usage of digital tools such as FMIS should also be considered, as these systems also encourage cooperation between developer and facility management and enable them to improve their work processes. It is however also important to keep non-value adding processes in mind, especially when looking at communication lines between facility management and technical parties, as it often occurs they these parties do not have the competencies to create added value during technical meetings and should therefore be eliminated.

By clarifying the roles and responsibilities of facility management and linking them to the building lifecycle by integrating them in all processes of the real estate project cycle, they are linked to project development. By integrating developers in the usage phase of buildings they are also encouraged to generate this lifecycle focus leading to a full integration between development and facility management. The work processes between these stakeholders can than turn into value adding processes such as the integral work approaches. By eliminating non added value work processes, especially in terms of communication lines which are not needed, a value stream can be established and the second lean principle can be implemented. After this stage it is important to look at the possible barriers in order to establish continuous flow.

Research question 3

"Which work practices between the developer and facility manager can be rethought and which barriers need to be eliminated in order to create continuous flow?"

The third lean principle is flow and looks at establishing flow by eliminating barriers in the work processes between developer and facility management. Important aspects can be seen in the communication line, as barriers are created among facility management and various parties in the development team; technical department. By placing facility management in the technical department a delay in the work process is established, as both stakeholders do not have the competency to work with each other, it is therefore important to rethink or even eliminate facility management as part of the technical department. The most important barrier however can be seen when looking at the facility managements experience and thus competency in the real estate project cycle. As facility management is traditionally bound to the usage phase, they do not have the competency in the decision making processes in the pre usage phase, this can be seen as an important barrier as it leads to mistakes in the work process. It is therefore important for facility management to gain experience and more importantly competency and to make use of this in future projects. It is also important to prevent demarcation in complex projects with a great number of

stakeholders in the development team. This can be seen as an important barrier as it counter effects integration, which is needed in the work process between facility management and developer. Also continuity aspects need to be taken into account, as it does occur that knowledge is lost as different stakeholders are active in different phases in the real estate project cycle. As building projects often take years, it is important that knowledge from previous stages is kept and used especially for the facility management organization as they need to gain in terms of experiences. Complexity in building projects can also create barriers in terms of contracts leading to inflexibility among parties in the development team and thus affecting both developer and facility manager. As these barriers need to be removed or rethought in order to establish continuous flow, it is important that these barriers are understood and that both developer and facility manager are willing to focus on establishing continuous flow in their work processes. Important barriers such as the inexperience of facility management purely deal with the fact that they are not largely involved in pre usage stages, projects such as those being analyzed show that there is a shift towards the usage of facility management in a pre-usage stages. This shows that the experience barrier will form a smaller problem in the future due to these projects. It is however important to keep these barriers in mind and to rethink certain work processes to establish continuous flow. When summing up the main aspects, it can be said that barriers such as the communication with the technical department and demarcation needs to be eliminated, and work processes in relation to the decision making process of facility management need to be rethought by means of education. When continuous flow is established the next lean principle can be implemented, namely: Pull

Research question 4

"What are the facility manager's influences on the schedule and in what way can the process between facility management and developer be made fully pull, leading to pull planning?"

When looking at the pull principle and the relation to the research question it is noticeable that facility management currently has no or limited influences on the project planning schedule. This can do with the fact that facility management does not have the competency and experience on deciding on the planning schedule. Therefore it is obvious that facility management does not have any influence in the planning schedule of a project in the pre-usage phase. It is however important that they will gain influence in future projects as it is likely that they will be more involved in the pre-usage stage and have benefit and interest in being involved in the planning process. In order to implement pull planning it is important that facility management does take the responsibility and the step in order to make compromises and to have influence on the planning schedule in terms of pull planning. By planning backwards on logistical plans facility management can be more leading in their role in the pre-usage phase, this is however not only the responsibility of facility management but should also be accepted by the project developer. By showing the need of facility management in the planning schedule both stakeholders can compromise on the planning, leading to more facility management involvement and thus more pull planning. After establishing pull planning, the last principle can be applied; perfection.

Research question 5

"How could continuous improvement be established and what does this mean for the relation between developer and facility manager? "

When looking at the last lean principle: perfection, it has been noticed that measures which have been taken in order to establish improvement are mostly taken by means of evaluation sessions after the projects. It is however difficult for stakeholders to use their experience efficiently in future projects as they frequently deal with other stakeholder teams, but it has to be said that there are enough parallels in relation to experiences of previous projects. This means that the dialogue

sessions need to be done efficiently in order to establish continuous improvement. The most interesting development in relation to this research question is the upcoming usage of digital tools, especially FMIS and BIM. By using FMIS in the usage phase, both facility management and developer are enabled to gather data on the building facilities, especially in terms of exploitation. This system therefore enables them to quickly react on various issues involving facility management and thus implementing improvements on a short term notice. Also BIM systems are upcoming and provide the needed information to developers in relation to structural and installations of building elements by showing the whole building in detail in 3D. An interesting aspect would be to find a link between FMIS and BIM, creating the optimal digitalization between the two software's. The fact that digital tools are rising does mean that the relation between facility management and developer will become more intense and will be linked much more, especially in terms of exploitation. It is therefore relevant for both stakeholders to use these systems for continuous improvements.

After answering all sub research questions the main research question can be answered

Main research question

"How can Lean, when using its main principles in an early interaction, starting from the initial phase till the final phase of construction projects, between developer and facility manager, lead to an effective real estate project cycle and also result in an office building which fulfills the current demand of flexibility?"

By implementing the lean principles in the process between developer and facility manager an effective real estate project cycle can be established. Firstly, value should be determined and the developer should concentrate on defining the wishes of facility management in the initial phase. This can be done effective through frequent interaction by means of meetings and dialogue sessions. It is important that both stakeholders create a common objective in terms of end product, as this will show the developer the importance of determining facility managements needs and thus intensify their cooperation.

After the value determination, the second lean principle: value stream, should be implemented. This can be done by clearly defining the roles and responsibilities of both developer and facility management and linking them to a building lifecycle orientation, and thus on the long term focus. By implementing a current state map and eliminating non-value adding activities such as the presence of facility management in the technical department, a value stream can be made. The focus on value adding activities should than be made, important aspects such as the lifecycle focus should also play an important role at this stage. This can be done through means such as contracts; e.g. DBFMO. After identifying all value aspects, the value stream map can be completed.

The next step is to establish flow, by eliminating all barriers. By eliminating the presence of facility management in the technical department the first step towards creating flow is set. By looking at the inexperience and lack of competency of facility management in the decision making process it is important to rethink this issue through educational means of facility management employees. Also ensuring continuity by preventing the loss of information through the real estate project cycle creates continuous flow. An important barrier which should also be prevented can be seen as demarcation. It is important that the development team is represented (preferably) by one organization, preventing demarcation and enhancing integration. By establishing this, a more integral work approach can be reached, leading to fewer barriers in terms of integral working.

Pull will be implemented after establishing continuous flow. Here it is important for facility management to be involved in the planning process by means of pull planning. By, again, educational

implementations in relation to planning, facility management can create possibilities to be more active in the planning process in the pre-usage stage. By starting with backwards planning (starting from the end), facility management will gain more responsibility and will be able to implement pull.

After implementing all these principles, it is important to complete the lean framework through means of: perfection. By emphasizing on evaluations and by implementing evaluations during projects to use of control mechanisms such as feed forward can be made. Feed forward mechanisms send signals to the next stage in order to implement perfection, creating more efficiency. By also emphasizing on the use of digital systems such as FMIS and BIM, the perfection cycle can be complete.

The implementation of these five lean principles according to the given descriptions can lead to an effective real estate project cycle leading to the creation of an office building according to the current demand of flexibility standards. This has to do with the fact that the integration of facility management can be seen as the integration of the building user in the pre-usage phase. As this will lead to the integration of exploitation and logistics, a building will be provided which will be easy maintainable and will be flexible according to logistical innovations. And thus it can be said that the information of facility management on the building user leads to this fulfillment of the flexibility demand.

11.2 Hypotheses

As the usage of the Eisenhardt approach has been made, the hypotheses will be formed in this paragraph. As research has been conducted on the five lean principles, each of these principles will be linked to a hypothesis. They will be stated underneath according to the lean principle. The hypotheses have been formulated by looking at the practical data gathered and by looking to the theoretical information discussed in the literature study of this report. This will ensure that the practical information is correctly linked to the theoretical information available and thus creating a strong and interesting hypothesis.

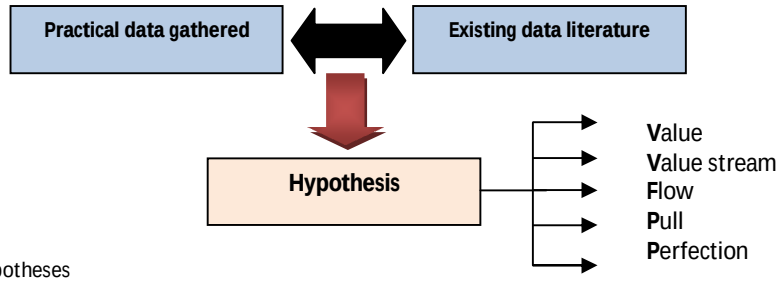


Figure 72- Forming hypotheses

Value

When looking at the practical data gathered in relation to the value principle, the most interesting aspects was the fact that there was intense cooperation between developer and facility manager. This was noticeable as they both had the same objective in relation of the integration of exploitation and therefore strived towards value knowledge. This had to do with the involvement of developer in the usage phase in terms of exploitation. It can be said that there is a strong relation between the objective of the developer and the value determination of facility management leading to intense cooperation.

When looking at the literature study on the value principle, it is noticeable that an important aspect in defining value is that the client (facility manager) should be treated as an integral part of the organization. Where the Toyota Company treat their customers as part of the product by letting them determine the car specifications, the developer is involving facility management in a pre-usage stage and is cooperating with this party in order to determine their needs by means of frequent interaction.

It can be said that both practical data and the existing literature on value have parallels at this specific case. By combining them and focusing on various relations, the following value hypothesis is formed:

"If the developer is responsible for the exploitation of a project, he will gain more interest in gaining value knowledge of facility management, leading to the treatment of facility management as integral part of the organization."

