

**“AgiLean PM”**  
**– A UNIFYING STRATEGIC FRAMEWORK**  
**TO MANAGE CONSTRUCTION PROJECTS**

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## **Abstract**

A challenge in Lean Construction is how to make it applicable when there is a high degree of complexity and uncertainty. In many construction projects there are changing project requirements, unique products and a need for actions that are highly focused on meeting customer/client expectations. Such scenarios require management methods that are characterised by being flexible and able to react to change. The aim of this thesis is to introduce a method that has such characteristics. Project Management, Lean and Agile paradigms are merged through the application of the fission and fusion approach of nuclear physics. This research is facilitated through a sequential explorative method. In the first instance, interviews with 22 practitioners in the fields of construction project management, Lean and Agile have been conducted. Then a quantitative self-administered questionnaire with 213 useful responses has been utilised to validate the transferability of the interview findings. It is concluded that Lean is not ideally suited to dealing with the dynamic nature of construction projects. Agile methods, which were developed to cope with the high levels of uncertainty inherent to IT projects, are more flexible and able to react to change. Hence utilising Agile-based methods might be the key to the successful utilization of Lean in construction. Therefore a management method based on combining Lean and Agile approaches has potential. Such an approach needs creative thinking to develop a solution that is different to that of “Leagile”. Leagile uses Lean and Agile methods in the execution phase sequentially, through using a decoupling point model to separate the two. This thesis introduces a new paradigm in which such a decoupling or separation does not take place. Rather, project management, Lean and Agile have been merged together to develop a new holistic and strategic framework. The paradigm presented in this thesis is termed “AgiLean Project Management”.

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# 1 Introduction

Gann (1996) and Crowley (1998) argue that the construction industry can learn from other industries. This is not a new idea. But if one considers the high complexity and the uncertainties which construction projects are facing,

*“[...] it might well be that management techniques that improve performance in other industries are not readily transferable to this context, if construction follows a different logic then it might even be a mistake to try to adopt management techniques applied in other contexts”* (Dubois and Gadde, 2002, p 622).

AgiLean Project Management [PM] is the result of a synthesis between PM, Lean and Agile. It is derived from leading paradigms of other industries, but it is tailored for construction. The term “AgiLean PM” has been for the first time coined by the researcher of this work and his first supervisor. The following sections will give an overview about the research context, problem and aim. After this the scope of this work and a short guide about the thesis will be provided.

## 1.1 Research context

Construction is one of the oldest disciplines of human endeavour (Ritz, 1994). The management of construction projects has been already carried out since the first time people have worked together to construct facilities (Walker, 2007). Over the centuries, the construction sector faced a lot of new technical challenges, which have been managed well as more and more new projects are completed (Ritz, 1994; Dubois and Gadde, 2002). However the focus was mostly on the technical challenges, i.e. in constructing the project (Dubois and Gadde, 2002), as yet there is little documented knowledge of how people interacted with these processes (Walker, 2007). Furthermore Walker (2007) found out that the focus of the writers over the ages has been upon the construction projects themselves, particularly on aesthetics, the use of new materials, technological developments and the impact of construction facilities on the environment. The management and organisation of projects has received less attention (Walker, 2007).

Gidado (1996, p. 214) argues further that the “*continuous demands for speed in construction, cost and quality control, safety in the work place avoidance of disputes, together with technological advances, economic liberalization and globalization, environmental issues and fragmentation of the construction industry have resulted in a spiral and rapid increase in the complexity of construction processes*”.

Hence construction projects can be classed as complex projects; and complex projects call for new management paradigms (Williams, 1999). Greater attention to the further development of the management of construction tasks and processes is required (Walker, 2007). While setting the focus on new ways which allow coping with today’s highly complex construction projects a new management paradigm, called “Lean construction”, became highly topical over the past two decades. Today Lean’s “[...] *core principles (flow, value, pull, minimizing waste etc.) have become the paradigm for many manufacturing (and service) operations*” (Lewis, 2000, p. 959). The term “Lean” was introduced by researchers of the Massachusetts Institute of Technology, who focused on the significant performance gap between Western and Japanese car manufacturers (Bhasin, 2005).

Lean means “[...] *a third form of production system, one capable of producing more and better vehicles in less time, in less space and when using fewer labour hours than the mass or craft production systems that proceed it*” (Ballard and Howell, 2003a, p. 120), i.e. to add value without waste (Liker, 2004).

The general approach of the Lean management philosophy is to eliminate waste (Womack et al. 1990; Womack and Jones, 2003; Liker, 2004).

To enable Lean to work in construction, the view of construction has to be changed. Projects have to be seen as temporary production systems (Ballard and Howell, 2003a).

*“When those systems are structured to deliver the product while maximizing value and minimizing waste, they are said to be “Lean” projects”. “Lean project*

*management differs from traditional project management not only in the goals it pursues, but also in the structure of its phases, the relationship between phases and the participants in each phase” (Ballard and Howell, 2003a, p. 119).*

Hence, projects have to be viewed as temporary production systems, in order to create a stable platform. This stable platform will allow categorisation of tasks; they can be divided into value adding, non-value adding and waste activities (Koskela, 2000). This enables the pursuit of perfection within the project (Womack and Jones, 2003).

However, even if the constructed facility is static in its nature, the environment of construction projects is highly dynamic. This dynamism is created because of unknown factors, which in turn cause changes (Collyer and Warren, 2009). Hence considering that construction projects will change over their project life cycle, like any other project, leads to the understanding that the dynamics in a construction project cannot be avoided. This is in contrast with production, which comprised of a static environment (Eccles, 1981), where Lean originated from. The unique nature of construction activities presents certain dilemmas for implementing Lean in construction. Firstly, Lean is good in static environments where a high repetition and a low variety exist, as it needs a stable platform where processes can be forecasted and optimised (Andersson et al., 2006). Secondly, Lean is not good in dealing with highly dynamic environments where low repetition and a high variety exists, which is typical of construction projects, “[...] *as there is no room for flexibility due to the focus on perfection* [...]” (Andersson et al., 2006, p. 289).

Advances of the theory of Lean construction have not been reflected by widespread adoption of Lean in construction practice. Indeed the industry is still struggling to implement the complex combination of Lean thinking, principles and tools to much of construction-related activity. It is this complexity that perhaps explains why it has not been widely implemented in the construction sector. Lean in construction was introduced by Koskela (1992), four years after the term “Lean” was introduced by Krafcik (1988) to production. Comparing

developments in production with those in construction indicates that the construction industry has not reached the same level of implementation and usage of Lean. This suggests that there might be barriers to implementing Lean in construction which need further investigation (Mossman, 2009).

To address some of the limitations of Lean in construction new paradigms linked to Agile management methods are receiving more and more attention in the sector. The concepts of agility are not new to manufacturing (Iacocca Institute, 1992), nor to IT (Agile Alliance, 2001), but are in their infancy within construction (Owen and Koskela, 2006a). The developments in manufacturing and IT took place independently (Kettunen, 2009) and according to Owen and Koskela (2006a) originated from the Deming Cycle. The origin of Agile management methodologies in construction can be linked to the Agile developments in both manufacturing and IT (Owen et al., 2006; Owen and Koskela, 2006a; Owen and Koskela, 2006b). All Agile management paradigms, however, are generally associated with the same concept, which is that a rigid or static project planning cannot cope with a dynamic project environment.

Nevertheless, the PM discipline has to deal with two environmental typologies. On the one hand it is highly dynamic, but on the other it becomes increasingly static as the project proceeds (Sidwell, 1990). This has led to the focus on combining Lean and Agile paradigms together sequentially (Naylor et al., 1999; van Hoek, 2000; Mason-Jones et al., 2000; Goldsby et al., 2006), which is called “Leagile” (Naylor et al., 1999). The demand for Leagile came through viewing the whole supply chain (van Hoek, 2000). The current market place within which organisations are operating consists of two environmental typologies. On the one hand demand being relatively stable, predictable and with variety low (Atiken et al., 2002). On the other hand, demand being volatile and the customer requirement for variety high (ibid.). Therefore researchers who are involved in supply chain management disciplines tried to benefit from the relative strengths of Lean and Agile management paradigms through using them sequentially (Naylor et al., 1999; van Hoek, 2000; Mason-Jones et al., 2000; Goldsby et al., 2006). To facilitate this, the “decoupling point model” was developed by Naylor et al.

(1999). The decoupling point is the point at which the supply chain switches from one paradigm to the other (Mason-Jones et al., 2000). Hence, Lean and Agile paradigms should not be seen as competing, but rather as overlapping, paradigms when considering the whole supply chain (Narasimham et al., 2006). However, concepts of agility are still immature for construction (Owen et al., 2006) and therefore Leagile construction is in the very early stages of development.

## **1.2 Problem statement and research question**

Tah et al. (1993) and Nassar et al. (2005) as well as Meng (2012) argue that poor performance in terms of time and cost overruns is a common issue in construction projects. Corfe (2011) explains further that there is a need for performance improvement, because a construction project is exposed to different pressures by its environment. These pressures can be related to globalisation and competition, external market influences, risk and uncertainty, and the continuous desire of the clients to get more value for less money (Corfe, 2011). Hence there is an increase in the level of the complexity of construction processes (Gidado, 1996). Construction projects face meanwhile new problems, which are more complex. Paradoxically, these problems are still managed with management methods, which are not up to date anymore. Therefore there is a need for new management practices, which will improve performance when planning and constructing the project (Pan et al., 2007).

In search for such new management practices, the industry got attracted to Lean construction. Because, early proponents of Lean argued that the result of Lean construction is a new delivery system which can be applied to any kind of construction - see, for example, Howell (1999). This would include complex projects with high degrees of uncertainty and time compressed schedules. However, the practical achievements of using Lean in construction do not always reflect those stated in theory. This can be related to the debate about the implementation of Lean construction, which is extremely one sided (Green, 1999a; Green, 1999b; Green and May, 2003). There are barriers and limits of using Lean in construction, which have been already identified in manufacturing

outside of Japan and barriers which are unique for construction. Instead of changing the nature of Lean so that it is better aligned with construction, the Lean movement has focused on re-conceptualising the nature of construction, with the general approach being to make construction more like production (Latham, 1994; Egan, 1998; Wolstenholme, 2009).

Changes and uncertainty, or changes caused by uncertainty in the project life cycle create a dynamic environment in construction. Manufacturing, in turn, consists on a static environment and dynamic product. This has been realised by Ballard and Howell (1998) who stated that for construction projects Lean production is insufficient, as well as by Egan (1998, p. 18), who argued that the “[...] *parallel is not with building cars on the production line; it is with designing and planning the production of a new car model*”. To keep the Guru-Hype alive Ballard and Howell (1998; 2004) argue that Lean construction differs from Lean production in a way that it is able to deal with the dynamic nature of construction projects, but complexity needs to be reduced (Ballard and Howell, 1997), changes are not welcomed (Gabriel, 1997) and the industry needs to be defragmented (Egan, 1988), all that just to push for Lean in construction.

An alternative approach may be to re-emphasize construction as projects. So a Lean management approach needs the ability to react to change and become more flexible. This is not currently the focus of Lean construction approaches, as it requires a stable platform where processes can be forecasted with a high degree of certainty and hence can be optimised. Winch (2006) argues further that if Lean construction has the requirement of viewing construction projects as temporary production systems, then the core of this temporary production system should be based on uncertainty management.

Lean construction, therefore, might be improved with the inclusion of Agile paradigms. Agile PM methods focus on the team as an important expertise factor, aiming to satisfy the client and react to uncertainty (Chin, 2004; Hunt, 2006; Dyba and Dingsoyr, 2008).

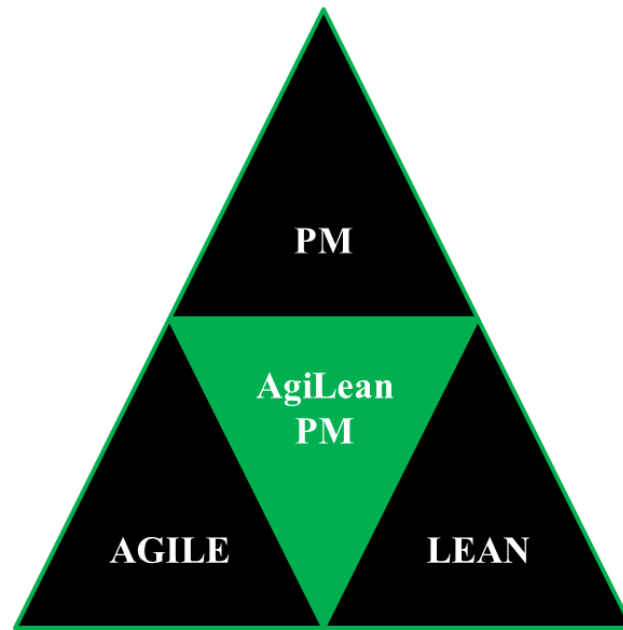
As a result, the construction industry faces two ways to implement Lean. One is to change the characteristics of the construction industry so that Lean is more applicable. The other is to change Lean. The first approach is to reduce the construction projects' complexity and the second approach is to develop a method to be able to deal with that. This study proposes the second approach. Dealing with complexity is related to being more flexible, more Agile. Therefore Lean needs to be more Agile if it wants to reach the same amount of acceptance in practice as it has achieved in theory.

To do this there is a need for a method which is labelled as "AgiLean PM". In this sense the term "AgiLean" is carefully chosen, as preferable to other alternatives, such as "Leagile". "Leagile" uses Agile in the preconstruction phase and then has a de-coupling point to switch to Lean in the execution phase (Naim and Barlow, 2003). The notion of "AgiLean" is that the foundation is Lean, but that in some situations, including through the execution phase, Lean needs to be "agitated" i.e. become more irregular, rapid and agile – hence "AgiLean".

By undertaking a synthesis of PM, Lean and Agile, the research question is as follows:

*How can a universal and unifying strategic framework based on PM, Lean and Agile be generated?*

The combination of PM, Lean and Agile which is conceptualised in this research project as "AgiLean PM" eliminates waste in the processes and is able to react to change. This new innovative management method could be the best way of dealing with the complexity in construction projects in order to achieve maximum performance in future. Figure 1-1 gives an overview of the proposed new management method.



**Figure 1-1 synthesis of AgiLean PM**

AgiLean PM is underpinned by universal PM methodologies, such as those from the Project Management Institute [PMI] on the strategic level. At the operational level it synthesises modern management paradigms, such as Agile and Lean. This ensures that the whole project view is taken. It enables the right paradigm to be chosen depending on the requirements of the project. The outcome is the management of project uncertainty in an effective and efficient manner.