Value stream

When looking at the practical data gathered on the value stream it can be said that the project lifecycle focus has a relation with the roles and responsibilities of both facility manager and developer in the real estate project cycle. An important tool enhancing this lifecycle focus is the usage of the DBFMO contract, creating added value. It is however important to consider and leave out none adding value processes between facility management and technical departments in order to create the value stream.

The lean literature on value shows that a value stream is important as it highlights all activities which add and do not add value. It is important to identify three types of processes: those which do not create value, those who do create value and those who do not create value but are needed. In this case two important aspects can be seen: DBFMO as value creating and communication as non-value creating. By discussing these aspects, the following hypothesis is generated:

"DBFMO contracts lead to the integration of development and facility management in a building project, benefiting both stakeholders and leading to an efficient the value stream".

Flow

When looking at the flow principle gathered by the practical data, an interesting aspect was the demarcation in the ministry of finance project, effecting the real estate project cycle. This demarcation was a consequence of the large development team and did proof to be a barrier. It is therefore important to look at this barrier.

The literature study on the flow principle describes an important problem in relation to flow at a Toyota production line:

"If some problem occurs in one piece flow manufacturing then the whole production line stops. In this sense it is a very bad system of manufacturing. But when production stops everyone is forced to solve the problem immediately"

The building industry is not similar to the car industry, but there are interesting parallels when looking at this flow statement. In Toyota they say that one barrier stops the whole production line and people are forced to stop the problem. In the building industry the demarcation can affect the whole building process, leading to miscommunication and double work. These aspects occur as teams are not integrated, but are isolated and task oriented. By looking at these aspects, the following hypothesis is generated:

"In large complex projects where process integration is essential, the development team should exist out of one organization, as multiple organizations representing the development team would in most cases lead to demarcation"

Pull

The practical data gathered by means of the pull principle focused on pull planning showed that there was no involvement of facility management in the planning schedule phase. An important factor can be seen as their inexperience and lack of knowledge in creating a planning schedule in the pre-usage phase.

The literature on pull and pull planning shows the importance of working backwards in terms of planning and emphasizes on the importance of the clients influence on the pull system. In Toyota the main principle of pull is to avoid overproduction, in the building process between developer and facility manager, overproduction is not an aspect, but planning does influence both parties and it is therefore important that facility management is part of the planning process. By looking at these elements, the following hypothesis is created:

"The lack of competency on the hand of facility management in the pre-usage phase leads to their limited input of the scheduling process and thus no pull planning is generated"

Perfection

The practical data gathered on perfection showed the various evaluation meetings which were used to learn from their (development team and facility management) experience and to draw important lessons from them. Another interesting development was the usage of digital tools such as FMIS and BIM, enabling both parties to gather data which can be used to improve building processes.

When looking at perfection from the existing lean theory, it shows that continuous improvement should be implemented in all phases from lean, starting from value till perfection. It therefore indicates that evaluation meetings should take place in relation to the lean steps. As digital tools do present the future it should therefore strongly be taken into account. In terms of perfection, the following hypothesis is generated:

"The usage of digital tools such as FMIS and BIM will be of essential influence in future projects, as they provide essential data and help both developer and facility manager in creating the most efficient building as continuous improvements can be implemented "

As these hypotheses have been created during the case studies and by means of reflecting back at the literature study they can be seen as solid. It is interesting to use these hypotheses for future research and to test them with other case studies. Later on in this chapter the relation between the hypotheses and future research will be discussed.

11.3 Recommendations

As the research questions are answered and the various hypotheses are formed, it is important to make recommendations for organizations in the field of project development and facility management. With help of process models the recommendations will be given. These process models make use of the lean principles and could lead to effective work processes among the stakeholders. The process models can be seen on the pages 138 till 141, and are divided according to the value principles.

Value

The chart on page 138 of this report describes the recommendations in respect to the value principle. It shows that the first step should include the determination of the objective of both stakeholders and to match their objectives. By creating a mutual objective, the cooperation between developer and facility management will be more intense and the gaining of facility management value by developer will be more efficient. It is important to put emphasis on the usage phase in terms of exploitation and to integrate this in the objective as this will enhance the usage of facility management in the initial phase. After this aspect, the program or output specification, depending on the type of project, should be analyzed. During tenders this analysis is extremely important to provide an appropriate offer for the customer. In this phase also meetings should take place between the developer and facility manager in order to gain more value knowledge. By implementing a dialogue session at the end of the initial phase between all stakeholders of the development team, facility management and client, a dialogue can be started in order to make agreements on aspects such as logistics. In the design phase it is important to continue and emphasize on the logistical aspect and to determine facility management's needs by means of logistics, layout and exploitation criteria in the design. At this stage weekly meetings between the stakeholders should still be emphasized on and a dialogue session should be planned. It is important that the facility manager's needs are considered during all design phases, including sketch design, preliminary design and final design, with emphasize on the final design. In the execution stage the needs of facility management should be already implemented and they should take an advisory role and thus their advice should be considered during meetings. At this stage the last dialogue session should take place to involve the client. In the usage phase usage of FMIS should be made, determining the needs of facility managements by gathering data of the digital tool. The involvement of developer at this stage depends on the contract form, as a DBFMO will create the urgency of intense cooperation between facility management and developer.

By being consisted on the meeting and dialogue sessions throughout the whole project lifecycle, the optimal value knowledge can be generated by the developer.

Value stream and flow

The chart on page 139 describes the recommendation in relation to the value stream and flow perspective. In order to create value stream it is important to define roles and responsibilities and to create a value stream with processes that create value. Therefore in the initial phase it is important for the developer and facility manager to be life cycle oriented, meaning to look at the long term perspective of the project. This can be done by using a DBFMO contract, which enhances the lifecycle focus among processes between developer and facility manager. The facility manager should also put their emphasis on mark comfort, meaning that they should integrate the main trends, e.g. logistical aspects in relation to flexible workplaces, in the building. Also the integration of (internal) facility management in the program (PVE) should be considered, in order to implement main facility management perspectives in the program. At the end of the initial phase usage of BIM should also (preferably) be made, in order to see and react on possible building failures in terms of structure and installations. It would be interesting to see whether a link between BIM and FMIS could be made in

order to optimize the facility management's integration in the digital tool. In the design phase the developer and its architect should take the leading role in the sketch design in terms of the main building form. The facility manager should take an advisory role at this stage in order to give the architect freedom. In the preliminary design phase, facility management should cooperate with the developer on logistical and layout aspects. And in the final design phase, the facility manager should focus on detailing aspects in cooperation with developer. In the execution phase the developer should lead the realization of the building process, the kitchen however, should be led by facility manager, in order to provide optimum efficiency in the usage phase. In the usage phase FMIS should play an important role and facility management should focus on soft FM issues. If the developer has a leading role in exploitation, they should focus on hard FM issues. In order to conduct these processes with continuous flow it is important that the development team consists out of one organization, as this will limit demarcation and enforces integration with the various departments of the developer. Another important aspect is the emphasis on continuation in respect to information. It is important to keep people from the development team and facility management involved in all stages of the real estate project cycle. This prevents information from previous stages to get lost and will also ensure a better flow between the phases. Another important aspect is educating facility management staff in pre-usage decision making aspects. This should be done before projects in order to enhance facility management skills in such projects and to prevent them from making mistakes in the various phases. By ensuring these steps an efficient value stream can be made, followed by continuous flow.

Pull

When looking at page 140 the recommendations for implementing pull (planning) can be seen. Here it is important that facility management is involved in the planning process in order to gain more influence and thus apply pull planning. In the initial phase the developer should lead the planning process, as here the team needs to be gathered and the initial agreements need to be made by the development team. In the design phase, facility management should be involved in the planning process. This should also be the case in the realization phase. This should be done by means of backwards planning, enhancing facility management to start describing the data for the completion of e.g. the layout/logistical plan and then work backwards describing the various deadlines of the stages of this plan. This backwards planning can be seen as pull planning and creates a certain structure in facility management planning. In order to implement this, the developer should provide a certain degree of freedom for the facility manager.

Perfection

When looking at page 141 the recommendations for implementing the last principle; perfection can be seen. It is important to make use of the technology by means of BIM in the premature stage and FMIS in the usage stage. As mentioned, a link between these two digital tools could enhance better integration of facility management in the project and thus could lead to improvements. Another important measure to be taken is to feed forward between the various stages. Meaning that feedback concerning problems are processes towards the next stage so that problems are not hidden and can be dealt with. After the execution stage all stakeholders should hold an evaluation meeting in order to draw lessons from their experience by looking at encountered problems and processes which went well. Such an evaluation should also take place after a longer period, in order to generate feedback from building users and to see whether the building performs well in terms of exploitation. The usage phase should also be focused on the usage of FMIS in order to implement continuous improvements throughout the usage phase in terms of exploitation.