### **1.3 Research aim and objectives**

The aim of this research project is to develop a unifying strategic framework for managing construction projects, which is conceptualised as “AgiLean PM”. To achieve this aim the following objectives have been derived:

- Objective 1.** To assess the suitability of Agile manufacturing and Agile IT paradigms to construction.
- Objective 2.** To identify the strengths and weaknesses of traditional PM, Lean and Agile in relation to the management of complex construction projects.
- Objective 3.** To explore the perceptions of traditional PM, Lean and Agile among industry practitioners.

- Objective 4.** To analyse the influence of moderating variables, such as country context and party involved on the perceptions of traditional PM, Lean and Agile.
- Objective 5.** To develop a framework for the management of complex construction projects based on PM, Lean and Agile principles.

The relationships between the objectives can be illustrated through the following figure.

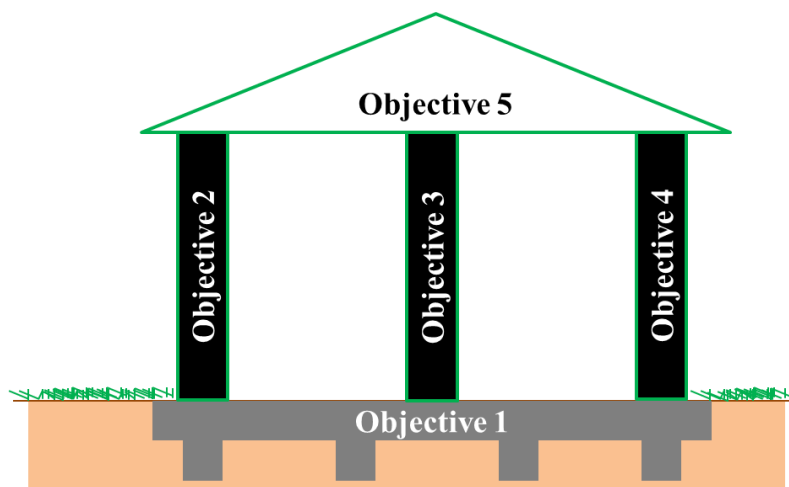


Figure 1-2 relationship between research objectives

As illustrated in Figure 1-2, objective one is the underpinning objective of this research. The assessment will tell if further considerations in objective two and consequently three should be on Agile manufacturing or Agile IT. The first objective will be achieved through reviewing the literature. The columns of this research are the objectives two, three and four. Objective two will focus on identifying the strengths and weaknesses of the different management paradigms. This will be facilitated through the literature review and through the collection of qualitative interview data from the practitioners in the fields of PM, Lean and Agile. Qualitative data, however, is criticised that it is unstructured and unreliable (Denzin and Lincoln, 2005). To validate the transferability of the qualitative data collected a quantitative survey will be conducted in objective three, which is based on the interview findings. PM, Lean and Agile have been reported in a more

general manner. There has been little research specifically focused on comparing the perceptions about PM, Lean and Agile in a country context and between the parties involved in construction, i.e. is Lean perceived the same in Europe as it is in North America, or is Agile perceived by the architects in the same way as it is by the contractors, and so forth. This gap will be addressed in objective four with the questionnaire. The outcome of objective four will give an indication about the universality of the AgiLean PM framework. Finally objective five will synthesise PM, Lean and Agile and enable answering the research question. This will be achieved through the translation of the nuclear fission and nuclear fusion approaches.

#### **1.4 Research scope**

The scope of this research is primarily on developing the concepts and principles of the AgiLean PM framework. This research does not provide methods for implementation, but rather wants to keep the AgiLean PM framework more universal and generic. A “construction project” means different things to different individuals (Ritz, 1994). Therefore there are many ways of categorising or classifying construction projects. However, within the scope of this research, the focus will be on dynamic projects. According to Collyer and Warren (2009) dynamic projects are characterised by their uncertainties, which exceed the known factors. Hence the more unknown factors a project consists of, the more dynamic it is. AgiLean PM is made to be a strategic framework. If this research needs to be associated with any party involved in construction (client’s side, designer’s side, and contractor’s side), then is this research associated with the client’s side, as the parties there are more related to the strategic level and have a holistic view about the project life cycle.

#### **1.5 Guide through the thesis**

This thesis is divided into seven chapters. The current chapter introduced the field of research and defined the aim and objectives of this study. The second chapter will provide an overview about the recent developments of PM, Lean, and Agile

through conduct of a literature review. The third chapter will discuss the philosophical approach of this work. This chapter is followed by the research method. Then in chapter five, the findings of the collected data will be presented. Chapter six covers the framework development. Finally conclusions will be drawn and the contribution to knowledge will be stressed in chapter seven.

## 2 Literature Review

This chapter of the thesis aims to obtain a deep understanding of the salient concepts of PM, Lean and Agile and wants to identify the strengths and weaknesses of those. To facilitate this, the following sections aim to critically review, compare, and contrast the relevant literature in the above mentioned fields. The literature review consisted of reviewing PM, Lean, Agile and Leagile literature. The focus was on key literature from the past and current developments in those different management fields. References have been integrated within the narrative to support the discussion.

### 2.1 Overview about Construction projects and PM

In this section a succinct review of the salient literature about construction PM will be provided. To highlight the dependencies and relationships, a top-down approach has been chosen, i.e. going from abstract to detail.

#### 2.1.1 Illustration of the current environment of construction PM

Construction consists predominantly of a project based environment (Carrillo et al., 2013). Alzahrani and Emsley (2013) argue that the successful completion of construction projects is an important issue for the society, because the physical development of construction projects, i.e. bridges, roads, skyscrapers and infrastructure projects, reflects the economic growth of the country. Paradoxically, Tah et al. (1993) and Nassar et al. (2005) as well as Meng (2012) elaborate that poor performance in terms of cost and time overruns is a common issue for construction projects. Hence project performance improvement seems something which is unavoidable for construction projects (Zhang and Fan, 2013).

The current environment of construction projects is characterised with an increase of project complexity. Ochieng and Price (2008) and Ochieng et al. (2013) related the increase of complexity to the globalised environment, which construction projects are facing nowadays. This globalised environment results in multicultural

project teams with team members from different cultures and countries (Ochieng,2008). In the construction environment, each party has accepted the temporary nature of the construction project and is solely focused on the own interests (Ochieng et al., 2013). Hence cultural differences in a globalised construction environment can cause more conflicts, and misunderstandings, which can consequently result in poor performance (ibid.). Another interesting observation which can be made is that the culture of the industry becomes similar between different countries. For instance Li et al. (2012) reflect principle characteristics of the construction environment between China (Hong Kong) and the UK, which are similar. Ochieng et al. (2013) showed similar characteristics between Kenya and the UK. Hence the construction environment, which was perceived as something local, acts more and more global and shows similar characteristics worldwide. This explains why scholars refer in their publications to the construction environment in general and do not put anymore the country context behind, i.e. construction in UK, construction in Kenya, or construction in the USA. Given this generalisation of the construction environment, views and perceptions about the construction environment can be used in a general manner, too.

Hence Polat and Donmez (2010) experienced that the construction industry is characterised by extreme competitiveness and low profit margins. Hoonakkera et al. (2010) report the increase of client expectations, where the clients expect more service quality and more value for less money. Yang and Kao (2012) emphasised that construction projects face difficult situations during execution, have many interfaces, many stakeholders and are also influenced by external factors (for instance external market influences). Hence the current construction environment is changing rapidly (Hwang and Ng, 2013), because it is exposed to different forces. This is illustrated in Figure 2-1.

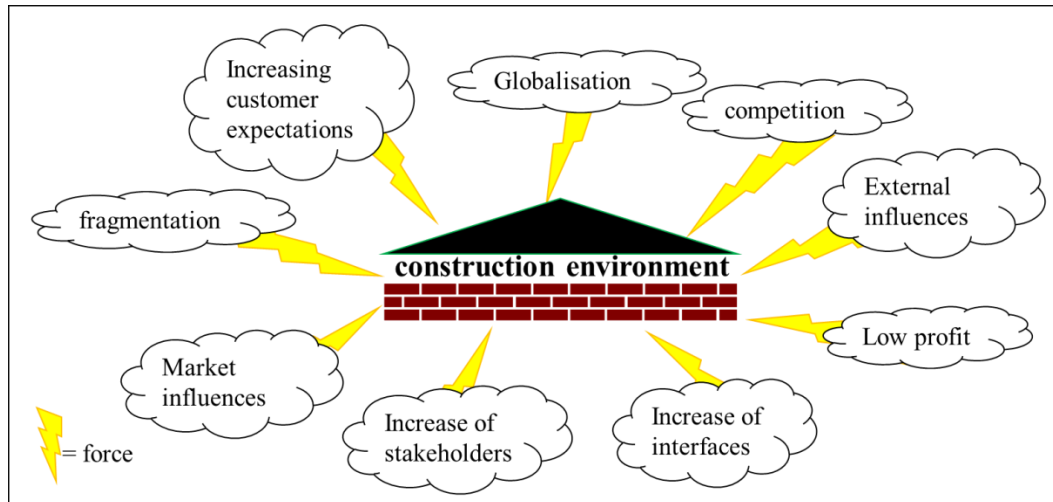


Figure 2-1 Illustration of the construction environment

The forces illustrated in Figure 2-1 result in that the project complexity is increasing. Hence the sources of project complexity are wide ranging as for instance described by Ochieng et al. (2013): *“The continual need for improved speed, cost, quality, safety, together with technological advances, environmental, issues and fragmentation through the construction industry, have contributed to the increased complexity of construction projects”*.

However, the construction environment is changing (Hwang and Ng, 2013) and the construction projects are exposed to different uncertainties and risks (Cruz and Marques, 2013). The ideas behind traditional PM, which is bound to control and monitoring, are changing, too (Labelle and Leyrie, 2013). Hence even if the construction environment can be meanwhile generalised to different country contexts (Li et al., 2012; Ochieng et al., 2013), construction projects are perceived as social constructs, which are unprotected to change, risk and uncertainty (Cicmil et al., 2006; Morris, 2010).

### 2.1.2 Construction projects and their industry

According to Bennett (2003) construction is big business.

*“The industry’s significant impact on the world economy can be demonstrated by reviewing construction’s proportion of the total value of goods and services, as well as the number of people employed in construction as a proportion of the total workforce and the number of construction firms compared with the total business in all industries”* (Bennett, 2003, p. 3).

It is also one of the key economies in the United Kingdom [UK], as the share of the gross domestic product [GDP] is about 6.8% (Office for National Statistics, 2013). The whole of the European construction industry is highly fragmented with medium and small sized companies (Egan, 1998; Walker, 2007), which is in contrast with other sectors (Eccles, 1981; Winch, 1989; Egan, 1998; Walker, 2007).

However construction has a project character (Bennett, 1983; Knoepfel and Burger, 1987; Winch, 2003, Kochendoerfer et al., 2007; Toor and Ofori, 2008; Carrillo et al., 2013), i.e. construction is mostly characterised by the management of projects. In order to provide the reader with the contextual meanings of the used terminologies, such as construction, project, construction project, and PM, it is worth getting an understanding of these and their relationships.

According to the Project Management Institute [PMI] (2008, p. 442) a project is “[...] *a temporary endeavour undertaken to create a unique product, service, or result*”. A quite similar definition can be found at the Association for Project Management [APM] (2006, p. 150), where a project is defined as a “[...] *unique, transient endeavour undertaken to achieve a desired outcome*”. The German standard DIN 69901-5 (2009) as well as the British standard BSi 6079-1:2010 (2010) define the main characteristic of a project as a transient and unique endeavour. Furthermore the British standard 6079-1:2010 (2010, p. 4) has defined the following principal features and characteristics to projects:

1. *Their duration is usually predetermined (finite) with definite start and end dates*
2. *What happens during the undertaking of a project invariably affects the subsequent events both inside and outside the organisation*
3. *The project organisation is often temporary and can sometimes change through the project lifecycle*
4. *All projects are undertaken in an environment of risk and uncertainty*
5. *Projects are seldom carried out in isolation, and can often interact with other projects and organisational entities*

“Construction project” as a term, means different things to different individuals (Ritz, 1994). Woudhuysen and Abley (2004) relate this to the fact that every human is or will be in some way involved in building, hence everyone has an opinion about construction and its industry. Santana (1990, p. 102) defines a construction project “[...] *as the sum of planned activities, material or otherwise, of an organization to convert an idea or a design for engineering or construction work to fulfil human or economic needs within limits of quality, cost and duration*”. Other researchers tried to define construction projects through a categorisation of different construction project types (Ritz, 1994; Bennett, 2003; Winch, 2003). Bennett (2003) divides the construction industry into two very broad categories, which are general building construction and engineered construction. General building construction includes residential, commercial, institutional and industrial buildings, i.e. in which the design is prepared mainly by architects (ibid). Engineering construction includes highway construction, dams, tunnels, pipelines, marine structures, bridges, i.e. in which the design is rather prepared by engineers than architects, because the focus is more on functionality rather than aesthetics (ibid). Kochendoerfer et al. (2007) argue that there is also a relationship between “Basic Life Function” and “Construction Project Type”, when categorising construction projects. This is illustrated with the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at:  
Kochendoerfer, B., Liebchen, J. H., & Viering, M. G. (2007). *Bau-Projekt-Management - Leitfaden des Baubetriebs und der Bauwirtschaft* (3rd ed.), p. 5. Wiesbaden: Teubner Verlag.

Figure 2-2 construction project categorisation (Kochendoerfer et al., 2007, p.5)

Figure 2-2 shows that each construction project has a large impact on society and the wider environment. In this respect there are numerous parties who can affect or can be affected by the outputs and outcomes of a construction project (Eccles, 1981; Gann, 1996; Chinyio and Olomolaiye, 2010), which makes the management of construction projects a complex task.

### 2.1.3 Complexity of construction projects

Not all projects are difficult (Boddy and Paton, 2004), but projects or project processes are those that usually deal with highly customised products, ill defined, uncertain and sometimes changing activities (Slack et al., 2008). Slack et al. (2008, p. 108) argue that project processes are almost certainly complex “[...] *because each unit of output is large with many activities occurring at the same time* [...]”. Furthermore construction projects are amongst the most complex of all project undertakings (Winch, 1989; Baccarini, 1996; Winch, 2003; Raiden et al., 2004; Winch, 2006) and are one of those projects which are plagued most by uncertainties (Tah and Carr, 2000) as well as are one of the most hazardous industries world-wide (ILC, 2003; Sacks et al., 2009). Gidado (1996) argues that the complexity of construction projects can be divided into two categories, on the one hand the managerial perspective and on the other the operative and technological perspective. The complexity of the managerial perspective, when realising a construction project is related to the following factors (ibid, p. 217):

- *Management is unfamiliar with local resources and the local environment*
- *Lack of complete specification for the activities at the construction site*

- *Lack of uniformity of materials, work and teams with regard to place and time (every project is unique)*

The complexity of the operative and technological perspective is related to the following (ibid, p.217):

- *The number of technologies involved in a task, repetition of their roles and interdependences*
- *The rigidity of sequence between the various main operations*
- *The overlap of stages or elements of construction*

Cox and Goodmann (1956), Eccles (1981) and Vrijhoef and Koskela (2000) as well as Dubois and Gadde (2002) argue that there is also high complexity in logistics, when realising a construction project, because the requirements for delivering the variety of materials is changing from project to project, which works against routine working. If it is an overseas project there are many additional problems such as market situations, knowledge and language (Walker, 2007; Badenfelt, 2011). The increasing client expectations resulted in specialised niche markets with a lot of different types of workman and a high variety of experts (Eccless, 1981; Walker, 2007). This high variety of project participants resulted in multiple feedback loops and non-linear relationships (Lee et al., 2006), consequently ending up with the management of firms rather than functional scope management (Eccles, 1981; Reve and Levitt, 1984; Winch, 1989; Walker, 2007). Walker (2007) argues that the complexity of construction projects will continue increasing, because the demands of the clients in regard to the functionality, aesthetics, the capital and running costs, environment and sustainability as well as the schedule will increase. This is related to factors such as “[...] *technological developments, globalisation, uncertain economic conditions, social pressures, political instability*” (Walker, 2007, p. 2). Basically the complexity of construction projects can be related to dynamic problems of the construction processes (Baccarini, 1996; Gidado, 1996), resulting in that the construction sector is representing one of the most dynamic industrial environments (Raiden et al., 2004).

#### 2.1.4 The dynamic construction environment

Even if the constructed facility is static the environment of construction projects is highly dynamic (Sidwell, 1990). The term “dynamic” is characterised by “constant change” (Oxford Dictionary Thesaurus, 2001, p. 388), further in a PM context, Jaafari (2001, p. 89) defined dynamic as “[...] *exhibiting varying degrees of uncertainty over time*”, i.e. it is a project dimension representing “[...] *the extent to which a project is influenced by changes in the environment in which it is conducted*” (Collyer and Warren, 2009, p. 355). Hence the dynamism of construction projects can be related to changes caused by uncertainty. Pender (2001, p. 81) defined uncertainty “[...] *as the variability of future outcomes where probability distributions cannot be constructed*”, consequently risk applies “[...] *when there is repetition and replicability. Uncertainty applies when there is no prior knowledge of replicability and future occurrences defy categorisation*”. Hence uncertainties create changes (Atkinson et al., 2006) and those changes create a dynamic environment, which can be related to the “top-down” planning of construction projects (Winch, 1998; Koskela and Vrijhoef, 2001; Bertelsen, 2003). This is in contrast with the “bottom-up” planning approach (Sabatier, 1986; Koskela and Vrijhoef, 2001). The top down management or planning approach has been criticised by Winch (1998) as well as Koskela and Vrijhoef (2001) for not promoting innovative solutions for construction, because a problem solving strategy cannot be applied, as it is with the bottom up approach (ibid.).

However, PM is understood as the management of changes (Gabriel, 1997; Voropajev, 1998; Saynisch, 2005) and changes make the top down approach suitable for construction, because a project faces many unknown factors (Pickering, 2004; Collyer and Warren, 2009; Sheffield and Lemetayer, 2013), i.e. uncertainties (Love et al., 2002a; Atkinson et al., 2006), which cannot be planned in detail at the beginning of the project (Rodrigues and Bowers, 1996; Chapman, 1998; Atkinson et al., 2006; Cui and Olsson, 2009; Denyer et al., 2011; Sheffield and Lemetayer, 2013). Therefore there is a relationship between the number of unknowns and the dynamisms of a construction project, which has been illustrated by Collyer and Warren (2009) in Figure 2-3 as follows:

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at:  
Collyer, S., & Warren, C. M. (2009). Project management approaches for dynamic environments. *International Journal of Project Management*, 27(4), p.356.

Figure 2-3 relationship between uncertainty and dynamism (Collyer and Warren, 2009, p. 356)

Hence the above figure shows that the more changes caused by unknown uncertainties a project is facing, the more dynamic will be the project (Collyer and Warren, 2009). The sources of uncertainty are wide ranging and have an effect on the project (Atkinson et al., 2006). Rosel (1987, p. 251) identified the following changes, which might be caused by uncertainties in a construction project:

- The uniqueness of each project
- Changing designer teams consisting of architects and engineers and formed only for that project
- Awarding of unknown contractors, where decisions were only made because of the lowest tender price
- The uncertainty about the qualitative, quantitative and physical performance of the successful tenderers and their staff
- Ground conditions
- Changing material costs
- Weather conditions

One way to deal with the dynamic environment of construction projects is to make it static through freezing the design and rejecting change orders (Collyer and Warren, 2009). However, many changes are caused by the client, because of new ideas and the lack of noticing the project concept during different phases (ibid.; Levander et al., 2011). Levander et al. (2011) related this to the client's difficulty to gather the right information, because in most cases construction clients are not familiar with building. This might be the reason, why there is a gap between the need for information by the client and the submitted information by

the PM (Turner and Muller, 2004). This means that the information expected by the client does not match with the submitted information by the PM, which might result also in distrust (ibid.). However, considering that construction projects have powerful clients (Ankrah et al., 2005), the result is that the dynamic nature of construction projects cannot be made easily static, because the customer satisfaction would suffer from this (Bourne and Walker, 2005). This consequently makes change management a key element of PM (Love et al., 2002a; Wu et al., 2005). Changes can occur in the project or in its environment and are normally not expected (Voropajev, 1998). Knowledge plays an essential role when managing the changing demands of construction projects (Senaratne and Sexton, 2008). However, considering that each project is unique in its circumstances (Loosemore, 1999; Toor and Ofore, 2008; Ibbs and Liu, 2011) the result is that the knowledge and experience cannot be directly transferred to other projects (Winch, 1989; Pender, 2001). Over time the uncertainties of a project will get reduced, because more knowledge will be gained, which will also result in there being a reduction in changes (Pender, 2001). However, there is still the desire for “[...] *room to manoeuvre* [...]”, to be able to adjust the project during its project life cycle (Olsson, 2006, p. 66). Hence it can be consequently concluded that there is also a need for being flexible when undertaking a construction project.

Flexibility will help the project team to cope with unexpected problems (Walker and Shen, 2002; Osipova and Eriksson, 2013; Cruz and Marques, 2013). Furthermore it will help to simplify the building process and reduce cycle times (Sacks et al., 2010). Being flexible is related to communication, because communication plans in the project have to be established, which will allow the detection of changes (PMI, 2008). This requires feedback channels within the construction project (Rodrigues and Bowers, 1996), which have been illustrated by Kartam (1998) and are shown below.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at:  
Kartam, N. A. (1998). Making effective use of construction lessons learned in project life cycle. *Journal of Construction Engineering and Management*, 14(2), p. 15.

Figure 2-4 feedback channels in project life cycle (Kartam, 1998, p.15)

Those feedback channels in Figure 2-4 will result in lessons learned during the construction project's life cycle and continuously improve the project (Kartam, 1998). Furthermore they will warrant the understanding of the interrelationships between the tasks (Rodrigues and Bowers, 1996). However, besides the flexibility achieved through communicative feedback channels, Rodrigues and Bowers (1996) as well as Chapman (1998) relate the ability to cope with the dynamic environment of construction projects to the use of a PM system, because the management tools are dynamic, as they are able to respond to new information.

### 2.1.5 Universal PM systems

Previously the researcher reflected the definition of a project and a construction project. Almost all definitions of the term project refer to this combination of “[...] *uniqueness, defined objectives, limited time cycle, and three fold constraints (cost, time, and quality)*” (Williams, 2005, p. 497). Wysocki (2006, p. 8) categorised projects in four broad areas, which is illustrated in Figure 2-5 below:

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Wysocki, R. K. (2006). *Effective Software Project Management*, p. 9. Indianapolis: Wiley Publishing.

Figure 2-5 project types (Wysocki, 2006, p. 8)

The above categorisation of Wysocki (2006) covers projects which are linear (defined goal and solution), iterative (defined solution but no defined goal), incremental (defined goal but no defined solution) and adaptive (no clear goal and solution). Construction PM deals mainly with linear projects (ibid). According to Liu and Wang (2007) linear projects are characterised by the configuration of several activities into separated phases (units), performing the work sequentially. Universal PM systems are also mainly under the umbrella of linear projects (Larman and Basili, 2003; Owen and Koskela, 2006a). Two international professional organisations dominate and represent the knowhow and knowledge of universal PM systems (Saynisch, 2005, p. 559), which are listed below:

- *The International Project Management Association (IPMA), which is more European oriented*
- *The Project Management Institute (PMI), which is more U.S.-oriented.*

The IPMA is subdivided into further national PM associations, like the Association for Project Management [APM] in the UK, German Project Management Association [GPM], Cyprus Project Management Society [CPMS] or the Turkish Project Management Association [TrPMA] (International Project Management Association, 2012). The IPMA focus of this thesis will be on the APM and its Body of Knowledge [BoK], because it is widely used in different countries and is the most common one. Both, PMI and APM have defined Bodies of Knowledge [BoKs], what is considered as core knowledge for the management of projects (Williams, 2005). The PMI's BoK uses five phases to represent the project life cycle and divides the knowledge into nine areas which need to be in place when managing a project (PMI, 2008). The IPMA's BoK for the UK, i.e. APM (2006), gives seven sets which are subcategorised into 52 areas of knowledge. Construction PM Practitioners are using these BoKs for achieving full professional status for PM (Winch, 2006). The geographical location is more determining the kind of certification, because local BoKs have more reputation in their area (Saynisch, 2005). This research will use both APM and PMI BoKs, because it wants to benefit through exploring both universal PM systems.

### 2.1.6 Construction project management

Mainly three parties are involved in a construction project, which are the owner, the designers and the contractors (Nassar et al., 2005). Each of these individuals have their own objectives and threats when realising a construction project (Zhi, 1995). In more common situations, it is the case that the owners have not the required skills and qualifications for undertaking their projects on their own (Reve and Levitt, 1984). Therefore owners are normally hiring a project manager to manage the design and the construction processes of the project (ibid.; Low, 1998; Sommer, 2009). Consequently PM is an overall discipline, in which the project manager is responsible for the “[...] *overall success of delivering the owner’s physical development within constraints of cost, schedule, quality and safety requirements*” (Edum-Fotwe and McCaffer, 2000, p. 111). This definition of construction PM reflects also the normal definitions of PM. The APM defines PM as “[...] *the process by which projects are defined, planned, monitored, controlled and delivered such that the agreed benefits are realised*” (APM, 2006, p. 2). A quite similar definition is stated by the PMI, where they described PM as “[...] *the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements*” (PMI, 2008, p. 6). Hence, all definitions emphasise the importance of meeting the project requirements. A central role of the PM is to manage the parties involved in construction (Edum-Fotwe and McCaffer, 2000; Kochendoerfer et al., 2007; Lonergan, 2009). Kochendoerfer et al. (2007) found out that all the parties involved in construction also have different perspectives on the project aims and objectives. They argued further that the owner will always try to achieve the maximum in quality and functionality at the lowest costs and risks. The same applies analogously for the designers, but with the difference that the focus on better solutions might cause higher costs. The focus of the contractors is on costs rather than other factors. This has been illustrated through the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Kochendoerfer, B., Liebchen, J. H., & Viering, M. G. (2007). *Bau-Projekt-Management - Leitfaden des Baubetriebs und der Bauwirtschaft* (3rd ed.), p. 54. Wiesbaden: Teubner Verlag.

Figure 2-6 weighting of project aims and objectives (Kochendoerfer et al., 2007, p. 54)

Figure 2-6 emphasises that the aims and objectives of all parties involved have to be balanced by the PM to reach the optimum (Kochendoerfer et al., 2007). Sommer (2009) argues that the task of the PM is to take the tasks of the owner. The tasks of the owner are to define the target for the purpose and scope of the construction project brief; creation of the project structure and determination of contract typologies; decision making and securing of decisions; monitoring of time, cost and quality targets; ensuring the financing and marketing (ibid.). Further focus will be on project organisational issues, as it seems more relevant for the research aim and objectives.

#### **2.1.6.1 Organisational structure**

The people involved make projects complicated and not the technical problems which the projects are facing (Okmen and Oztas, 2010). The extended use of subcontracting allowed on the one hand to transfer risks and achieve more flexibility, but on the other it made the project coordination more complex (Raiden et al., 2004). Considering that the client appoints a project manager to act as his agent (Reve and Levitt, 1984; Low, 1998; Kochendoerfer et al., 2007; Sommer, 2009), the result is that the PM has a more integrative character (Low, 1998; Lenfle, 2011), which has been illustrated for construction projects as follows:

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at:  
Low, S. P. (1998). back to the basics: biblical wisdom for effective construction project management. *International Journal of Project Management*, 16(4), p. 210.

Figure 2-7 the project management approach (Low, 1998, p. 210)

Figure 2-7 shows that among other things the task of the PM is to integrate the design and construction in order to achieve the aims and objectives of the client. Hence effective PM can be only achieved, if there is cooperation between the design team and the building team (Low, 1998). There are several ways of organising a construction project (Bennett, 1983; Sidwell, 1990; APM, 2006; Girmscheid, 2007; PMI, 2008; Sommer, 2009). APM (2006) and the PMI (2008) distinguish between functional-, matrix- and pure project- organisational structures. Sommer (2009) on the other hand distinguishes between hierarchic, group dynamic and organisational monolithic. The effectiveness of the project organisation depends on different factors (Bennett, 1983; Sidwell, 1990; APM, 2006; Girmscheid, 2007; PMI, 2008; Sommer, 2009). Sidwell (1990, p. 162) related the effectiveness of the project organisation on the “[...] *technology of the project, its size, the project environment, role and relationships of team members, and the degree of management control*”. Mostly the pure project organisational structure is preferred in construction (Girmscheid, 2007). According to Toor and Ofori (2008) this results in the focus of managing the teams and the day to day work, rather than leading the project participants to long term objectives. However, “[...] *project management requires that projects are seen as being subdivided into separate tasks each of which can be made the responsibility of a separate team*” (Bennett, 1983), which is achieved on the one hand through the project organisational structure and on the other through structuring the project (APM, 2006; PMI, 2008; Sommer, 2009).