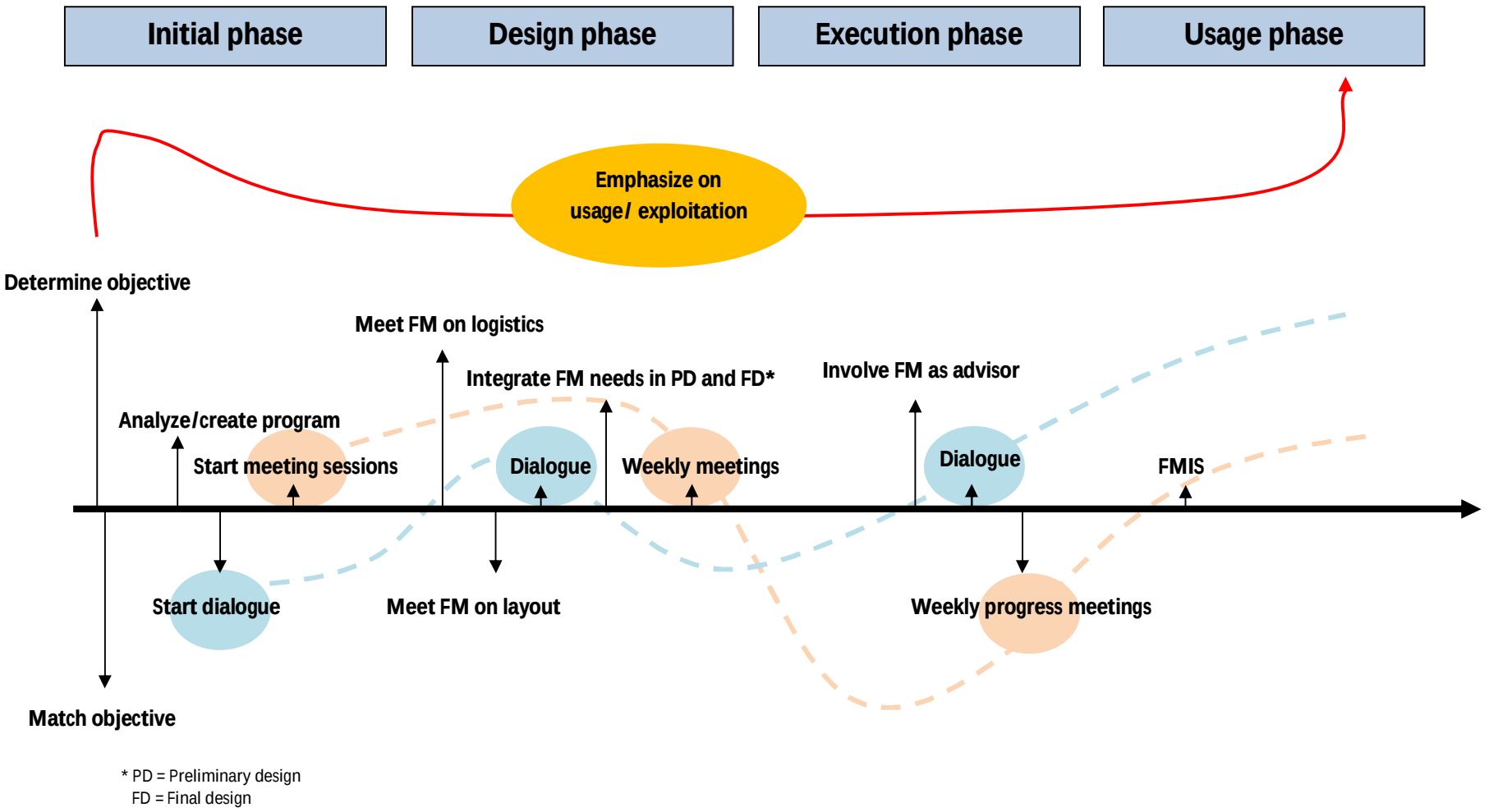


Figure 73- Recommendation on value implementation

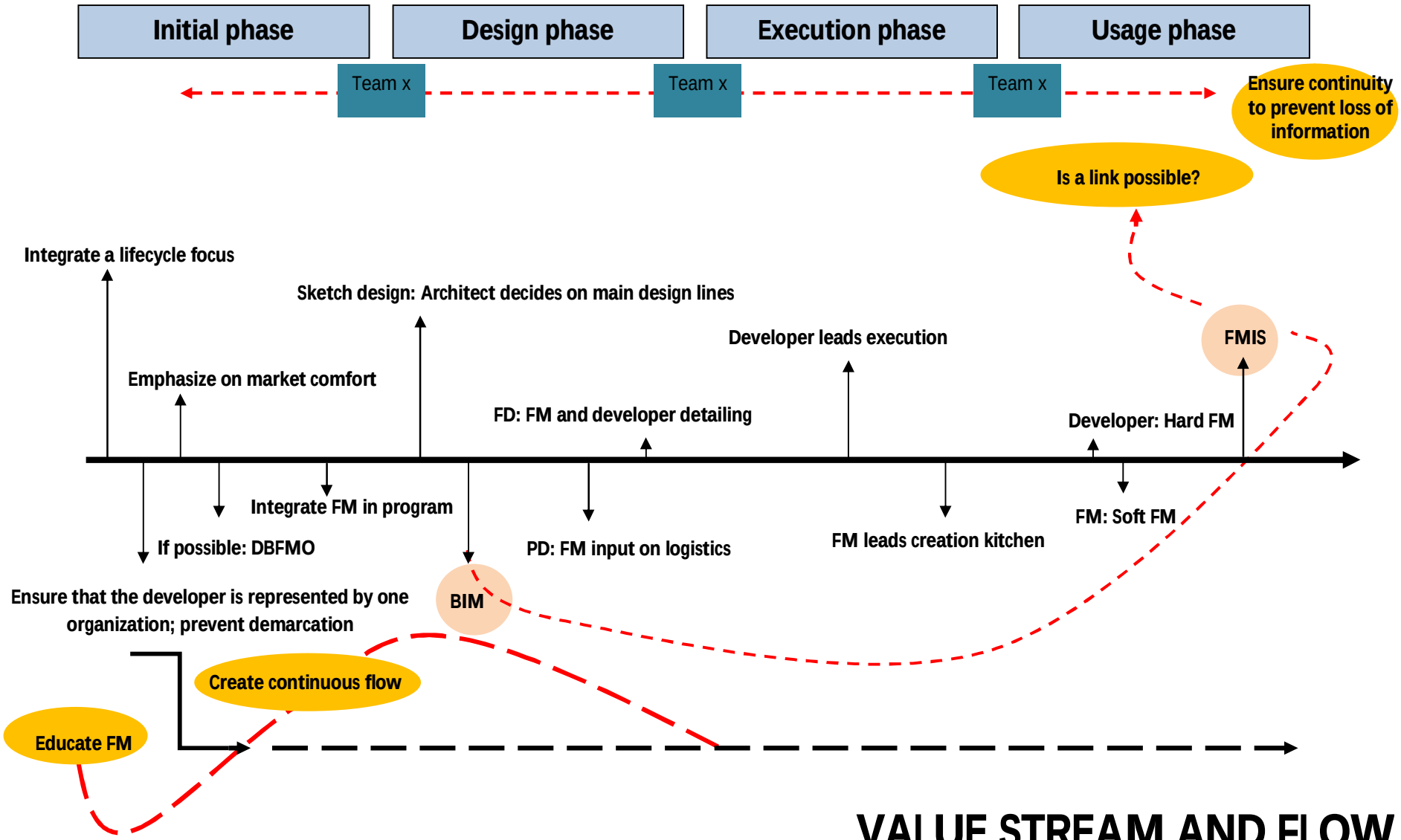


Figure 74- Recommendation on value stream and flow implementation

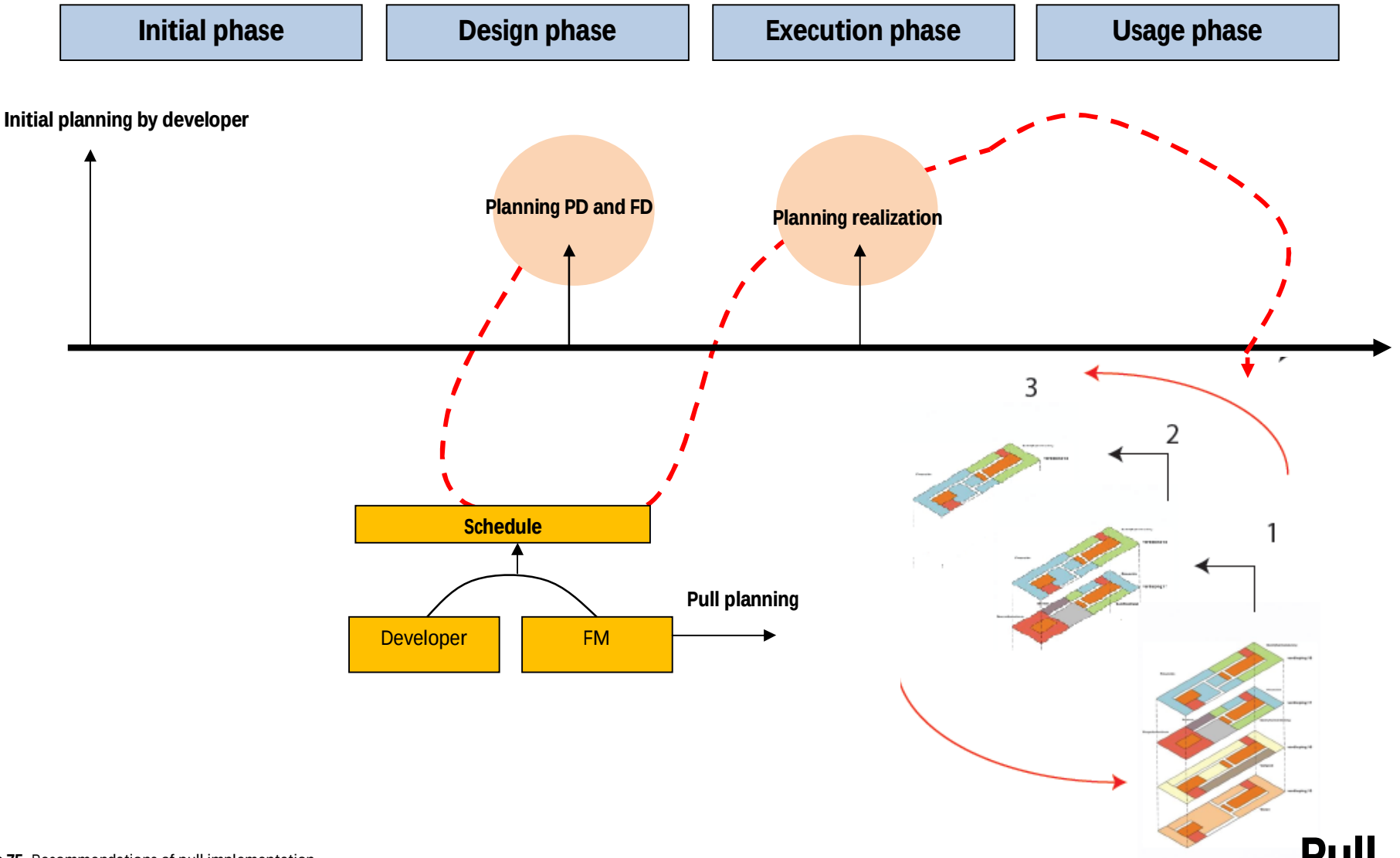
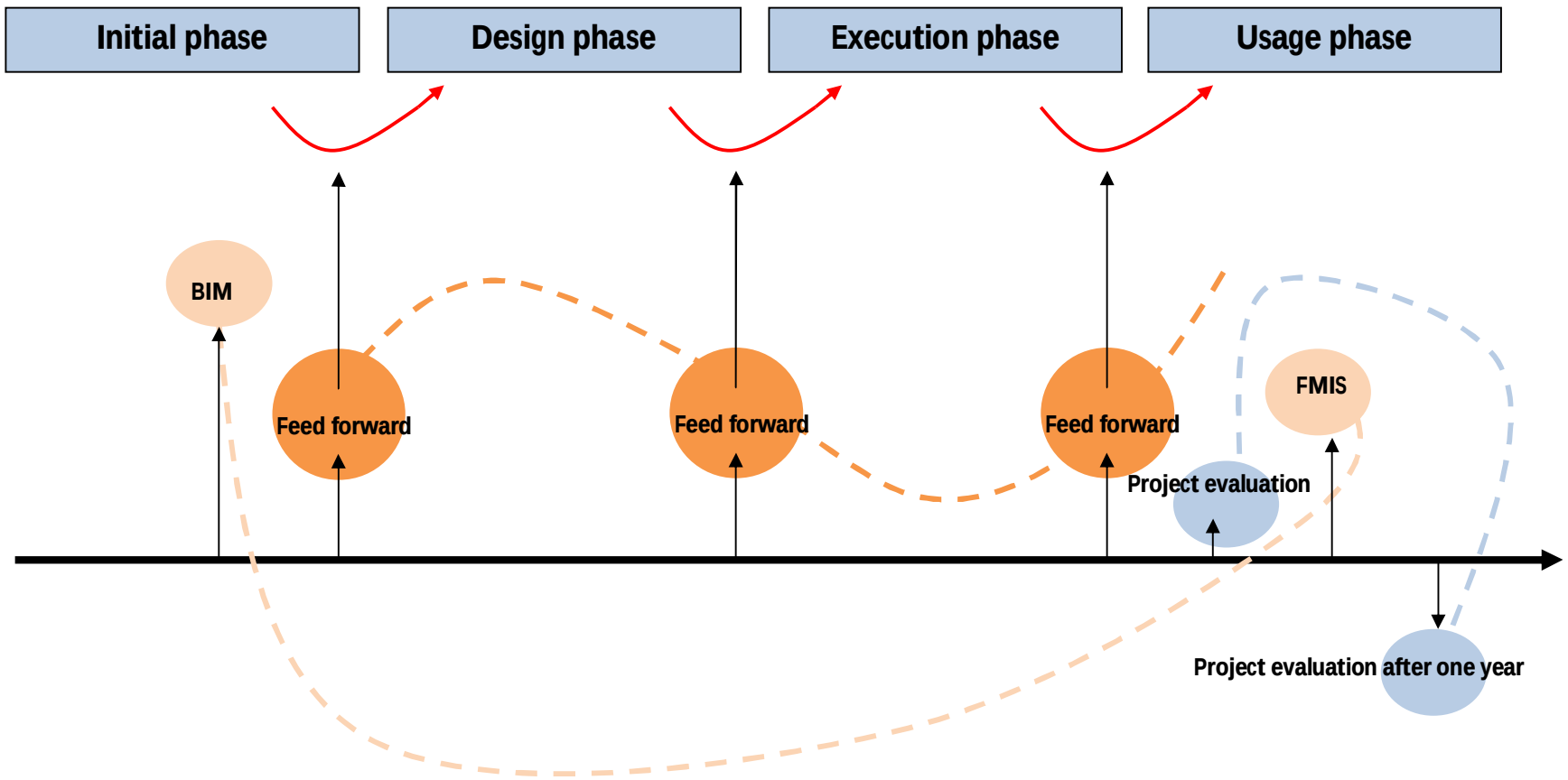