### 2.1.6.2 Project Structure

The role of the project organisation is to integrate the separate teams into one unit in order to achieve a good project performance (Bennett, 1983; Low, 1998; Lenfle, 2011). The aim of the project structure is to provide for those in the project organisation a common framework for communicating information regarding cost, scope and schedule (Ayas, 1996; D'Arrigo and Smith, 1996; Kochendoerfer et al., 2007). This is achieved through breaking the project down into smaller manageable tasks (APM, 2006; Winch, 2006; PMI, 2008). The work breakdown structure [WBS] is a tool for this (D'Arrigo and Smith, 1996). The APM (2006, p. 34) articulated the difference between a WBS and a product break down structure [PBS] as follows:

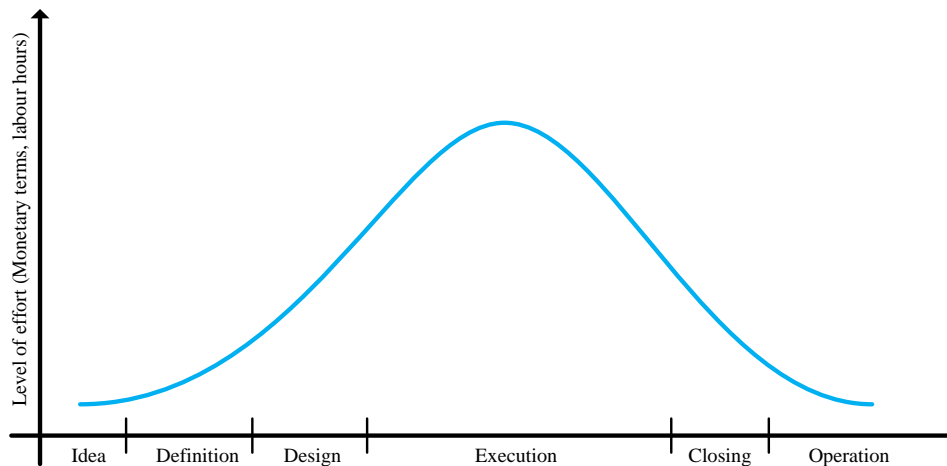
- *The PBS defines all the products (deliverables that the project will produce. The lowest level of a PBS is a product (deliverable).*
- *The WBS defines the work required to produce the deliverables. The lowest level of detail normally shown in a WBS is a work package.*

Hence a WBS is organising the work with a small task oriented hierarchal listing of activities (D'Arrigo and Smith, 1996). This results in different levels. According to Globerson (1994) as well as Kochendoerfer et al. (2007) the first level of the WBS is the project; the second level might refer to the functions or components; the third level includes all further attributes. There are also different types of WBSs (Globerson, 1994; APM, 2006; Kochendoerfer et al., 2007; PMI, 2008). In the context of construction PM the most commonly used are object oriented WBS, activity oriented WBS and logic (mix of activity and object) oriented WBS (Kochendoerfer et al., 2007). When to choose which type of WBS depends on the project and its organisational structure (Globerson, 1994; Ayas, 1996). The commonality of the different WBS types is that each level represents an objective of the project for a managing unit (Ayas, 1996). The work packages of the WBS can be correlated to the people from the organisational structure and responsibilities can be clearly defined (D'Arrigo and Smith, 1996; APM, 2006). However, a WBS is not a static system. Given that a project changes over time

(Voropajev, 1998), and considering that the WBS is reflecting the project scope (PMI, 2008), results consequently in the change of the WBS according to the altering needs and constraints. These changes require changing PM systems for different project situations during the life cycle of a project (Globerson, 1994).

### ***2.1.6.3 The project life cycle and situational project management***

All projects go through different phases and through a typical life-cycle (Ritz, 1994). Figure 2-8 shows the different phases of construction projects and the level of effort required in each respective phase. “*The construction project team is a living organism, at each phase in the project life-cycle it transforms in structure and style*” (Sidwell, 1990). Jaafari (2001) distinguishes here between strategic PM, which sets the aims and objectives from a life cycle perspective as basis for further decision making; and activity based PM where the focus is more on the processes in a respective operative phase. The focus of the researcher will be on the strategic PM where the whole life cycle (as shown in Figure 2-8) will be considered.



**Figure 2-8 project life cycle<sup>1</sup>**

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<sup>1</sup> Content adopted from Ritz (1994) and PMI (2008) and Bennett (2003), Figure is own Figure.

It is the aim of the strategic PM to achieve the project objectives through the different project phases (Association for Project Managers, 2006), as shown in Figure 2-8. The PM needs to define, with its existing workshop tools, the aims and objectives of the client. This will enable the determination of the project success criteria, as project success is perceived differently by different individuals (Chan and Chan, 2004). The successful completion of a project can be conceptualised in different ways. DeWit (1988) differentiates between PM success and project success. PM success focuses on the management of the “Iron-Triangle”; meeting cost, time and quality objectives (Atkinson, 1999). PM success can be seen as a part of the project success. But the project success considers more factors than the Iron-Triangle, such as stakeholder satisfaction, performance of the end product or service, and motivation (deWit, 1988; Chan and Chan, 2004). A project may not be considered as successful, even if it stayed within the planned cost, time and scope framework, if the customer or key stakeholders are not satisfied (Bourne and Walker, 2005), or vice versa. Besides this, the project success criteria can change through the life cycle of a project (Voropajev, 1998). Furthermore different phases can have different success criteria (Bennett, 2003). Sidwell (1990) goes further and argues that different phases need also different organisational and management styles, which are able to fulfil the project needs of the respective phase. This is illustrated by the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Sidwell, A. C. (1990). Project management: Dynamics and performance. *Construction Management and Economics*, 8(2), 159-178.

**Figure 2-9 situational holistic project management (Sidwell, 1990, p. 160)**

Hence, Figure 2-9 shows that a whole project view is required (Kagioglou et al., 2000), which makes PM at the strategic level essential.

The researcher has previously discussed that the top down management approach, which means the planning from a macro view to a micro view (from abstract to detail), must allow room for changes, as at the beginning of a project, detailed planning, is in most cases, not possible. These project dynamics also create uncertainties which affect the management styles of the PM (Shenhav and Dvir, 1996). As a result of project dynamics, and the resulting changes in the project the PM is required to make clear and timely decisions otherwise the project will falter (APM, 2006). Decisions might not be the most appropriate if they are made too early or too late (PMI, 2008). Therefore in addition to different phases, the PM is facing different situations where the “[...] *project team must be able to assess the situation and balance the demands in order to deliver a successful project*” (PMI, 2008, p. 7). These different situations require different leadership styles (Hersey and Blanchard, 1982), but also different management styles (Globerson, 1994), because the relationship “[...] *between PM and performance may vary with managerial style*” (Lewis et al., 2002). So, besides the different management styles in the different phases, the PM style or PM system needs to adapt to different situations in the dynamic nature of construction PM in order to be able to meet the contemporary needs of the project (Ancona and Caldwell, 1992; Papadimitriou and Pellegrin, 2007). “*Managers for instance, may alter their approaches in response to new resource allocations, changes in market demand, progress by competitors on similar projects, or novel scientific discoveries*” (Lewis et al., 2002, p. 551).

An effective construction PM plan needs to be focused on value for the client and performance driven (i.e. focused on effective and efficient processes) (Winch, 2006; Geraldi, 2008; Koppenjan et al., 2011; Osipova and Eriksson, 2013). The potential for changing the PM plan, because of different situational aspects in the project life cycle, is iterative (PMI, 2008), because construction projects change over their life cycle (Eccles, 1981; Gidado, 1996; Dubois and Gadde, 2002; Badenfelt, 2011). “*Project Management is an essentially straight-forward concept*” (Bennett, 1983, p. 183). But over time new ideas come up, new technological advances are introduced (SI-Sedairy, 2001), which might have significant impacts on the PM system (Love et al., 2002a). Therefore, only those

projects will not fail where the PM is able to increase the speed of learning and matching the changing project requirements on time (Raiden et al., 2004; Gareis, 2010). This results in a need for flexibility and agility for construction projects (Walker and Shen, 2002).

As a result, successful managers have to use iterations between their management methods in order to be able to respond to changing project circumstances (Lewis et al., 2002). Even, if the project managers know that each situation or stage of a project requires adaptation to the particular circumstances; Rodrigues and Bowers (1996) and Chapman (1998) as well as Atkinson et al. (2006) argue that the traditional PM methods are too focused on operational planning. The result is that they struggle to incorporate the consequences caused by dynamics. Therefore what seems to be missing is a PM framework which is able to cope with the different situational circumstances (Shenhar and Dvir, 1996). In addition, there seems to be a gap in the current literature, which shows a PM framework that is control and flexibility oriented at the same time (Winch, 2006; Geraldi, 2008; Koppenjan et al., 2011; Osipova and Eriksson, 2013).

## **2.2 Lean construction**

Lean provides increased productivity by eliminating the wasteful activities and continuous improvement of processes through constantly monitoring them. The benefits of Lean construction have been related to cost and time savings as well as quality improvements (Anderson et al., 2012; Sarhan and Fox, 2013). Besides the quite “old school” areas of new builds, recent studies focused also on the implementation to other types of construction projects. As such, Pasquire (2012) reported that the implementation of Lean construction principles will result in increased value in engineering projects. Bryde and Schulmeister (2012) found out that Lean is applicable also for refurbishment projects and will consequently result in better project success. A broader perspective was provided by McGrath-Champ and Rosewarne (2009), who have described the potential benefits of restructuring the construction industry in Australia, to a model which is in line with the Lean concepts, consequently comparable to the production industry.

However, the practical achievements of using Lean in construction do not always reflect those stated in theory. This can be related to the debate about the implementation of Lean, which is extremely one sided (Green, 1999a; Green, 1999b; Green and May, 2003). Given the extremely positive sided interpretation of Lean construction, this section aims to provide a deep understanding of Lean construction i.e. philosophies, thinking, tools and methods through providing a critical literature review. This section is concluded with an overview about the Last Planner System, so that the reader gets a clear understanding about Lean construction.

### **2.2.1 Definition of Lean**

Construction projects can be articulated as complex projects, and complex projects call for new management paradigms (Williams, 1999). In the search for new paradigms to manage construction projects (Sanderson and Cox, 2008), meanwhile, the construction industry promotes a new management paradigm, originated in the automotive industry to get widely adapted and implemented which is called “Lean” (Green and May, 2003; Green and May, 2005; Jorgensen and Emmitt, 2008). The term “Lean” was introduced by Krafcik (1988) who defined Ford’s mass production system with the term “Buffer” and used the term “Lean” as contrasting words to describe what Toyota did or is still doing. The Lean philosophy has been first summarised in detail by Womack et al. (1990, p. 13) who stated that

*“Lean production [...] is ‘lean’ because it uses less of everything compared with mass production - half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also results in many fewer defects, and produces a greater and ever growing variety of products”.*

Later Womack and Jones (2003) have focused on how to implement Lean in organisations. They concluded that Lean is more than using or adapting tools and best practices from Toyota (ibid). It is a way of thinking which has been defined as follows (Womack and Jones, 2003, p. 15):

Lean thinking “[...] *provides a way to specify value, line up value-creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively. In short, lean thinking is “lean” because it provides a way to do more and more with less and less human effort, less equipment, less time, and less space - while coming closer and closer to providing customers with exactly what they want.*”

To be able to implement Lean, the following principles have been derived (Womack and Jones, 2003, p. 10):

1. *Specify **value** by specific product*
2. *Identify the **value stream** for each product*
3. *Make value **flow** without interruptions*
4. *Let the customer **pull** from the producer*
5. *Pursue **perfection***

To conclude so far, the Lean principles as well as the term “Lean” are developed and introduced by the International Motor Vehicle Programme, which consists of researchers of the Massachusetts Institute of Technology [MIT], who tried to describe the key success factors of Toyota in an abstract way to make them applicable for one’s own organisation in the West and to make it applicable for other industries (Womack and Jones, 2003).

### **2.2.2 Topicality of Lean in construction**

The basic idea which has been created by the management team of Toyota was to eliminate waste in the internal processes (Ohno, 1988). Trying to work efficiently and effectively is nothing new for construction (Winch, 1998), but the Lean movement today created an enormous amount of complexity which disables the understanding of Lean in construction (Green and May, 2005), following also in a trend of “Lean less” in PM (Agerfalk and Fitzgerald, 2006).

Even if the advocates of Lean in construction have still not agreed on a definition of the term “Lean” and “Lean Construction” (Mossman, 2009), resulting in no common understanding of the term in practice (Green and May, 2005), Lean thinking or the term “Lean” on its own is still trendy in the construction industry. It has a “Guru-Hype” character (Green, 1999b), resulting in a debate which is extremely one sided interpreted in construction research (Green, 1999a). This Guru-Hype character of Lean is facilitated through neglecting or not considering the critical literature and research which exists on Lean production (Green, 1999b), before giving trials on it in the construction industry. Furthermore, because of this Guru-Hype character, things which did exist before or things which are not related to Lean management methodologies are articulated as Lean, because it is efficient and effective. This is articulated by Hines et al. (2004, p.1006) as follows: “[...] *any concept that provides customer value can be in line with a lean strategy, even if lean production tools on the shop floor, such as kanban, level scheduling, or take time, are not used*”. Researchers who consider only the positive aspects of Lean do neglect the new existing theory, which is that a tool is Lean when it full fills the Lean principles because the Lean principles fulfil Lean thinking. In Lean production, there is a clear relationship between thinking, principles and tools (Womack and Jones, 2003), which cannot be neglected (Koskela, 1996), which in fact does not exist for Lean construction (Mossman, 2009). If there is a tool or method, which is effective and efficient in the project life cycle of a project, but does not fit into the Lean principles and therefore not in the frame of Lean thinking, quite simply, this tool or method is effective and/or efficient in management and not Lean. The Concept of being Lean in construction is not that simple, as it “[...] *consists of a complex cocktail of ideas including continuous improvement, flattened organisation structures, teamwork, the elimination of waste, efficient use of the resources and co-operative supply chain management*” (Green, 1999b, p. 23), otherwise it would be widely implemented in the construction sector.

Lean advocates argue that the current PM theory, such as suggested by the PMI (2008), is obsolete in today’s dynamic and globalised construction projects (Koskela and Howell, 2002a; Koskela and Howell, 2002b; Koskela and Ballard,

2006). Furthermore the promoters of this modern management paradigm stated that construction is more backward in PM performance in comparison with other industries (Latham, 1994; Egan, 1998; Bertelsen, 2003; Winch, 2003; Ballard and Howell, 2004). This view is not shared by Woudhuysen and Abley (2004, p. xi) who stated that:

*“[...] who can truly say that construction is any more backward than the markets it serves? Anyone old enough to remember the labour-intensive building sites of the 1950s, with their rows of batch mixers discharging into wheelbarrows to be pushed and pulled up ramps of scaffold boards to distant formwork, would have to concede that today’s tower craned and weatherproofed construction site, served by trucks making just-in-time deliveries of pre-mixed concrete and pre-engineered assemblies, represents a tremendous advance in organisation methods”.*

Construction has defined and will continue defining the PM discipline (Wysocki, 2006), because the construction industry is a lively source of new ideas (Winch, 1998), which can be related to the high pressure and the solving of problems in a time and cost effective fashion (Alves et al., 2009). The industry tries always to work efficiently and effectively, as for example prefabricated elements have been introduced into construction in order to save costs and provide higher quality to the customer long before Lean approaches in construction existed (Gann, 1996). PM will be always an essential part of construction (Winch, 2006). The perception that the construction PM practitioners are performing poorly in PM is not shared, as reflected by a recent survey of Bryde (2008) who declared that the practitioners of PM in construction believe that their sector is performing significantly better than other sectors, in terms of PM performance. This brings us to the creation of purpose arguments (Latham, 1994; Egan, 1998), which are established to create a need for Lean in construction (Green, 1999b).

Comparing the flip side of the same coin, Lean in construction was initiated by Koskela (1992) four years after the term “Lean” was introduced by Krafcik (1988) to production. Comparing the Lean developments in production with the developments in construction shows clearly that the construction industry has not

reached the same level of implementation and usage of this still new management paradigm, with the conclusion that not construction PM but Lean in construction might be more backward than in other industries.

Another perspective of the dramatic success in the UK of Lean construction, which is also related to the one sided interpretation of Lean construction, is according to Green (1999a; 1999b) and Green and May (2003) related to the evangelical nature of the key literature. Evangelical in that sense, is derived by evangelism which could be interpreted as “gospel” or “good news”. In search of the “good news” Green (1999b) as well as Green and May (2003) found the following quotes:

*“In the pages ahead we’ll explain in detail what to do and why. Your job, therefore, is quite simple: just do it! (Womack and Jones, 2003, p.)*

*“Lean thinking presents a powerful and coherent synthesis of the most effective techniques for eliminating waste and delivering significant sustained improvements in efficiency and quality. We are impressed by the dramatic success being achieved by leading companies that are implementing the principles of "lean thinking" and we believe that the concept holds much promise for construction as well”. (Egan, 1998, p. 22)*

These “good news” have been articulated by Green (1999b, p. 23) as that “[...] the reader is not required to think, or waste time reading any other books, or indeed to waste time gaining education. All of these are considered as muda<sup>2</sup> and irrelevant to the quest for improved productivity”. More than that, Green and May (2003, p.99) stated that “It is almost as if the available research literature is screened in accordance with an ideological filtering system”.

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<sup>2</sup> “Muda” is the Japanese word for “waste”.

### 2.2.3 Barriers and limits to Lean in the construction industry

The construction industry is dominated by medium and small-sized companies (Egan, 1998; Walker, 2007), which explains why the industry acts more locally than it acts globally (Woudhuysen and Abley, 2004). That is not only the case in the UK. The structure and the acting behaviour can be transferred to the whole of the European construction industry (Bennett, 2000). This characteristic results in a high attention to flexibility in Europe's built environment, which is not similar to the United States of America [USA]'s or to Japan's construction industry (ibid.). Hence a fragmented construction market creates the ability to act flexibly when dealing with highly variable workloads (Egan, 1998; Raiden et al., 2004). However, this fragmented nature of the construction industry means a functional differentiation for construction projects (Reve and Levitt, 1984; Winch, 1989; Low, 1998; Zanelidin, 2006). Therefore this requires in a construction project, besides the high variety of workmen, such as “[...] *carpenters, bricklayers, plumbers, pipefitters, electricians, painters, roofers, drywallers, sheet metal workers, glaziers, and labourers*” (Eccles, 1981, p. 337), also an increasing variety of experts, e.g. architects, quantity surveyors, structural engineers, mechanical and electrical engineers, acoustics, safety (Walker, 2007). Even on a small project there are large numbers of involved parties and contributors (ibid). The coordination and management of the work of these specialists is also a complex task (Cox and Goodmann, 1956; Eccles, 1981; Vrijhoef and Koskela, 2000; Dubois and Gadde, 2002; Walker, 2007; Ibbs and Liu, 2011), which is unique for each project (Winch, 1989; Gidado, 1996; Loosemore, 1999; Pender, 2001; Toor and Ofore, 2008) and the result is that the mapping of the supply chain in any construction project is next to impossible (Bertelsen, 2003). This high variety of involved specialists and contributors result not only in a functional separation, but also in a separation of firms (Eccles, 1981; Winch, 1989; Egan, 1998; Walker, 2007), which have to be managed as well in the framework of a construction project. This is a major difference in comparison to other projects (Winch, 1989; Winch, 2003).

However, if one does not want to consider the critical literature caused by trials of adapting Lean production in other countries than Japan (Cusumano, 1994; Dedoussis, 1995; Humphrey, 1995; Morris and Wilkinson, 1995; Lillrank, 1995; Recht and Wilderom, 1998), it might be interesting to know that in Japan the midsized and small-sized companies are not using any Lean approaches (Dohse et al., 1985; Recht and Wilderom, 1998). The Lean advocates have tried to implement Lean construction without contextualising and exploring the construction environment and its market structures (Green, 1999a; Green, 1999b; London and Kenley, 2001; Green and May, 2003; Green and May, 2005). Hence, if there are already barriers in adopting Lean production in other countries and other market segmentations, the low success of the Lean movement might be explained by the trial of adopting Lean in a different fragmented construction industry.

The high degree of fragmentation creates a high amount of complexity for construction projects (Eccles, 1981; Reve and Levitt, 1984; Winch, 1989; Walker, 2007; Yang and Kao, 2012). Complexity is not in the sense of Lean construction, as the aim is to reduce the high complexity of construction projects through Lean (Ballard and Howell, 1997; Bertelsen, 2003; Ballard and Howell, 2004). However, the structure of the industry (highly fragmented) is a barrier for Lean construction, which has been realised by Egan (1998, p. 8) who argued: “[...] *the extensive use of subcontracting has brought contractual relations to the fore and prevented the continuity of teams that is essential to efficient working*”. However, in the evangelical nature of Lean research, if something does not fit into the Lean philosophy it has to be changed in a way that it works (Green and May, 2005). Therefore this barrier has been easily removed through introducing partnering by Egan (1998), without mentioning the potential negative impacts. Partnering creates a higher profitability of the powerful industrialists (Egan, 1998; Green, 1999c), which is facilitated through their high buying power. This issue has negative impacts on the so called “partners” (Green, 1999c). In fact the best advocates of partnering are or have been under investigation by the Office of Fair Trade (Ibid.). Considering the potential consequences and scenarios caused by changing the fragmented structure of the construction industry into a model which

exists in car manufacturing or retail will be not explained further as it serves a new field of research (Black et al., 2000; Rosewarne, 2009).

There is an increase of client demands over the decades in construction, i.e. the client wants always more value for less money (Gidado, 1996; Wild, 2002; Kochendoerfer et al., 2007), and if one considers that “*Toyota developed the lean approach, but it makes only low returns*” (Cox and Chicksand, 2005, p. 651), it could lead consequently to the conclusion that it does not matter how efficient the construction industry is performing, the clients might still desire more value for less money.

#### **2.2.4 Labour and working culture perspective**

The discussed fragmented nature of the construction industry causes a highly hierarchic and static organisational structure in construction projects as best practice, as suggested by the Office of Government Commerce (2003) in their latest Procurement Guide for project organisation, where besides the functional separation also a firm separation takes place (as explained previously). This is in contrast with Lean organisational structures, where hierarchies are flat, dynamic and related to minimal staff functions (Jenner, 1998), because Lean PM has the focus on the project as a whole to avoid conflicts (Ballard and Howell, 2003b; Orr, 2005; Rybkowski, 2010; Seppanen et al., 2010), but considering the high degree of fragmentation in the construction industry, this results in a high degree of cultural diversity within the different involved firms in the project (Wild, 2002). This cultural diversity creates psychosocial dynamics which can cause conflicts emerging within and between individuals and groups with a significant impact on the project (ibid.). Conflicts arise because each involved organisation is focusing on their (mainly economic) interest and does not focus on the project as a whole (Winch, 1989; Bertelsen, 2003). Therefore team building is a complex task for construction projects (Low, 1998; Okmen and Oztas, 2010).

Instead of re-engineering Lean construction, which is clearly derived from Lean production (Green and May, 2003; Jorgensen and Emmitt, 2008), the Lean construction movement tries to change the existing project environment, through

changing the organisational structure (Ballard, 2000a; Ballard and Zabelle, 2000) or the whole industry (Egan, 1998) in order to push for Lean.

A main principle of Lean is the focus on continuous improvement (Womack and Jones, 2003). Continuous improvement is not only focused on the process, the improvement of the labourers is on the same focus, which explains lifetime employment (Recht and Wilderom, 1998). Lifetime employment can be applied by the construction organisations, but not by the project, as a project is a so called “temporary production system” (Ballard and Howell, 2003a), but ironically each project requires “[...] *new design work, and new production problems to be solved, but, by the time these are solved the project has ended and not all expertise gained is transferable*” (Winch, 1989, p. 337). The focus on continuous improvement brings with it the human cost of control (Green, 1999a; Green, 2000; Green, 2002), as the “[...] *ultimate test for an effective project team is that it should “work like a well-oiled machine”*” in a Lean environment (Green and May, 2003, p. 101). The human cost of control is caused for instance by Lean tools like “process observation”, where the staff will be observed, if they are working well and in the right sequence through video recording, note and protocol taking (Corfe, 2011). The human costs of the labourers used on the Lean construction project are explored by Green (1999a; 1999b; 2000; 2002) and Green and May (2003), with the conclusion: “*The term “karoshi” is now in common use amongst Japanese workers to describe sudden deaths and severe stress resulting from overwork. Muda is to be eliminated; karoshi is the price to be paid*” (Green, 1999b, p.25).

### **2.2.5 Lean meets PM**

Generally two basic approaches can be distinguished to explain Lean, namely the cultural and the management aspect (Dohse et al., 1985). The cultural as well as environmental barriers and limits have been discussed so far. Now the management aspects will be explored. The basic idea, to eliminate waste, is not a novel approach for construction. The degree of success depends on the

capabilities of the project or construction management (Green and May, 2005). So, what causes the topicality of Lean in construction?

Ballard and Howell (2003a, p.120) defined Lean as “[...] a *third form of production system, one capable of producing more and better vehicles in less time, in less space and when using fewer labour hours than the mass or craft production systems that proceed it*”. Hence, the novelty of Lean lies in the view on construction projects, which have to be seen as a so called “temporary production system” (Ballard and Howell, 2003a). Production processes which do add value without waste (Liker, 2004). The general approach of the Lean management philosophy is to eliminate waste (Womack et al. 1990; Womack and Jones, 2003; Liker, 2004). Ohno (1988, p. 129) has defined the seven types of waste, which have been described in detail by Liker (2004, pp. 28-29):

- *Overproduction*  
*Producing items for which there are no orders, which generates such wastes as overstaffing and storage and transportation costs because of excess inventory.*
- *Waiting*  
*Workers merely serving to watch an automated machine or having to stand around waiting for the next processing step, tool, supply, part, etc., or just plain having no work because of stock outs, lot processing delays, equipment downtime, and capacity bottlenecks*
- *Transporting*  
*Carrying work in process (WIP) long distances, creating inefficient transport, or moving materials, parts, or finished goods into or out of storage or between processes.*
- *Too much machining (over processing)*  
*Taking unneeded steps to process the parts. Inefficiently processing due to poor tool and product design, causing unnecessary motion and producing defects. Waste is generated when providing higher-quality products than necessary.*

- *Inventories*  
*Excess raw material, WIP, or finished goods causing longer lead times, obsolescence, damaged goods, transportation and storage costs and delay. Also, extra inventory hides problems such as production imbalances, late deliveries from suppliers, defects, equipment downtime, and long-time setup times.*
- *Moving*  
*And wasted motion employees have to perform during the course of their work, such as looking for, reaching for, stacking parts, tools, etc. Also walking is waste.*
- *Making defective parts and products*  
*Production of defective parts or correction. Repair or rework, scrap, replacement production, and inspection mean wasteful handling, time and effort.*

Koskela (1992) initiated the theoretical implementation of the Lean management approach to construction. This work was expanded by Ballard (2000a), who developed the Last Planner System [LPS] and made the Lean management approach applicable for construction. Meanwhile, there is a debate between Lean advocates about how to interpret Lean construction (Green and May, 2005; Jorgensen and Emmitt, 2008). Some advocates want to adapt Lean production directly to construction, others want to develop a new implementation methodology (ibid.). However what both interpretations have in common is that projects are conceived as temporary production systems (Ballard and Howell, 1998; Choo et al., 1999; Koskela et al., 2002; Howell et al., 2004; Vrihhoef and Koskela, 2005).

According to Howell (1999, p. 4) the management of construction projects under Lean is different from current practice, because of the following reasons:

- *Lean has a clear set of objectives for the delivery process*
- *Lean is aimed at maximizing performance for the customer at the project level*
- *Lean designs concurrently product and process, and*
- *Lean applies production control throughout the life of the project*

Ballard and Howell (2003a) developed “Lean PM”, in which they argue that projects can be seen as temporary production systems: “[...] when those systems are structured to deliver the product while maximizing value and minimizing waste, they are said to be “lean” projects” (Ballard and Howell, 2003a, p. 119). Furthermore, “Lean project management differs from traditional project management not only in the goals it pursues, but also in the structure of its phases, the relationship between phases and the participants in each phase” (ibid.). To facilitate the PM under the umbrella of Lean, a new PM system has been developed and constantly further improved by Ballard (2000b; 2006; 2008), called “Lean Project Delivery System” which is shown below:

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Ballard, G. (2008). The Lean Project Delivery System: An update. *Lean Construction Journal*, 1(1), p. 5.