Figure 75- Recommendations of pull implementation



Perfection

Figure 76- Recommendation for perfection implementation

11.4 Reflecting on the problem and future research

Problem reflection

After discussing the research questions and forming the hypotheses a reflection needs to be given in relation to the initial problem statement of this research and whether the problems (statements) have been solved by means of this research. The initial problem statements which were defined can be seen underneath:

Theoretical problem statement:

"There is no specific lean theory focusing on the relation between facility management and project development, creating a knowledge gap"

Practical problem statement:

"There is no clear link between developers and facilities management, creating a gap for developers on user flexibility standards, resulting into a mismatch between office supply and demand

The first problem described a theoretical problem and showed the gap on specific lean theory focusing on the relation between facility management and project development. By applying and integrating the lean principles of: value, value stream, flow, pull and perfection in this research, data is generated among the process between developer and facility management. The fact that both cases; the renovation in the Hague and the construction of the DUO building in Groningen did indeed provide information on the process between developer and facility manager created the possibility to analyze these processes by means of the lean philosophy. Therefore it can be said that this research has generated theoretical information on the relation between developer and facility management by means of lean thinking. This means that the theoretical problem has been handled and (partly) solved by means of this research. It is important to acknowledge that this research can be seen as a first step in closing the gap on theoretical lean standards. However it takes more research on this specific topic to close the whole gap, as more data on more case studies is needed to provide different lean approaches from different researchers. Therefore this research can be seen as a first step towards more research.

When looking at the second problem statement, the research on the case studies showed that there is a start in relation to the cooperation between developers and facility management. It however also showed that the cooperation is relatively new and can be seen as unique in the field of development as the integral projects involving facility management in the pre-usage stage does not occur frequently. The research also showed the various barriers and difficulties there are in the processes between these stakeholders due to the fact that there has never been a clear link. It however also showed positive developments and opportunities for future cooperation between the stakeholders. By analyzing both cases and by providing recommendations in the previous paragraph, the process between these stakeholders is emphasized and various value adding aspects are added. This means that the provided frameworks highlights on more integration between development and facility management, creating a better link between the two disciplines. As facility management represents the building user and is part of the building user, the recommendations emphasize the fact that the user is involved in the pre-usage stage and thus matches supply and demand. The interesting development in both cases was that the developer was also responsible for the building exploitation, and made it a must for them to integrate and cooperate with facility management to provide a user oriented building. It can be said that the provided recommendations do handle the practical problem and, when using correctly, it does result into a match between supply and demand as the user is involved in the pre usage stage.

Future research

After reflecting on the problem statements, it is noticeable that both problems have been handled, but still more research is needed in order to provide more data and to generate more advice on these problem related topics. Therefore it is important that future research will be conducted in relation to these aspects. It will be interesting to focus on the shaped hypotheses for future research. This research has looked at all principles of lean, providing a global lean framework. This provides the opportunity for future researchers to segment the research and to look at their findings in relation to the shaped hypothesized. Therefore recommendation is made in order to conduct research and test the shaped hypotheses underneath:

Value

"If the developer is responsible for the exploitation of a project, he will gain more interest in gaining value knowledge of facility management, leading to the treatment of facility management as integral part of the organization."

Value stream

"DBFMO contracts lead to the integration of development and facility management in a building project, benefiting both stakeholders and leading to an efficient the value stream".

Flow

"In large complex projects where process integration is essential, the development team should exist out of one organization, as multiple organizations representing the development team would in most cases lead to demarcation"

Pull

"The lack of competency on the hand of facility management in the pre-usage phase leads to their limited input of the scheduling process and thus no pull planning is generated"

Perfection

"The usage of digital tools such as FMIS and BIM will be of essential influence in future projects, as they provide essential data and help both developer and facility manager in creating the most efficient building as continuous improvements can be implemented "

Conclusion

When concluding this chapter, it is noticeable that all research questions have been answered. The presence of developer in the usage phase has been noticeable and has linked them with facility management. This also led to better understanding of both principles. Various relations have been found between development and facility management, providing interesting hypotheses which will need to be tested in future research. When looking back at the recommendations it was noticeable that the building lifecycle orientation has been an essential aspect in striving optimization between these stakeholders, and should therefore be considered. Overall the research has led to the important step in solving the problem statements and it is therefore important that future research will be conducted in relation to the provided hypotheses.

Epilogue

"Reading without reflecting, is like eating without digesting "
- Edmund Burke

Reflecting back on this research period; choosing lean

After the completion of this research a great deal of information has been generated for me as student and future professional in the building industry. Information concerning lean and the application of such a theory in case studies did provide me with a firm insight on the work processes between developer and facility management and on how these processes could be optimized. As I was able to achieve my objective in terms of this end product, it is important to look back at the research process and to reflect on this period.

During the start of my research I was challenged to find an up to date topic both relevant and interesting in terms of construction management. As my objective would be related to process optimization in the building industry, I was quickly fascinated by the lean philosophy and challenged by this philosophy as it was widely integrated in the car industry, which differs greatly from the building industry. After collecting literature a quick link could be made with lean construction, showing the integration of lean in the building industry. The next step was to narrow down my research scope, which led to project development and facility management. This had to do with my back ground in facility management and my personal fascination in project development. After conducting research on lean, project development and facility management I quickly came to the conclusion that a link between project development and facility management was missing. After reviewing various articles of authors which also referred to this aspect i was able to find a relevant and interesting problem in this field. This first step in defining the research problem can be seen as the most important point in the research as you as researcher need to be triggered by the topic and it needs to be relevant in academic purpose. I had therefore put a great deal of focus in this stage and now as the research is completed I can say that I am glad that I have chosen this specific topic.

After analyzing the topic by means of data reviews it was important to form a literature driven view on how to handle the problem. The literature study showed me the lack of information on this specific topic, making it absolutely necessary to provide this missing information by means of case studies. After various reviews red on cases, I came to the conclusion that two cases would be most relevant; the renovation project in The Hague and the construction of the DUO building in Groningen. It was easy to see the relevance, as these would be the largest projects in the Netherlands making use of facility management in the pre-usage stage. I was therefore eager and convinced that these cases would provide the necessary data on my research topic. This would mean that I needed to contact the companies involved in these projects on short term notice. As I felt that this research would be relevant for the organizations I tried to convince them to conduct interviews, and I am grateful that the various organizations were open to provide me with information. The information gathered did provide interesting and relevant data, leading to the completion of this research report.

Concluding my reflection, I would like to advice future graduate students to conduct research on a topic which appeals to them on professional level and most importantly on personal level. Personal interest does provide you with the needed ambition to complete the research and to provide data useful for both the academic world and for the student as future professional. I hope that this research has given answers to the reader and that it has provided “added value” such as the lean philosophy would say.