**Figure 2-10 Lean Project Delivery System (Ballard, 2008, p. 5)**

Hence, Figure 2-10 illustrates that the Lean Project Delivery System is divided into four phases, which are project definition, Lean design, Lean supply, Lean assembly and operation.

However, to warrant that Lean management is applicable to construction, it has to be analysed that construction is a different type of production (Howell, 1999;

Ballard and Howell, 1998), which has been proven in theory by Koskela (1992; 2000).

In its most basic form, the concept of production theory can be related to the Input-Transformation-Output [ITO] -Model (Koskela, 1992), which is a kind of operations and process management thinking (Slack et al., 2008). According to Slack et al. (2008, pp. 9-10) “*all processes have inputs of transforming and transformed resources that they use to create products and services*”, i.e. each input will be transformed and creates an output. This can be illustrated with the following figure:

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Slack, N., Chambers, S., Johnson, R., & Betts, A. (2008). *Operations and process management - principles and practice for strategic impact* (2nd ed.), p. 11. Harlow: Pearson Education.

**Figure 2-11 Input-Transformation-Output Model (Slack et al. 2008, p. 11)**

In addition to Figure 2-11, Slack et al. (2008, p. 11) have defined three levels of analysis which are as follows:

- Analysis at the level of the supply network  
In which a supply network is an arrangement of operations (flow between operations)
- Analysis at the level of the operation  
In which an operation is an arrangement of processes (flow between processes)
- Analysis at the level of the process  
In which a process is an arrangement of resources (flow between resources, people and facilities)

The ITO-Model is related to the analysis at the level of operations and processes (ibid). Lean is also related to these levels of analysis, but with another perspective.

Lean is looking on three different types of activities when analysing the transformation (Womack and Jones, 1996; Koskela, 2000; Womack and Jones, 2003; Liker, 2004), which are value adding activities (“[...] *those which actually create value as perceived by the customer*[...]” (Womack and Jones, 2003, p. 38)), non-value adding activities (“[...] *those which create no value but are currently required by the product development, order filling, or production systems [...] and so can't be eliminated just yet [...]*” (ibid)), and waste activities (“[...] *those actions which don't create value as perceived by the customer [...] and so can be eliminated immediately [...]*” (ibid)).

The aim of Lean is to maximise the value adding activities, minimise non-value adding activities (because they cannot be eliminated) and eliminate the waste activities (Koskela, 2000).

Lean has been developed in an environment (production/manufacturing) where “[...] *raw materials are progressively transformed over a series of separable steps into the final product*” (Eccles, 1981, p. 337).

Construction on the other hand, “[...] *is large and usually immobile; there is a higher degree of complexity in the number and range of component parts; its production on site introduces varying degrees of uniqueness; [...] must be more durable and is often more expensive than other manufactured goods*” (Gann, 1996, p. 438). Furthermore the constructed facility is produced at the point of consumption, which is in contrast to manufacturing where finished products are transported to market (Gann, 1996). Winch (1989, p. 338) stated that “[...] *construction projects are amongst the most complex of all production undertakings*”, and this hypothesis has been re-stated continuously (Baccarini, 1996; Winch, 2003; Raiden et al., 2004; Winch, 2006). The management of construction projects is generally characterised by “[...] *physically large and expensive products, separation of design from construction, powerful clients, extensive specialisations, delivery of products at the client's premises and bespoke designs usually without prototype models or precedents to provide guidance [...]*” (Ankrah et al., 2005, p. 730).

The different characteristics between construction and manufacturing (where Lean is originated from), causes clear barriers for implementation of Lean tools, which have been identified by Alinaitwe (2009) for adopting LPS, Just in Time, Concurrent Engineering, Total Quality Management and even for teamwork. Bashir et al. (2010, p. 4) listed the following management barriers for Lean in construction: “[...] *delay in decision making, lack of top management support and commitment, poor project definition, delay in materials delivery, lack of equipment, materials scarcity, lack of time for innovation, unsuitable organisational structure, weak administration, lack of supply chain integration, poor communication, use of substandard components, lack of steady work engagement, long implementation period, inadequate preplanning, poor procurement selection strategies, poor planning, inadequate resources, lack of client and supplier involvement, lack of customer focus and absence of long term planning*”.

The first thing which needs to be questioned here, if the above stated points of Bashir et al. (2010) are barriers, then what is going to be improved by Lean in construction? Next, considering that the above mentioned are barriers, shows clearly a limit of Lean construction. Namely, that Lean is not good with uncertainty (Winch, 2006; Andersson, 2006). Construction and other project based industries, face higher levels of uncertainty in comparison with the production sectors (Winch, 2006). Therefore if one wants to see construction as temporary production systems, the heart of this production system should be based on uncertainty management (ibid.).

Changes and uncertainty, or changes caused by uncertainty in the project life cycle create a dynamic environment in construction, where manufacturing consists of a static environment and dynamic product. This contrast between the environments of these two sectors creates a dilemma for implementation. Lean is good in static environments where a high repetition and a low variety exists (Booth, 1996; Naim et al., 1999; Naim and Barlow, 2003; Ribeiro and Fernandes, 2010) (as it is originated from there), because Lean needs a stable platform where processes can be forecasted and optimised (Andersson, 2006). Researchers agree

on the simple fact that Lean is not good in dealing with highly dynamic environments where a low repetition and a high variety exist (for instance like construction projects) (Cusumano, 1994; Hines et al. 2004; Andersson et al., 2006), “[...] *as there is no room for flexibility due to the focus on perfection* [...]” (Andersson et al. 2006, p. 289).

However, this has been realised by Ballard and Howell (1998) who stated that for construction projects Lean production is insufficient, as well as by Egan (1998, p. 18), who argued that the “[...] *parallel is not with building cars on the production line; it is with designing and planning the production of a new car model*”. To keep the Guru-Hype alive Ballard and Howell (1998; 2004) argue that Lean construction differs from Lean production in a way that it is able to deal with the dynamic nature of construction projects, but complexity needs to be reduced (Ballard and Howell, 1997), changes are not welcomed (Gabriel, 1997), and the industry needs to be defragmented (Egan, 1998), because Lean constructions aims to reduce the complexity of construction projects and increases through that efficiency (Ballard and Howell, 1997).

The first Lean principle is to define value (Womack and Jones, 2003), which is an essential element for Lean construction, as the separation of three different activities takes place (Koskela, 2000). However, the definition of value is in construction closer to the customer than in manufacturing. In manufacturing, the needs of the customer will be assumed, and then the product will be produced several times and served to the market (Green, 1999b). From a Lean perspective value is highly related to efficiency in the production process (Green, 1999a; Naim et al., 1999; Naylor et al., 1999; Mason-Jones et al., 2000; Winch, 2006), i.e. costs, but the assumption that efficient production might reflect the value perception of the customer does not reflect the truth (Piercy and Morgan, 1997), as the customer does not care about the way of production and the profit of the organisation made when buying the product (ibid.) and because an efficient Lean production might end up in fewer customer choices (ibid.). Value, on the other hand, from a PM perspective is related to parameters such as “*cost, function, quality, etc.*” (Salvatierra-Garrido and Pasquire, 2011, p. 8). Construction projects

are built for individual clients and individual clients define value differently (Winch, 2003), which also reflects a barrier for Lean construction, because the focus on efficiency might not reflect the customer's value perception (Piercy and Morgan, 1997).

Most of the Lean construction tools (for instance like the LPS (Ballard, 2000a), or 5S, Kanban etc.) focus on the execution phase (see Figure 2-8, p. - 28 -) and not on each phase of the project, which shows that Lean construction is more beneficial for contractors than clients (project managers), architects or consultants. Hence, a holistic project view is required (Kagioglou et al., 2000), but it cannot be provided with the traditional Lean construction tools.

### **2.2.6 The Last Planner System [LPS]**

The LPS of production control has been developed and constantly further improved by Ballard (1994; 2000a) as well as Ballard and Howell (2003b). Over time the LPS became equal to Lean construction and can be seen as a main tool which makes Lean applicable to construction (Green and May, 2005; Jorgensen and Emmitt, 2008; Rybkowski, 2010). The tool is derived from Kanban and production levelling tools, which exist in Lean production (Salem et al., 2005; Salem et al., 2006). Ballard (2000a) argues that the traditional way of managing the execution is characterised by a push system, which has been illustrated below.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Ballard, G. H. (2000a). *The last planner system of production control*, p. 312. Birmingham: Lean Construction Institute- PhD Dissertation of the University of Birmingham.

**Figure 2-12 traditional construction project management system (Ballard, 2000a, p. 3.12)**

Ballard (2000a) explains further that the traditional way of managing construction projects is focused on detecting cost and schedule variances from the expected. This (traditional) approach has been interpreted as reactive by Kalsaas et al.

(2009). The “Should” in Figure 2-12 describes the traditional project master schedule (Ballard, 2000a; Salem et al., 2005; Porwal et al., 2010; Seppanen et al., 2010). However, to be able to convert the “Should” to “Did” requires to set feasible and achievable goals (Ballard and Howell; 2003b). This is seen as difficult as at the beginning reliable planning cannot be performed (Ballard, 2000a), because of the many unknown factors which a construction project is facing (Bertelsen, 2003). According to Ballard et al. (2009, p. 490) this requires a production system, which consists of the following principles:

- *Plan in greater detail as you get closer to doing the work.*
- *Produce plans collaboratively with those who will do the work.*
- *Reveal and remove constraints on planned tasks as a team.*
- *Make and secure reliable promises.*
- *Learn from breakdowns*

Hence the LPS is seen as a proactive approach for managing construction projects (Kalsaas et al., 2009), which is shown in the figure below:

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Ballard, G. H. (2000a). *The last planner system of production control*, p. 315. Birmingham: Lean Construction Institute- PhD Dissertation of the University of Birmingham.

**Figure 2-13 Last Planner project management system (Ballard, 2000a, p. 315)**

Figure 2-13 shows that the LPS creates out of the traditional project master schedule a pull driven schedule, which is facilitated through a reverse phase scheduling technique (Ballard, 2000a; Salem et al., 2005; Ballard et al., 2009; Porwal et al., 2010; Seppanen et al., 2010). Then it moves down from the PM level to the production management level through transforming the “what Should be done” into “what Can be done” with using a five weeks look ahead planning technique (Ballard, 2000a). Then the LPS will plan through rhythmic meetings the

production with all parties involved in the assembly (Ballard, 2000a; Salem et al., 2005; Ballard et al., 2009; Friblick et al., 2009; Kalsaas et al., 2009; Porwal et al., 2010; Seppanen et al., 2010). This will be done daily (ibid.). To control the difference between expected and achieved (the “Did” level) the LPS uses a factor called “Per cent Plan Complete”, which is the number of achieved tasks (referred as assignments) divided with the number of scheduled tasks (Ballard, 2000a; Salem et al., 2005; Ballard et al., 2009; Porwal et al., 2010; Seppanen et al., 2010). Hence the Last Planner is the person or group who defines the daily tasks (assignments) (Ballard, 2000a). These actions within the LPS structure have been illustrated as follows:

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Steffek, P. (2007, November 11). *Einsatz des Last Planner Systems*, p.6. Retrieved May 15, 2012, from Lean Construction Institut: [http://www.google.co.uk/url?sa=t&rct=j&q=einsatz%20des%20last%20planner%20systems&source=web&cd=1&sqi=2&ved=0CGsQFjAA&url=http%3A%2F%2Fwww.lean-management-institut.de%2Ffileadmin%2Fdownloads%2FLean\\_Construction%2FEinsatz\\_des\\_Last\\_Planner\\_Systems\\_Steffek.p](http://www.google.co.uk/url?sa=t&rct=j&q=einsatz%20des%20last%20planner%20systems&source=web&cd=1&sqi=2&ved=0CGsQFjAA&url=http%3A%2F%2Fwww.lean-management-institut.de%2Ffileadmin%2Fdownloads%2FLean_Construction%2FEinsatz_des_Last_Planner_Systems_Steffek.p).

**Figure 2-14 Last Planner System (Steffek, 2007, p. 6)**

Figure 2-14 illustrates that the LPS system consists of planning and control (Ballard, 2000a), in which planning is defined as establishing criteria for success and producing the strategies for achieving the objectives (AlSehaimi et al., 2009). Control is defined as taking the actions to achieve the expected, initiate re-planning when the established sequence is not feasible anymore and promote learning (ibid.). The control perspective of the LPS makes it flexible and agile, because the number of unknown factors gets reduced through planning the tasks one day before in detail and sequencing the activities one day before, too (Ballard and Howell, 1997; Ballard, 2000a; Ballard and Howell, 2003b; Salem et al., 2006; Ballard et al., 2009). Hence LPS works “[...] *in three phases, beginning with stabilization and reducing in-flow variation (process), and finally turning to operations*” (Ballard and Howell, 1997, p. 115). The result is that the LPS deals with the dynamic environment through making the dynamic process more static

with the planning of activities on a daily basis. The focus of the LPS is more on the execution, but there are also developments for managing the design with this production technique (Jorgensen and Emmitt, 2008). Ballard and Howell (2003b, p. 5) developed a further component for the LPS which is called the “Lean Work Breakdown Structure”, which consists of the following levels:

- *Project:*        *work scope*
- *Activity:*       *cost and time control level; physical segment of project*  
                         *(a subdivision of work scope)*
- *Operation:*     *synthesis of work processes*
- *Process:*        *recognizable portion of construction operation*
- *Work task:*     *assignment*

The focus of the Lean Work Breakdown Structure is to create a transition from scope to process (ibid.).

## 2.3 Agile

In sharp contrast to Lean products, there is a requirement for products which have high variety with high variability (Booth, 1996), as well as the fact that projects change over their lifecycle (Gidado, 1996; Arditi and Gunaydin, 1998; Chin, 2004; Andersson et al., 2006; Hunt, 2006), this requires new management paradigms, one of which is “Agile”. The concepts of agility are not new for manufacturing (Iacocca Institute, 1992), nor to Information Technology [IT] (Agile Alliance, 2001), but are in its infancy within construction (Owen and Koskela, 2006a). The developments in IT and manufacturing took place independently (Kettunen, 2009) and according to Owen and Koskela (2006a) originated from the Deming Cycle. The origin of Agile management methodologies in construction can be linked to the developments in IT and manufacturing (Owen et al., 2006; Owen and Koskela, 2006a; Owen and Koskela, 2006b). This section aims to provide an overview between Agile manufacturing and Agile IT as well as Agile construction.

### **2.3.1 Agile manufacturing**

This sub-section analyses the concepts of Agile manufacturing and assesses the suitability of its characteristics to construction. The developments of Agile manufacturing can be divided into two parts, namely the vision and the infrastructure which needs to be in place to become an Agile manufacturer (Zhang and Sharifi, 2007; Zhang, 2011). This reflects also the way how the Iacocca Institute (1991a; 1991b; 1992) wanted to approach the industry wide implementation of this paradigm. In this respect, this section is divided as follows: First, there will be an explanation of what Agility in manufacturing means, what the concepts are and what the characteristics are of the Agile paradigm in manufacturing. Then the infrastructure, which needs to be in place for an Agile manufacturer will be determined. Finally the appropriateness of Agile manufacturing for the purposes of this research will be discussed.

#### ***2.3.1.1 The vision of Agile manufacturing***

Agile manufacturing is a new production philosophy developed in the early 90s (Qi et al., 2007). The development of Agile in manufacturing was initiated through market research, where the Iacocca Institute (1992) found out that the future markets for manufacturing will require a production system, which is able not only to produce the right volume, but also to supply the right variety into its market niches (Booth, 1996). Hence the manufacturing industry has the vision that in future their markets will be based on highly fragmented and specialised producers (Maskell, 2001). Further, the more the industry gets fragmented the more it is difficult to apply existing production techniques, such as Lean production (Iacocca Institute, 1991a; 1991b; 1992). This can be reflected by the work of Dohse et al. (1985) as well as Recht and Wildrom (1998) who found out that in Japan the midsized and small companies are not using any Lean approaches.

Once the future market analysis had been conducted and the identification of the future market characteristics had been done, the Iacocca Institute (1991a) made scenarios in different manufacturing industries, such as automotive, chemical and

electronics, to identify, if there would be any possibility to achieve leadership in manufacturing. The conclusion of the Iacocca Institute (1991a; 1991b; 1992) was that the world's leading manufacturers have to build up a new infrastructure, which will allow them to be Agile, further the Iacocca Institute (1991a, p. 1) saw the possibility for the USA to “[...] *to regain the leadership it lost in the 1970s and ‘80s*” in manufacturing. The early advocates of Agile manufacturing saw in this new paradigm the ability to compete with Lean production (Booth, 1996), which would result in market leadership for the USA (ibid.). The reason for this thinking is, because the concept of Lean works well where demand is relatively stable, predictable and where the variety of production goods is low (Christopher and Towill, 2001). Contrariwise Agile is focused on producing goods where the demand is volatile, less predictable and the customer requirement for variety is high (Christopher and Towill, 2001; Qi et al., 2007). Maskell (2001, p. 5) interpreted the differences of those two paradigms as that *"Lean or world class manufacturing is being very good at doing the things you can control. Agile manufacturing deals with things we cannot control"*. Hence the assumption of the early advocates of Agile manufacturing was that the future markets in manufacturing will change in a way that Lean production alone might not be enough anymore for gaining competitive advantage. The Iacocca Institute (1991a, p. 6) states further: *"Success in the new manufacturing era will be achieved only by dealing with the enterprise as a whole. It cannot be achieved by dealing only with manufacturing as narrowly viewed today"*. This statement explains why it is called “Agile manufacturing” and not “Agile production”, because the focus of Agile manufacturing is more on the whole business strategy rather than on tools and techniques on the operative level.

Therefore Agile manufacturing is defined *"as a system in which technologies, management structures, and social values are synthesized into a powerful competitive weapon"* (Iacocca Institute, 1991a, p. 1). A more current definition can be found by Zhang and Sharifi (2007, p. 352) which is as follows: *"Agility is a manufacturing strategy that aims to provide manufacturing enterprises with competitive capabilities to prosper from dynamic and continuous changes in the business environment, reactively or proactively"*.

However, the vision of the Iacocca Institute (1992) is that production will leave the build-to-forecast option, because it is risky for most companies as it requires the perfect match between supply and demand (Booth, 1996). The global competition in manufacturing results in that the markets as well as the clients are getting more fragmented and specialised (Maskell, 2001). Increasing customer expectations and changing market needs are resulting in specialised producers, which cannot enter into new market segments that easily anymore (Booth, 1996). Therefore successful organisations require the implementation of a corporate wide flexible strategy, which is able to change depending on the respective circumstances (Gunasekaran, 1999). Hence "*Successful organisations must be able to foresee, adapt and respond to change using tactical initiatives to achieve strategic objectives*" (Yusuf et al., 1999, p. 35). So the main reason to become Agile is change (Yusuf et al., 1999), which is caused by the environment (Bottani, 2010), in the areas of marketplace, competition, customer requirements, technology and social factors (Sharifi and Zhang, 2001; Zhang and Sharifi, 2007; Zhang, 2011).

Though, the Iacocca Institute (1991a; 1991b; 1992) refers to the year 2006, when addressing the future markets in the report. A vision of the scenario in the automotive industry is illustrated with the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Iacocca Institute. (1991a). *21st Century Manufacturing Enterprise Strategy - An Industry-Led View*, p.30. Bethlehem: Lehigh University.

**Figure 2-15 the vision of Agile manufacturing (Iacocca Institute 1991a, p. 30)**

The vision of the Iacocca Institute (1991a; 1991b; 1992) illustrated in Figure 2-15, to have organisations, which provide the capabilities of producing such different types of vehicles in low development times, obviously does not reflect current reality. Even though this extreme change of manufacturers did not take place by

2006, a change in the manufacturing industry has been reported by several researchers (Wang et al., 2002; Lim and Zhang, 2003; Lim and Zhang, 2004; Zhang et al., 2007; Akanle and Zhang, 2008; Nambiar, 2009; Zhang, 2011). The focus of the industry is moving more and more to uncertainty management and customer satisfaction as well as efficiency (ibid.). The result is that many manufacturing firms are becoming Agile (Bottani, 2010; Inman et al., 2011). For that reason is there still a trend towards Agile manufacturing.

The aim of Agile manufacturing is to combine the enterprise, people, and technology into an integrated and coordinated whole, which will result in agility (Kidd, 1994). This agility enables the reaction to demands in the market through the ability to use and exploit corporate knowledge (ibid.). The first attributes suggested by the Iacocca Institute (1991b) are shown in the following figure.

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**Figure 2-16 Agile enterprise attributes (Iacocca Institute, 1991b, p. 7)**

These attributes shown in Figure 2-16, sometimes also referred to as capabilities (Bottani, 2010), have to be in place if an organisation wants to become an Agile manufacturer (Iacocca Institute, 1991a; 1991b). Yusuf et al. (1999) propose that the concepts of Agile manufacturing shall be based on core competence management, capability for reconfiguration, knowledge-driven enterprise and virtual enterprise. An organisation is Agile when it covers all the conceptual elements, but meanwhile the concept of virtual enterprise came to the fore (Bottani, 2010), even though the Iacocca Institute (1991b) was focused on several other ways of cooperation, because it has been realised that companies cannot be truly Agile without integrating the whole supply chain (Booth, 1996; Gunasekaran, 1999; Yusuf et al., 1999; Christopher, 2000; Bottani, 2010). As the

concept of Agile manufacturing is built around the synthesis of a number of enterprises that each have some core competencies put together to a cooperating organisation, based on using each co-operators knowledge and resources in order to fill the new occurred need in the market through changing and adopting the required business strategy (Kidd, 1994). This creates a virtual enterprise, which does not exist in reality, as it is formed only for this particular demand in the market, but makes them Agile as the virtual enterprise can be formed and changed rapidly. The virtual enterprise can for example have the design competency of one company, the manufacturing competency of another, with the distribution and logistics competency of another, which will create a new innovative product, produced and brought to the market as best as possible (Kidd, 1994). An industry example of this, is for instance the cooperation between IBM, Apple and Motorola which came together to develop the next generation of Power Personal Computers (Shocker et al., 1994). Therefore Agile manufacturing can be also called Agile enterprise (Ross, 1994), because it is more related to business strategy. However, the issue of how to become an Agile manufacturer is still not fully understood (Zhang, 2011), but several different practices have been proposed which will enable the build-up of parts of the required infrastructure (Zhang and Sharifi, 2007).

#### **2.3.1.2 The infrastructure for Agile manufacturing**

The driver for Agile manufacturer is the ability to respond to change, which can be caused among other things with “[...] *continuous variations in customer requirements, fluctuations in demand patterns, proliferation of niche markets, continuous increases in product mix, decreases in product life cycles and increasing competition amongst manufacturers* [...]” (Anosike and Zhang, 2009, p. 334). This requires on the one hand manufacturers which have the company culture that encompasses Agile attributes, but on the other manufacturing systems which create the required infrastructure (Iacocca Institute, 1991b; Anosike and Zhang, 2009). Therefore new manufacturing practices need to be also in place, which allow this agility, i.e. responsiveness and flexibility in the business (Zhang

and Sharifi, 2007; Zhang, 2011). To achieve this, the focus of the Agile manufacturing advocates has been on several different techniques (ibid.).

Zhang et al. (2007) and Wang et al. (2002) developed a way of integrating the product design with the production design, because both argue that the production plant has to be responsive and flexible as well as dynamic for new products. This work has been further detailed by Lim and Zhang (2003), who propose a framework for responsive process planning. Hence flexible layout organisations within factory became necessary, which have been investigated by Montreuil et al. (1999) and Goh and Zhang (2003). Other research focused on the rapid configurations of the supply chain, so that cooperation can be formed at the right time to deliver the market demands (Mason-Jones and Towill, 1999; Akanle and Zhang, 2008). To be able to forecast the right demand at the right time, Zhang and Zhang (2007) have even focused on consumer characteristics. The management and organisational aspects of Agile manufacturing have been developed by Crocitto and Youssef (2003) and are shown in the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Crocitto, M., & Youssef, M. (2003). The human side of organizational agility. *Industrial Management & Data Systems*, 103(6), p. 392.

**Figure 2-17 organisational agility (Crocitto and Youssef, 2003, p. 392)**

The enabler for Figure 2-17 and what most of the current different techniques and practices have in common is that they are based on a so called “agent-based” approach (Goh and Zhang, 2003; Lim and Zhang, 2003; Lim and Zhang, 2004; Zhang et al., 2007; Zhang and Sharifi, 2007; Akanle and Zhang, 2008; Anosike and Zhang, 2009; Lim et al., 2009; Bottani, 2010; Zhang, 2011). Hence the key enabler for Agile manufacturing on the more operative level lies in the agent based approach of structuring the production. An agent “[...] represents an entity (e.g. a machine or a job) and is capable of interacting with one another to achieve

*its goals. Each agent is endowed with a certain degree of autonomy and intelligence, which includes the ability to perceive its environment and to make decisions based on its knowledge [...]*” (Lim et al., 2009, p. 1069). The principle of an agent-based strategy can be illustrated with the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Lim, M. K., & Zhang, D. Z. (2004). An integrated agent-based approach for responsive control of manufacturing resources. *Computers & Industrial Engineering*, 46(2), p. 224.

**Figure 2-18 agent system (Lim and Zhang, 2004, p. 224)**

Figure 2-18 shows that all resources in a manufacturing system are grouped as agents (Goh and Zhang, 2003). These agents are able to make sub agents which are called “child agents” (Lim and Zhang, 2004). This allows flexibility and responsiveness within the organisational structure of a manufacturer, because one combines the traditional hierarchical organisational models with heterarchical ones (Anosike and Zhang, 2009). Zhang and Sharifi (2000) developed a methodology to implement Agile manufacturing in an organisation, which is shown below.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Zhang, Z., & Sharifi, H. (2000). A methodology for achieving agility in manufacturing organisations. *International Journal of Operations & Production Management*, 20(4), p. 498.

**Figure 2-19 implementation of Agile manufacturing (Zhang and Sharifi, 2000, p. 498)**

Figure 2-19 shows that the methodology for achieving agility consists of three steps, namely to identify the Agility needs, to determine the capabilities to become Agile and the derivation of tools and practices to gain the recognised capabilities (Zhang and Sharifi, 2000).

However, while these frameworks, models, tools and techniques help to get a clear overview about Agile manufacturing, they are of prescriptive and conceptual nature (Zhang and Sharifi, 2007). The problem can be related to the lack of theory building with empirical evidence (ibid.). The result is that the strategy of Agile manufacturing and concrete implementation principles cannot be fully understood (Zhang, 2011).

### ***2.3.1.3 Appropriateness of Agile manufacturing for construction PM***

The starting point of the Agile manufacturing movement was created through the realisation that the future markets and product mix will change in a way that traditional production practices will be not sufficient anymore to gain competitive advantage and market leadership (Wang et al., 2002; Lim and Zhang, 2003; Lim and Zhang, 2004; Zhang et al., 2007; Akane and Zhang, 2008; Nambiar, 2009; Zhang, 2011). Correspondingly the manufacturing industry tries to shift from traditional paradigms to Agile, with the focus more on the whole business as an entity (Inman et al., 2011). The main enabler is the principle of cooperation (Iacocca Institute, 1991a; 1992) with current focus on virtual enterprise (Yusuf et al., 1999; Lei et al., 2011). This principle of Agile manufacturing is not new for the Built Environment, but it is practiced in an informal way. As for instance joint ventures and strategic alliances are used by some construction organisations as a major procurement strategy (Black et al., 2000; Jewell et al., 2012). Those types of temporary organisational relationships are comparable with the virtual enterprise approach of Agile manufacturing, where each organisation brings in his core competence and where several cooperating companies have reconfigured themselves to one body and share their knowledge to fulfil the project requirements as best as possible.

In contrast, Agile manufacturing might be a discipline where the manufacturing industry could learn from the developments in construction research. The concepts of Agile manufacturing are related to strategic entrepreneurial issues, as it is also called Agile enterprise (Ross, 1994). However, the need of construction is not in getting new methods for business management, nor in managing the

technical challenges (Ritz, 1994; Dubois and Gadde, 2002). The increase in the level of the complexity of construction processes (Gidado, 1996), has resulted in the need for new management paradigms. According to Tah et al. (1993) and Nassar et al. (2005) as well as Meng (2012) poor performance in terms of time and cost overruns is a common issue in construction projects. Therefore there is a need for new management practices, which will improve performance on the operative level when constructing the project (Pan et al., 2007).