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Appendices

Appendix 1-Definitions

BIM	*Building Information Model*
Coding	*A systematic way in which to condense extensive data sets into smaller analyzable units through the creation of categories and concepts derived from the data*
DBFMO	*Building contract form which makes the contractor responsible for the following: Design, Built, Maintain, Finance and Operate*
Flexibility	*Buildings which have been created according to the wishes of the building users*
Flow	*Lean principle: Creating continuous flow*
FM	*Facility Management*
FMIS	*Facility Management Information System. An FMIS is the combination of procedures which are aimed on managing and providing information needed for integral planning, realization and managing the facilities of an organization"*
Hard FM	*Hard facility management issues; technical aspects e.g. ventilation failures*
Kanban	*Lean term for using visual signs*
Kaizen	*Lean term for creating continuous improvement*
Lean	*A philosophy initially used by Toyota focused on maximizing value by eliminating waste*
Lean construction	*A production management-based approach to project delivery -- a new way to design and build capital facilities"*
LPDS	*Lean Project delivery system: "Facilitate planning and control, maximizing value and minimizing waste throughout the construction process*
Output specification	*A clear description of the desired result in the form of a product or performance. The output specification describes: what the purpose of an object is, according to which principles these objects need to be designed and realized, the services which the contractor needs to provide*
Perfection	*Lean principle: Creating continuous improvement*

PPP	*Public Private Partnership, this is a form of cooperation between governmental institutes and private parties*
Pull	*Lean principle: Adding what the customer wants when required*
Real estate project cycle	*The real estate cycle are the phases in a building project; starting from initial till operation phase*
SLA	*Service Level Agreement; detailed memorandum specifying the outcomes from many elements of the outsourced function*
Soft FM	*Soft facility management issues; services e.g. cleaning processes*
Value	*Lean principle: Defining value in terms of what the customer wants*
Value stream	*Lean principle: Identifying processes which add value and eliminating the non-value adding activities*

Appendix 2- Interview questions facility manager

Intro

1. What is your function?
2. How long have you been active in this field?
3. What is your personal role and responsibility in the organization?
4. Does your company work on an outsourcing base?
5. If yes, how long does this cooperation exist?

Value

6. How does the cooperation with the developer look like?
7. How intense is this cooperation?
8. How do/did you translate your wishes to the developer?
9. How are changes in the needs of facility management dealt with by the developer?
10. Were your consulted in each phase of the project cycle?
11. Were you as FM content with the result of the project?

Value stream

12. What are your roles and responsibilities in the following phases?
    - Initial phase - Design phase
    - Execution phase - Usage phase
13. Would you like to be involved more in the processes? Which phases?
14. Which process/phase adds most value?
15. Which process could be done more efficient?
16. Which processes were missing according to you?
17. Do you think that the facility manager is able to cope with technical issues during construction or is this out of his/her field? How did this go during the project?
18. In your perspective, is there a clear understanding between FM and developers or is there more often a wide gap between both parties? How about the project?

Flow

19. Could these processes be standardized or would you consider them as unique?
20. Which aspects between the developer and FM could be seen as barriers slowing down the project?
21. How could these barriers be dealt with?

Pull

22. What were your influences on the planning schedule?
23. Was it easy possible to incorporate your demands during the meetings scheduled?
24. Were you involved in planning this schedule?

Perfection

25. Are there feedback sessions after projects?
26. If yes, how do these look like?
27. Is previous experience used to improve future processes?
28. What were the main bottlenecks in the project and what would you do differently next time?

Extra Questions

29. Is the FM able to communicate with the architect? (in a technical language)
30. Does the architect appreciate FM in the design team?

Appendix 3- Interview questions developer

Intro

1. What is your function?
2. How long have you been active in this field?
3. What is your personal role and responsibility in the organization?
4. Does your company work with FM? Is this a recent development or does this occurs in frequent projects?

Value

5. How does the co-operation with FM look like?
6. How are the FM's needs determined?
7. What steps are taken when these needs change?
8. What are the bottlenecks when determining these needs?
9. Do you believe that the demands of FM were fully integrated in the project?

Value stream

10. What are/were the roles and responsibilities of the developer in the following phases?
    - Initial - Design
    - Execution - Usage

11. How did the process between developer and FM look like?
12. Could these processes be done more efficiently?
13. Which processes added value and which not?
14. Which processes formed bottlenecks?
15. Do you think that the facility manager is able to cope with technical issues during construction or is this out of his/her field? How did this go during the project?
16. In your perspective, is there a clear understanding between FM and developers or is there more often a wide gap between both parties? How about the project?

Flow

17. Could the processes between developer and FM be standardized or would you consider them as unique?
18. What could be seen as the main barriers in these processes which slowed down the project?
19. How could these barriers be dealt with?

Pull

20. How did the project schedules look like?
21. What was FM's role in the scheduling?
22. Were the demands of FM fully integrated during the meetings?

Perfection

23. Are there feedback sessions after projects?
24. If yes, how do these look like?
25. Is previous experience used to improve future processes?

Appendix 4- Eisenhardt

Table 6- Process of building theory from case study research *(Eisenhardt, 1989:P533)*

Step	Activity	Reason
Getting started	Definition of research question Possibly a priory constructs	Focuses efforts Provides better grounding of constructs measures
Selecting cases	Neither theory nor hypothesis specified population Theoretical, not random, sampling	Retains theoretical flexibility Constraints extraneous variation and sharpens external validity Focuses efforts on theoretically useful cases
Crafting instruments and protocols	Multiple data collection methods	Strengthens grounding of theory by triangulation of evidence
Entering the field	Overlap data collection and analysis, including field notes Flexible and opportunistic data collection methods	Speeds analysis and reveals helpful adjustments to data collection Allows investigators to take advantage of emergent themes and unique case features
Analyzing data	Within case analysis Cross case patterns search using divergent techniques	Gains familiarity with data and preliminary theory generation Forces investigators to look beyond initial impressions and see evidence thru multiple lenses
Shaping hypothesis	Iterative tabulation of evidence for each construct Replication, not sampling, logic across cases Search evidence for 'why' behind relationships	Sharpens construct definition validity and measurability Confirms, extends and sharpens theory Builds internal validity
Enfolding literature	Comparison with conflicting literature Comparison with similar literature	Builds internal validity, raises theoretical leeve and sharpens construct definitions Sharpens generalizability, improves construct definition and raises theoretical level
Research closure	Theoretical saturation when possible	Ends process when marginal improvement becomes small

Appendix 5- Case study protocol

Section 1: Preamble

Confidentiality and data storage

The data to be collected will be stored by means of digital archives. The data from case 1 and case 2 will be stored separately. Confidentiality is applicable to the interviews which are held. All interviews will be processed confidential, which means that transcripts will not be publicly available.

Publication & documentation

This case study will be analyzed; these analyses will be publicized by means of this report. The publications will be done in accordance to the Harvard reference method, meaning that all sources will be provided. All documents related to the case studies will be archived, meaning that a bundle with all collected data will be held. This can be articles, presentations, and other publication material.

Section 2: General

Overview of research project

Case 1: Renovation ministry of finance

The client:	Rijksgebouwendienst, ministerie van financien
Consortium:	The building team consists out of a consortium, this consortium is called: Safire and exists out of: ABN amro, Burgers Ergon, GTI, ISS Nederland and Strukton (Strukton was the developer and investor, and ISS the facility management firm)
Architect:	Meyer en van Schooten architecten
Project form:	Public Private Partnership (PPP)
Contract form:	DBMFO
Project start:	Beginning of 2007
Project completion:	End of 2008
M2:	66000m2 BVO, parking 10000m2 BVO
Costs:	The DBMFO contract has a net value of €173 million

Case 2: Construction of DUO and tax office

The client:	Rijksgebouwendienst representing DUO and tax office
Consortium:	The building team consists out of a consortium, this consortium is called: Consortium Duo2, existing of: Strukton, Ballast Nedam, John Laing
Most important sub-Contractors:	ISS Nederland, YNNO, Arup, Lodewijk Baljon landschaparchitecten, Studio Linse
Architect:	UN Studio
Project form:	Public Private Partnership (PPP)
Contract form:	DBMFO
Project start:	31/12/2008
Project completion:	01/04/2011
M2:	47000m2 BVO offices, parking 10000m2 BVO
Costs:	€100 million building costs, and €13, 2 million annually for exploitation

The case research method

- ***The aim of the research project***

The aim of the research projects is to find relevant data for the research thesis. Both cases have a lot in common with the theme, as both projects integrate facility management in an early stage. The aim of the case studies is to analyze processes between facility management and developer in order to answer the research questions and thus the main research question:

"How can Lean, when using its main principles in an early interaction, starting from the initial phase till the final phase of construction projects, between developer and facility manager, lead to an effective real estate project cycle and also result in an office building which fulfills the current demand of flexibility?"

- ***Why it is important to conduct the research***

It is important to conduct the case studies as practical information is needed. Literature on this specific topic is not or almost not available, therefore information which is collected provides essential data, leading enabling the research question to be answered.

- ***How the research is to be conducted***

The case studies will be analyzed by means of: Interviews, video material, articles and archives

Section 3: Procedures

Case selection & Number of cases

There are a great deal of cases which do match the research in terms of; facility management integration in an early phase. This has led to the selection of: Renovation Ministry of Finance & Construction of DUO. Due to a limited time frame, only two cases will be analyzed.

Establishing contact

The organizations to be contacted in both cases will be those which can be placed into the category: Developer and Facility management. For case 1; Renovation ministry of finance this will be:

1) Developer
2) Facility management

For case 2: Construction of DUO2:

1) Developer:
2) Facility management:

A great benefit of these cases is that the parties to be approached are involved in both projects. This means that information on both cases can be gathered during each interview The contact will be established by means of:

Developer:	→Will be contacted telephonically and by email. A contact person is needed which has been involved in both cases, and thus covering case one and case 2

Facility management: → Will be contacted by telephone and email. A contact person from FM is needed which has been involved in both cases, covering case 1 and 2

When these appointments are established and the interview takes place, possibly more relevant persons involved in the project can be approached by means of enquiring the person to be interviewed for contact details.

Scheduling of field visits

No actual field visits will take place, only interviews as the cases are completed. It is important that all interviews take place before the beginning of November 2011, as they need to be analyzed and the report needs to be handed in before the end of November of 2011.

Length of the sessions

The interviews should take approximately 1 hour, this should be enough time to gather all the needed information.

Equipment and stationary

The interviews will take place at the location of the organizations to be approached. Both organizations are located in the same city. It is important that the interview is held in a closed area, as use of a voice recorder will be made. Thus the equipment needed: one voice recorder and a notebook with pen.

Section 4: Research instruments

The interviews to be conducted consist out of several questions which cover the research question. The interview questions can be seen in Appendix 2 and 3.

Section 5: Data analyzes guideline

Data analysis process

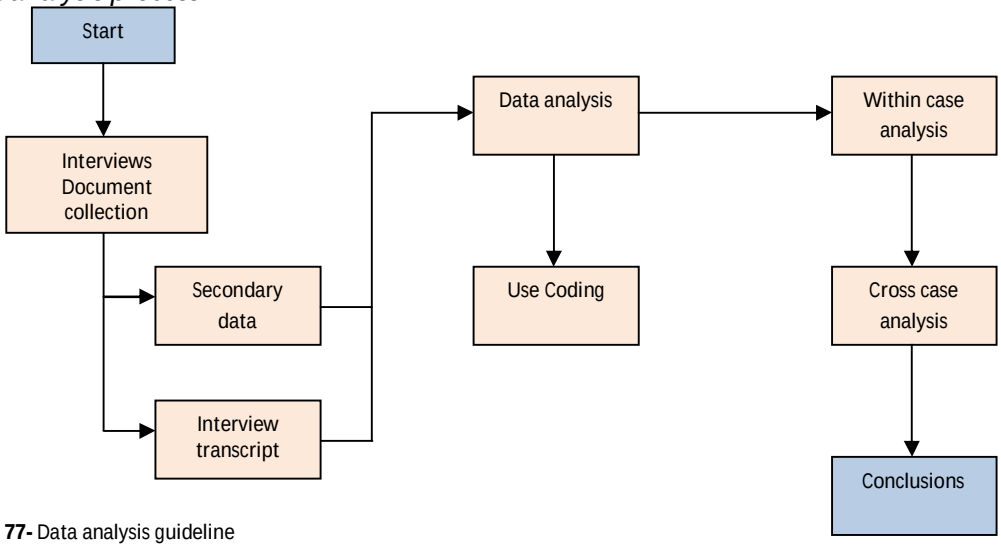


Figure 77- Data analysis guideline

The figure above is the data process model, firstly the interviews and document collection phase takes place, followed by secondary data and the interview transcript. This data will be analyzed, an important aspect here is coding, as the interview transcript needs to be coded. The coding applied can be seen in appendix 6. After this phase, the within case analyses takes place; meaning that each case will be analyzed separately. When this is done, the cross case analysis takes place, comparing case 1 with case 2. Finally all concluding findings will be summarized.

Appendix 6- Code list

In this appendix the code list is applied. There are two code lists, the first code list on the next page contains information on the first case; renovation of the ministry of finance. The second code list is the code list of the DUO construction. In order to gather the most important data, the codes are determined by the research questions. Therefore the choice has been made to use the following codes for both cases:

Table 7- Code list criteria

Value
Determination FM needs
Intensity cooperation
Value stream
Roles and responsibilities
Processes creating value
Processes not creating value
Flow
Barriers
Pull
Planning
Perfection
Organizational improvements

Value (Case 1)
Determination FM Needs
Weekly meetings were held with all members from the consortium
FM was part of the dialogue where various aspects could be discussed, also the client was present
FM needs needed to match to the output specification
As all meetings were held with the consortium, there were communication lines with all parties
In the realization phase, FM would only give advice on details, they were liable for wrong advice
Intensity cooperation
FM was part of the consortium and involved in all stages of the project cycle
In the realization phase FM was intensely involved as they leaded the creation of garden and kitchen
FM took part in all departments, from soft till hard, their focus however was on soft services
All parties involved in the exploitation phase already made agreements in the initial phase
FM was located on the building side during construction
In the usage phase usage of FMIS was made
The dialogue team and the weekly meetings showed the intensity of the cooperation

Value Stream (Case 1)
Roles and responsibilities
FM was shareholder in the consortium and stakeholder in the VOF
FM was also part of the exploitation team (25 years) and responsible for the soft services
Developer is responsible for hard FM
FM is looked at logistic aspects e.g. relation function/ personnel
FM also focused on the lay out and structure of the building
Initial phase: tendering, analyses output specification, layout plan, logistics, feasibility study (FM)
Design phase: Participation VO &DO, feasibility study (FM)
Execution phase: Monitor,participate kitchen and garden, detailing DO & determining work process
Usage phase: Exploitation soft services (FM) for a period of 25 years
The client made the output specification and was part of the dialogue team
Developer was key (together with the VOF team) (&investor)
Developer was also responsible for the exploitation (hard fm), (humidity, building condition etc)
Developer was also contractor
The character of the building needed to be remained and this would be important to know for all parties, including FM in the realization of the garden
The project can be divided into Safirebv and Safire vof, the finance team and the development team
The user was intensively involved in the project
Processes creating value
Creating a layout plan and the logistics determined between developer and fm
The weekly meetings and the dialogue session
The long term focus: lifecycle of the building, also lifecycle costing
The connection of exploitation and design and the contract form (DBFMO)
The use of FMIS, which can be accessed by both parties
FM leading kitchen and garden in execution phase
Processes not creating value
The communication between FM and the technical teams
In this project the tasks in development team were specifically divided, creating demarcation

Flow (Case 1)

Barriers
The communication line in relation to technical aspects, FM was present in all meetings also technical, but they lacked technical specialty
FM was involved late in the VO phase while some design elements were already implemented
The reception was already positioned and there was one storage room which was huge and positioned under ground level
The abstract output specification is a barrier, as you have to negotiate constantly with the client
It's difficult to translate the output specification in users needs and design
In this project there was demarcation; leading to specifically divided tasks in the development team
As the character of the building needed to be kept, it was difficult to create the in-door garden, surrounded by glass which is difficult to maintain
All parties stick to their contract, making them inflexible and thus creating a barrier
Creating a balance between FM and developer in terms of esthetics and functionality

Pull (Case 1)

Planning
The whole team is responsible for the planning process
FM however did not have an influence in the scheduling, it is also no part of their competency , late delivery has a consequence in to high fines
In the pre execution phase there was space for pull planning from the design team
In the realization phase there was no or little room for pull planning, FM could only give some advice
FM does not have the competencies for such explicit planning, but it should be the case as planning is important
FM should put conditions in relation to the planning schedule

Perfection (Case 1)

Organizational improvement
There have been feedback evaluation sessions with client and consortia
A future goal of the client is to work with BIM a linkage with FMIS would be interesting
In projects with other teams it is difficult to use previous experience as each project is unique
FMIS provides feedback

Value (Case 2)
Determination FM Needs
There were meetings with the consortium, ISS was not part of the consortium but a sub-contractor
There were management meetings with the internal FM party and consortium
Internal FM was approached when making the OS, FM needed to match their needs to this OS
In the realization phase FM would only give advice on details, for wrong advice they would be liable
Developer went to the supplier to look at the suggestions made by ISS to determine maintenance
Intensity cooperation
FM had a relative high percentage in the OS
FM was involved in all stages of the project as sub-contractor as all soft services were outsourced
Weekly meetings with the consortium show the intensity
There was a great degree of "*polderen*" as there was intense cooperation with all parties in all stages
The FM was involved in early stage as the budget had to be agreed on, also the exploitation budget
The cooperation was intense a reason for the intensity was that all contracts needed to be approved and signed in early stage
There was a dialogue team and two dialogue sessions
The cooperation in relation to the output specification was intense, because when things could not be arranged, discount has to be given by the FM
The usage of FMIS show the cooperation between FM and different parties
There were two dialogue sessions, one after the SO and one after the VO, they took around **3** weeks

Value Stream (Case 2)

Roles and responsibilities
FM was involved in all stages of the project as sub-contractor, they were not part of the finance team, but they had to agree with them on budget
Initial phase: tendering, analyze output specification , layout plan, feasibility study
Design phase: detailing on the SO, VO and DO, feasibility study
Execution phase: advice on detailing
Usage phase: Exploitation soft services for a period of 20 years
FM was also responsible for the internal planting, coffee machines, press container
FM was an important stakeholder in the VOF (development team), they needed to provide market comfort
The output specification cannot be changed by development team, only improved with the needed approval
The project can be divided into DUObv and DUO vof, the finance team and the development team
The DUObv has direct communication to the shareholders and client, DUOvof has no direct line to the client but to the DUObv
The difference between BV and VOF :the bv parties all have a share, the vof make agreements and divide tasks and are 100% liable
Developer and also responsible for the design of the interior and the detail work of the building
Hard FM is done by developer for a period of 20 years, hard FM also covers most costs
The internal FM party (fac.belastingdienst) is stationed in the building and if there are complaints concerning FM they are the contact point for client
The internal FM is active on operational level and were involved in the creation of the output specification
Both FM and developer have access to FMIS
Processes creating value
Design and usage was not separated, creating a good view on the exploitation in initial phase leading to a good transition from realization to usage
The fact that only 1 organ was developer created a more integral work process, as there was no demarcation, leading to better cooperation with FM
Use of control mechanism (kwaliteit meting) good for the exploitation budget and thus for FM
Use of FMIS is of great value as all complaints can be seen in initial phase and reacted on quickly
The focus on the life cycle and life cycle costing so on the long 20 year term
The dialogue sessions as they provide compromises such as short waiting lines in catering
The contract form (DBMFO) leading to a more integral approach in relation to FM
Involving FM in the design leads to less mistakes as they are specialists in logistics
In the dialogue the client asked on how the cooperation between architect and FM would affect the design and the usage of material
The client control mechanism for the development team were of great help, also when the building was delivered, relieving the pressure
They looked at a period after 20 years in terms of building usage (dwellings structure and lay out), great use of exploitation and good for rest value
The internal walls are of steal and magnetic, easy to maintain and flexible due to the integral appr
And the detailing of the toilets by FM leads to easy maintenance
It is important to invest more for maintenance in the design and realization phase in order to increase efficiency in exploitation phase
Processes not creating value

Communication technical department

Flow (Case 2)

Barriers
The facade created problems in terms of maintenance, also wind creates a problem here
The abstract OS it is more creative for the development team but also creates more needed communication
This was a complex project, more difficult to budget and therefore it had cost more
There were 2 frost periods, putting a hold on the building process
Everything goes through the dialogue sessions which also takes time (there are two main dialogue sessions)
The internal walls did not match the acoustic criteria, the integral approach of the development team did not satisfy this aspect
Communication between fm and technical department
The continuity barrier was a problem, as the project group changed in various periods leading to loss of knowledge (not same people in realization)Organizational
Creating a balance between FM and developer in terms of esthetics and functionality
FM does not have the experience to make decisions in the pre execution phase leading to problems such as the floor
Rubber floor is difficult to maintain they also decided not to coat creating more problems, FM and architect did not want to coat, focus on environment. Index
The formulation of the OS took one year time because of inexperience
In juridical terms, the dialogue can be very time consuming

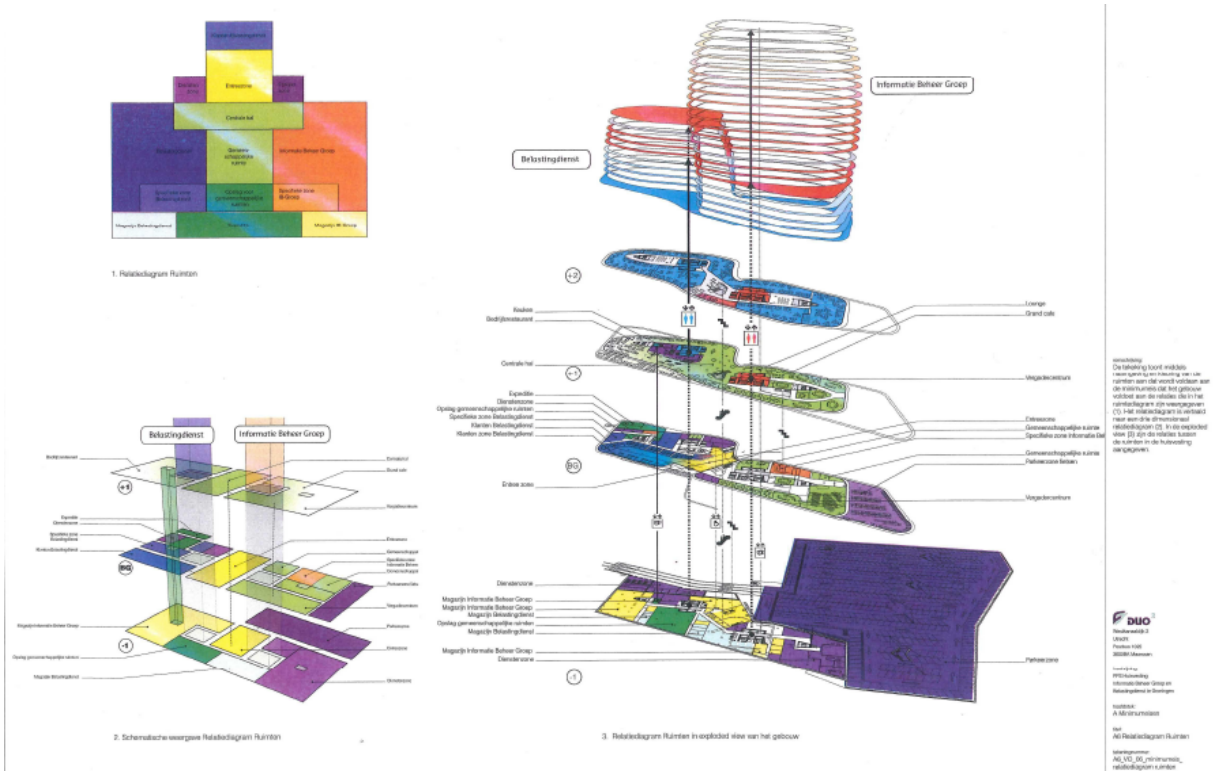
Pull (Case 2)

Scheduling
FM did not have a clear say in the planning
The internal fm was not involved in the planning
Developer was in charge of the schedule
The development team (including FM) had to make compromises with the planning
All risks are assessed and parties state of they agree with the planning (also FM) with plus and minus
In the design a roll container was set, but FM needed a press container, in the scheduling phase they decided to largen the building for FM demand

Perfection (Case 2)

Improvements
As ISS was earlier involved in the VO than in the Safire project, this led to better design in terms of FM
The use of FMIS for direct feedback in the usage phase
There are project evaluations with shareholders and stakeholders
The RGD wants to make use of BIM in future projects for improvements
It is difficult to make use of previous experience as each project is unique
There are not a lot of new projects to use previous experience
There are a lot of parallels to use from this projects with new projects in the future
BIM has been used by the architect, leading to see inefficiencies

Appendix 7- Secondary data cases



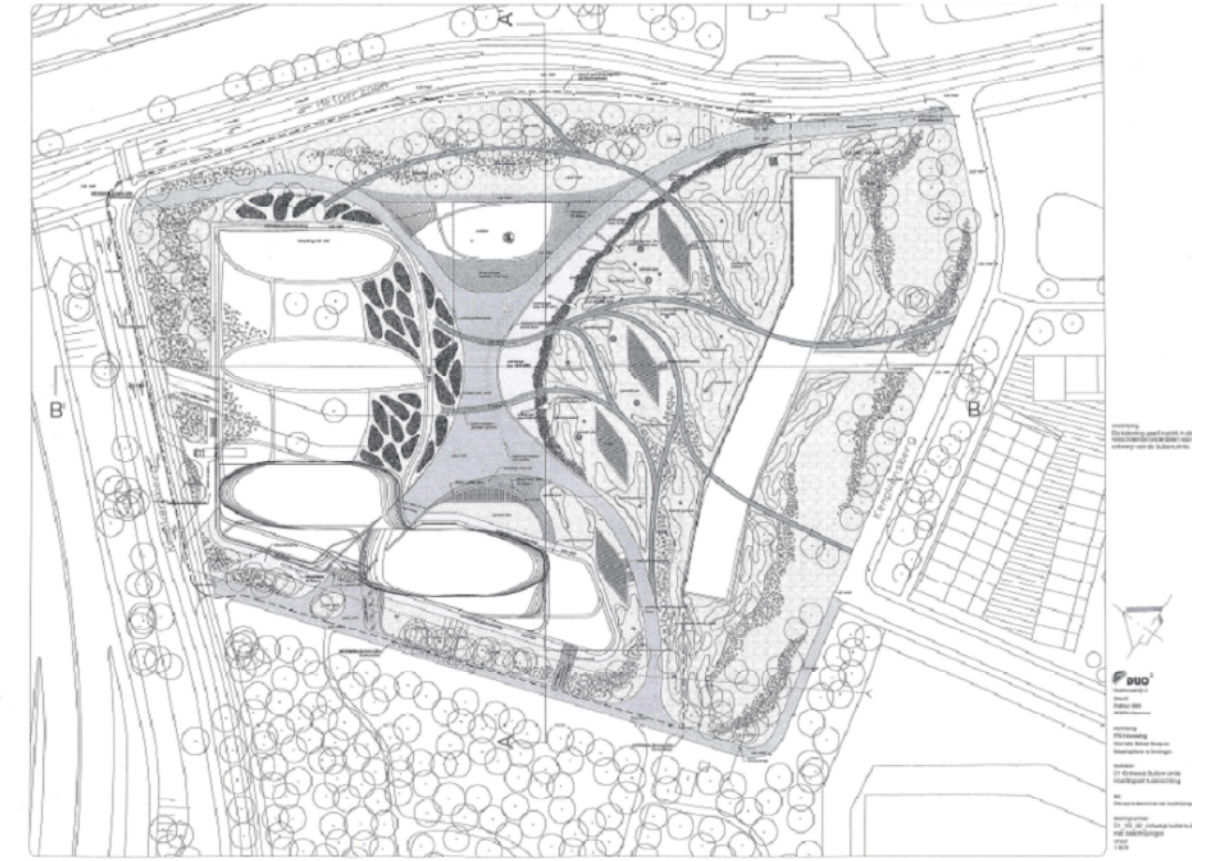


Figure 78- Illustrations DUO Groningen, layout plan and map

De bordjes met kantoorruimtenummers worden uitgevoerd met het etagenummer (klein en vet) met direct daarnaast een groot volgnummer. Het bordje heeft een afmeting van ca. 20 x 20 cm en wordt direct aangebracht op de wanden naast de deuren.

De lifthal maakt deel uit van de horizontale verkeersruimte en staat in verbinding met de kantoorruimten op de verdiepingen. Er is dus zicht op de verdieping zodra men uit de lift stapt. Iedere liftkern bestaat visueel uit twee losgekoppelde volumes. De wanden van deze volumes worden afhankelijk van de organisatie en afdeling anders vormgegeven. Zo sluit de kleurstelling aan bij het kleurconcept dat ontwikkeld is voor de organisatie. In materialisering en uitstraling zijn het beeldbepalende elementen, die over vrijwel de gehele verdieping uiting geven aan de identiteit van de hier gehuisveste organisatie.

Naast de bewegwijzering die gebruikt wordt om een afdeling of ruimte te vinden, wordt het gebouw tevens voorzien van vluchtwegaanduidingen. De plaats van de vluchtwegaanduidingen maakt integraal deel uit van het ontruimingsplan en wordt getoetst door de brandweer.

CIRCULATIE EN LOOPLIJNEN

Verticale verkeersruimten

De verticale verkeersruimte bestaat voor beide kantoorvleugels uit een liftkern, een hoofdtrappenhuis nabij de liftkern en een vluchttrappenhuis aan de punt van de kantoorvleugel. De liftkern en de aan deze liftkern gekoppelde trappenhuizen zijn specifiek voor een organisatie (laagbouw: Belastingdienst, hoogbouw: Informatie Beheer Groep). De capaciteit van de liften is afgestemd op het aantal medewerkers. Het vluchttrappenhuis wordt alleen gebruikt in noodsituaties. De deuren zijn aangesloten op het brandalarm.

Er zijn totaal vier liftkernen te onderscheiden, te weten de liftkern voor de hoogbouw, de laagbouw, de lift voor mindervaliden van de kelder naar de begane grond en de goederenlift naar het restaurant . De brandweerliften hebben allemaal als ondergrens de -1 verdieping. De overige liften vertrekken van de eerste verdieping. De liftkernen zijn alleen bereikbaar door de toegangspas aan de kaartlezer aan te bieden. Bij aankomst op de verdieping moet de kaart opnieuw worden gescand om de verdieping te betreden.

De trappenhuizen van de hoogbouw worden tussen laag 11 en 12 om brandtechnische redenen gescheiden. Toegangscontrole bij het hoofdtrappenhuis vindt plaats bij het betreden en verlaten van het trappenhuis. Hier moet de toegangspas worden aangeboden. Het vluchttrappenhuis is aangesloten op het brandalarm en is alleen in noodsituaties toegankelijk.

De centrale vide is per laag gerelateerd aan de kantoorverdiepingen. Hier zijn ontmoetingsplekken voor de betreffende afdeling gepositioneerd. Tussen de afdelingen kan verticaal transport plaatsvinden via de hoofdtrappenhuizen of kunnen in de vides, afhankelijk van de uiteindelijke wens van de gebruikers, trappen worden geplaatst.

Horizontale verkeersruimten

Op de begane grond worden bezoekers door de vorm van het gebouw naar de entree geleid, die van twee zijden toegankelijk is. Deze entree is ruim gedimensioneerd, zodat een goede doorstroming plaats kan vinden. Vanuit de entreehal zijn de klantenhal en het vergadercentrum bereikbaar. Ook deze verkeersruimten zijn ruim gedimensioneerd.
De eerste verdieping met het bedrijfsrestaurant en het vergadercentrum zijn via een roltrap (voor bezoekers onder begeleiding van een medewerker) bereikbaar.

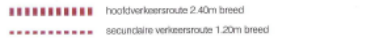
Op de kantoorverdiepingen is een hoofdroute en een secundaire route. Op een natuurlijke wijze kunnen de medewerkers op de verdiepingen via de hoofdroute van de ene zijde naar de andere gaan. De secundaire route is smaller en geeft toegang tot de rustige, meer gesloten kantooromgeving. Deze primaire en secundaire route vormen een rondgaande gang met aan de binnenzijde de facilitaire functies. De liftkern maakt deel uit van deze rondgang.

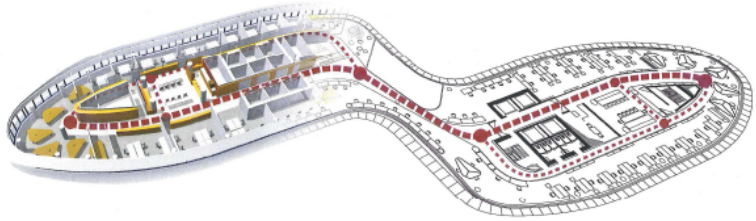
Stallingen

De parkeergarage is functioneel vormgegeven en biedt plaats aan 570 parkeerplaatsen voor de Informatie Beheer Groep en de Belastingdienst, inclusief opstelruimte voor voertuigen voor de FIOD/ECD (2 stuks) en CA/Autoheffingen (2 stuks) naast de apparatuurruimte waar informatie uit (auto-)apparatuur wordt overgeheveld naar apparatuur in deze ruimte. Op drukke dagen kunnen 125 parkeerplaatsen gebruikt worden naast het nieuwe NS station. Deze zijn door DUO² gereserveerd voor personeel van de Informatie Beheer Groep en de Belastingdienst. Van de 570 parkeerplaatsen zijn er 20 bestemd voor bezoekers en 10 voor mindervaliden. Daarnaast worden nog eens 10 parkeerplaatsen extra gerealiseerd voor het personeel van de dienstverleningsorganisatie. De mindervalide- en bezoekersparkeerplaatsen zijn in de onmiddellijke nabijheid van de toegang tot het gebouw gesitueerd. Speciale aandacht is besteed aan de rijroutes en een looppad voor medewerkers naar het entreegebied. Het 'zebrapad' komt uit bij de toegang tot het gebouw, die een directe verbinding heeft met de entreehal en de centrale hal.

De fietsenstalling ligt op de begane grond en heeft een capaciteit van 1.350 fietsen en 150 scooters/motoren. Vanuit de fietsenstalling kunnen de medewerkers na het aanbieden van de toegangspas via de speedlanes rechtstreeks naar de roltrappen.

VOORBEELD VAN HET BORDJE MET KANTOORRUIMTENUMMERS
In kleine cijfers het verdiepingnummer en groot het ruimtenummer





SCHEMATISCHE WEERGAVE
Logistieke route op de verdieping met de hoofdverkeersroute en de (smallere) secundaire gang met de verbindingen

145 J1 VISIE LOGISTIEK CONCEPT

DUO² INSCHRIJVING INFORMATIE BEHEER GROEP EN BELASTINGDIENST TE GRONINGEN

Figure 79- Illustrations DUO, logistical plan and office renders

Appendix 8- Facility management value map

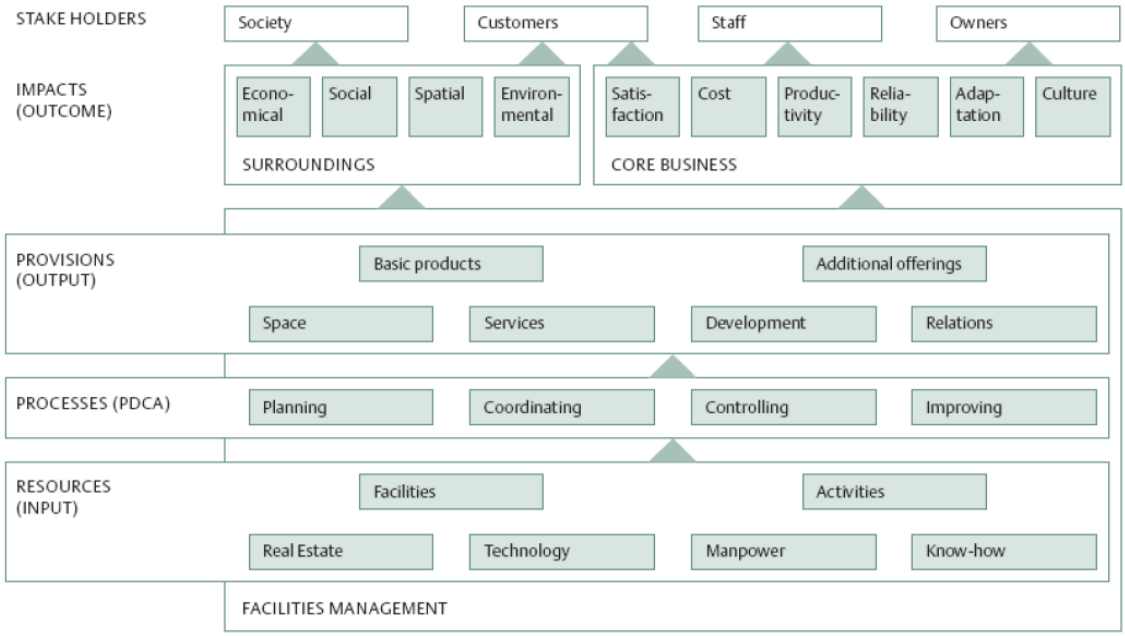


Figure 80- FM Value map (Emeraldinsight, 2012: online)

Appendix 9- Facility management timeline

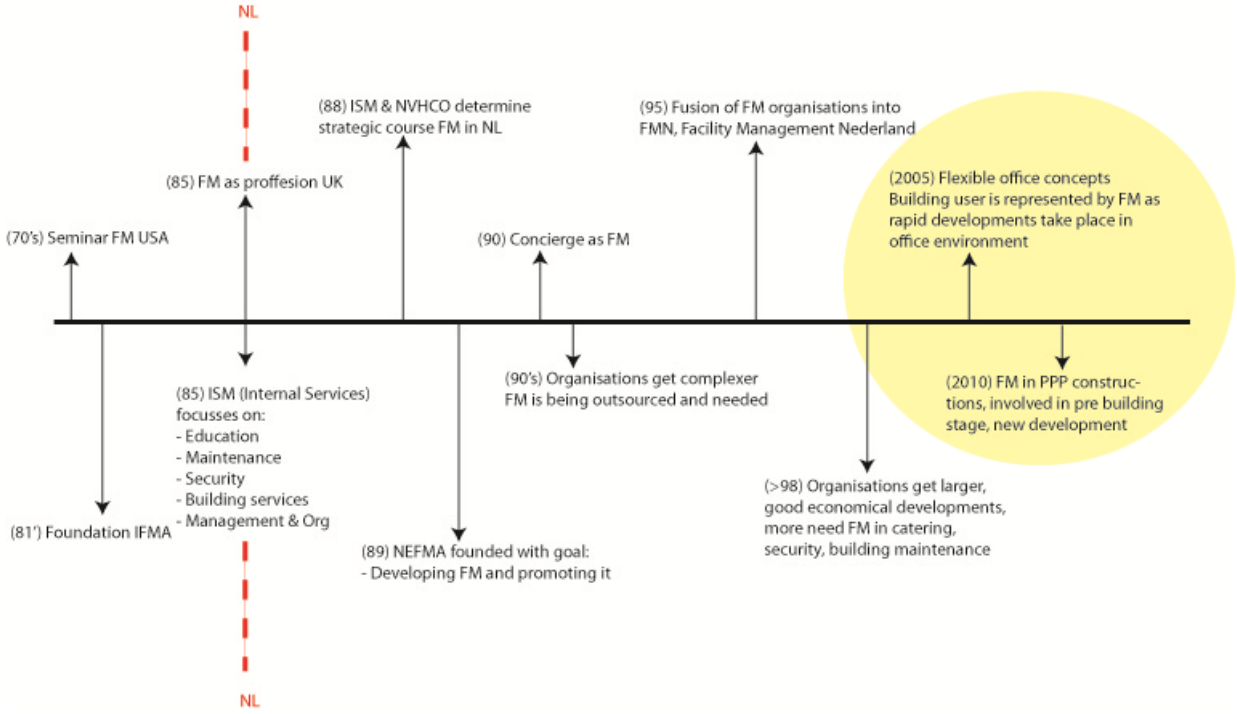


Figure 81- FM Timeline