Agile manufacturing has no detailed definitions, methods and techniques so far developed (Kettunen, 2009), and it is still more an aspiration (Kidd, 1994; Zhang, 2011). In addition it is more about setting up a business strategy to penetrate new market segmentations. Therefore it seems Agile manufacturing is not suitable to provide management practices on the operative level. Consequently it seems Agile manufacturing is not appropriate for achieving the aim and objectives of this thesis, as the aim of this thesis is to derive a unifying strategic framework to manage construction projects and not to set up business strategies for organisations.

### **2.3.2 Agile in IT**

A top-down approach has been selected, where first the concept and principles will be elaborated; followed by the practices; and finally insights to Scrum will be provided, so that the reader gets a clear understanding about Agile in IT.

#### ***2.3.2.1 Concept and Principles***

In contrast to Agile manufacturing, which has been derived by the need to find a methodology which can compete with Lean and bring market leadership in manufacturing back to the USA (Iacocca Institute, 1992), the developments of Agile IT practices go back to the 1930s (Larman and Basili, 2003). The developments can be related to the understanding that different types of projects do exist with different characteristics (see Figure 2-5) (Wysocki, 2006). The attention of the Agile IT PM community was created through a misinterpretation

of the waterfall model (Larman and Basili, 2003; Owen and Koskela, 2006a), which was developed by Royce (1970) and is shown below.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Royce, D. (1970). Managing the development of Large Software Systems. *IEEE WESCON* (p. 330). Los Angeles: IEEE.

**Figure 2-20 the Waterfall Model of Royce (1970, p. 330)**

This waterfall model (see Figure 2-20), also referred as traditional PM model, allows that the project life cycle phases are easily recognisable, tasks are completed sequentially and a significant part of the project needs upfront planning (Hass, 2007). Hence managing a project with the waterfall model requires purposeful planning and appropriate control methods (ibid.; Sheffield and Lemetayer, 2013). The IT PM practitioners see the waterfall model, as a static linear system, where each phase has to be completed sequentially, resulting in a slow and monolithic (Aoyama, 1998), as well as no feedback allowing PM system (Wysocki, 2006), assuming that all project requirements can be determined at the initiation phase (Highsmith and Cockburn, 2001). Working in a dynamic project environment results in changing project requirements over the project life-cycle (Burlereaux et al., 2013). Hence there is a need for flexibility when undertaking a project (Chin, 2004; Cruz and Marques, 2013). This created the attention on iterative and incremental (see Figure 2-5) solutions, where Agile methods are focused on (Wysocki, 2006; Fernandez and Fernandez, 2008). Out of that need the IT practitioners developed different PM methods, which are able to deal with changing project requirements and were applied in practice decades ago (Larman and Basili, 2003). The formalisation of those practices took place under the framework of a growing movement called “Agile Software Development Alliance” (Agile Alliance, 2001). This movement of IT and software practitioners produced a manifesto with the following values (Agile Alliance, 2001):

- individuals and interactions over processes and tools
- working software over comprehensive documentation
- customer collaboration over contract negotiation
- responding to change over following a plan

Based on these values twelve principles have been identified, which are summarised by Hunt (2006, pp. 11-12) and shown below:

- Highest priority is to satisfy the customer.
- Welcome change.
- Deliver working software frequently.
- Business people and developers must work together daily.
- Build projects around motivated individuals.
- Face-to-face communication is best.
- Working software is the primary measure of progress.
- Promote sustainable development.
- Continuous attention to technical excellence and good design enhances agility.
- Simplicity - the art of maximising the amount of work not done - is essential.
- The best architectures, requirements and design emerge from self-organising teams.
- Introspection - team should regularly review itself and its process to try and improve.

Agile has a clear theoretical base, because Agile is defined by the values expressed in the Agile Manifesto (Adolph, 2006). This results in that a tool or a method is Agile when it fulfils the twelve Agile principles. By fulfilling the twelve principles the four Agile values are met. This theory of Agile PM has been developed out of IT PM practice. That is in contrast with other management methods, where a theoretical framework is developed first, before introducing it to practice. This might explain the success of Agile methods, as the IT environment gets more and more attention to Agile paradigms (Cockburn and Highsmith, 2001;

Agerfalk and Fitzgerald, 2006; Hoda et al., 2008; Cui and Olsson, 2009; Dingsoyr et al., 2012; Mahnic, 2012).

A different perspective has been given by Owen et al. (2006), which is illustrated with the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Owen, R., Koskela, L., Henrich, G., & Codinhoto, R. (2006). Is agile project management applicable to construction? *International Group for Lean in Construction 14* (p. 57). Santiago, Chile: IGLC.

**Figure 2-21 traditional versus Agile project management (Owen et al., 2006, p. 57)**

Figure 2-21 shows the main difference between the traditional and Agile PM methodologies. The Agile PM methodologies allow changes in the scope, but to limited resources. Traditional methods pretend no changes in the scope. This cannot be pursued, as detailed planning in advance is not possible, due to the top-down management approach (see section 2.1.4). Hence managing a project under the umbrella of “Agile” requires different practices, which allow the iterative and incremental management of projects (Hass, 2007; Chow and Cao, 2008; Dingsoyr et al., 2012; Vijayasarathy and Turk, 2012).

#### **2.3.2.2 Practices**

Traditional PM methods focus on developing a project plan and sticking to that plan, which improves coordination, but reduces variability (Lindstrom and Jeffries, 2004). Agile methods have replaced the goal of optimisation from traditional models to the goal of flexibility and responsiveness (Moe et al., 2010). To gain the competence of working in iterative and incremental project environments within the four Agile values, requires a dramatic change of the work habits and the acquisition of new management skills (Chan and Thong, 2009).

Agile practices are Agile, because they embrace changes, which add value (Hass, 2007). This agility is achieved through feedback loops (Wysocki, 2006), because Agile methodologies assume that variability cannot be reduced, therefore the aim is not to minimise or eliminate change (Highsmith and Cockburn, 2001). Hence the feedback loop allows flexibility and responsiveness, consequently the ability to react to change in a systematic and structured way (Hunt, 2006). These feedback loops are called “iterations” (Chin, 2004; Hunt, 2006; Wysocki, 2006; Fernandez and Fernandez, 2008; Moe et al., 2010; Saleh, 2011; Dingsoyr et al., 2012). The iterative concept of Agile results in a different project life cycle model, which has been illustrated by Wysocki (2006).

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Wysocki, R. K. (2006). *Effective Software Project Management*, p. 207. Indianapolis: Wiley Publishing.

Figure 2-22 Agile project life cycle model (Wysocki, 2006, p. 207)

Figure 2-22 shows that the Agile consists of many iterative cycles, which allow the project team “[...] *to constantly evaluate the evolving product and obtain immediate feedback from users or stakeholders*” (Hass, 2007, pp. 3-4). This results also in continuous learning, consequently in continuous improvement (Moe et al., 2010). The focus is on planning these iterations, which is facilitated through designing and planning modular elements of the overall task rather than the whole as monolithic (Aoyama, 1998; Burlereaux et al., 2013). Those elements are called user stories or features, which is more tangible for the customer in comparison with tasks (Highsmith and Cockburn, 2001). Therefore involves Agile PM planning, design and documentation, but only as much as is required (Karlesky and Voord, 2008). The focus is more on delivering working features to a paying customer as soon as possible (ibid). This change in the PM system results in tighter collaboration within the project team (Chow and Cao, 2008; Chan and Thong, 2009). The teams are self-organised and are able to take

responsibility (Hunt, 2006; Moe et al., 2010). This results in a reduction of the project manager's role within an Agile project, because the project manager is not anymore seen as task master, but rather as leader (Hass, 2007). Further there is an expansion of the client's role through involving them in writing these user stories, prioritisation of user stories and providing constant rapid feedback to the development team (Saleh, 2011).

The Agile values do not specify a method; rather they define a guiding statement, to help people gain knowledge about agility and to see, if one is following an Agile methodology or not (Hunt, 2006). As such Agile is an umbrella term used to describe a number of different PM methods, for instance eXtreme Programming, Adaptive Software development, Crystal and Scrum (Boehm, 2005; Chow and Cao, 2008). Those methodologies have quite similar practices such as daily meetings, backlogs, user stories, and iteration planning (Weyrauch, 2006), which do reflect the Agile principles and therefore the Agile values. If an organisation wants to implement Agile, then all practices of that methodology have to be in place, otherwise it will result in project failure (Coffin, 2006). To provide a better understanding of how an Agile method really works, the researcher will explore one Agile method in the following section. The Agile methods have the same characteristics, such as *“flexibility, iterative stage, feedback and gradually approaching the target”* (Hu et al., 2009, p. 27). In the framework of this research project, the focus will be on “Scrum”, because it is the most widely used Agile method in the IT industry (Cho, 2009; Mahnic, 2012).

### 2.3.2.3 Scrum

The thoughts behind the Agile management methods can be illustrated with the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Hu, Z.-g., Yuan, Q., & Zhang, X. (2009). Research on Agile Project Management with Scrum method. *IIITA International Conference on Service Science, Management and Engineering* (p. 27). Zhangjiajie: IEEE Computer Society.

Figure 2-23 Agile management thoughts (Hu et al., 2009, p. 27)

Scrum is an Agile method which can be used to manage projects in an iterative and incremental way (Hu et al., 2009). The term “Scrum” is originated from the sport game rugby (Flouri and Berger, 2010), it refers to a strategy to get an out-of-play ball back into play (Cho, 2009). To name this IT PM method “Scrum”, was inspired by a publication of Takeuchi and Nonaka (1986), where new concepts for management have been introduced through using the term “rugby” (Larman and Basili, 2003; Moe et al., 2010). Schwaber (2004), who has developed the Scrum method, differentiates between two contrasting project processes, namely defined process control and empirical process control. Defined process controls are those, which produce repeated acceptable quality outputs (ibid.). The latter refers to processes, where defined process control cannot be achieved, because of the project complexity (ibid.). Empirical process control consists of three elements, which are visibility, inspection and adaptation (ibid.). Scrum processes deal with the project complexity through implementing an empirical process control approach (ibid.).

There are two groups within the Scrum project, which are called “the pigs” (those who are directly committed to a project) and “the chicken” (those who are spectators) (ibid.). Chickens have no direct authority within the project, but are somehow involved (ibid.). The “pigs”, define the three roles of the Scrum process (ibid.), namely the Product Owner, Scrum Master and the Scrum Team (ibid.;

Hunt, 2006; Potter and Sakry, 2009; Flouri and Berger, 2010). The Product Owner articulates the project vision and is responsible for prioritising the list of requirements (which is called “Backlog”) through queuing the most valuable Backlogs sequentially (Schwaber, 2004; Potter and Sakry, 2009; Fernandes and Sousa, 2010; Flouri and Berger, 2010). The Scrum Master is responsible for leadership as well as coaching and teaching the Scrum Process (Schwaber, 2004; Potter and Sakry, 2009). The Scrum Team are responsible for the project work (Hunt, 2006; Potter and Sakry, 2009; Hu et al., 2009; Fernandes and Sousa, 2010). *“Teams are self-managing, self-organizing, and cross-functional, and they are responsible for figuring out how to turn Product Backlog into an increment of functionality within an iteration and managing their own work to do so”* (Schwaber, 2004, p. 7). After defining the roles, next the Scrum process will be explored. An overview of the Scrum PM process is shown with the figure below (Murphy, 2004):

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Murphy, C. (2004). Adaptive Project Management Using Scrum. *Methods & Tools*, 1(Winter), p.13.

Figure 2-24 Scrum process (Murphy, 2004, p. 13)

Figure 2-24 shows that the Agile project starts with the Sprint Backlog planning (Koskela and Howell, 2002b; Murphy, 2004), where different Backlogs have to be determined and prioritised by the Product Owner (Schwaber, 2004; Potter and Sakry, 2009; Fernandes and Sousa, 2010; Flouri and Berger, 2010). The Sprint Backlog is prioritised so that the most valuable Backlogs are top priority (ibid.). The iterations are the crucial enablers of the Scrum Process (Schwaber, 2004). There are two iterations within Scrum. One has the function of execution (Sprint), the other has the function of daily control (daily Scrum) (Koskela and Howell, 2002b; Burlereaux et al., 2013). Before the Sprint starts, there is a Sprint planning meeting (Murphy, 2004; Cho, 2009; Paasivaara et al., 2009; Cho et al., 2011).

This meeting is used to identify the prioritised tasks (Backlogs) and to then further divide these Backlogs into releases by the Scrum Team (Schwaber, 2004; Hunt, 2006; Potter and Sakry, 2009; Flouri and Berger, 2010). During the main Sprint, daily Scrum meetings will be performed to gain a daily update/feedback about the project (Murphy, 2004; Schwaber, 2004; Cho, 2009; Paasivaara et al., 2009; Fernandes and Sousa, 2010; Cho et al., 2011). The performance is measured through using “Burndown Charts” (Schwaber, 2004; Cho, 2009), which is illustrated below:

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Hiranable, K. (2007, August 27). *www.infoq.com*. Retrieved May 22, 2012, from <http://www.infoq.com/articles/agile-kanban-boards>

Figure 2-25 Burndown Chart (Hiranable, 2007)

A BurnDown Chart is a way “[...] of visualizing the correlation between the amount of work remaining at any point in time and the process of the project Team(s) in reducing this work” (Schwaber, 2004, p. 11). Once the Sprint is completed, a Sprint review meeting and a Sprint retrospective meeting is conducted (Murphy, 2004; Schwaber, 2004; Hunt, 2006; Flouri et al., 2009; Hu et al., 2009; Fernandes and Sousa, 2010). The former is to present the achieved performance to the Product Owner (ibid.). The latter is to share lessons learned (ibid.).

### 2.3.3 Agile in Construction

The number of scientific publications about pure Agile management theory and practices for construction is limited (Ribeiro and Fernandes, 2010).

Koskela and Howell (2002a; 2002b) as well as Koskela et al. (2006) started questioning the traditional way of managing construction projects and compared it with modern paradigms. In their discussion they described also the underlying

theory of Agile with the focus on Scrum (Koskela and Howell, 2002b; Koskela et al., 2006). Followed by these publications, Owen and Koskela (2006a; 2006b) introduced their research project, where the underlying theory as well as the applicability to construction of Agile methods shall be analysed. This shows a quite similar approach to the introduction of Lean construction, where Koskela (1992; 2000) initiated the theoretical foundation. Owen and Koskela (2006a; 2006b) offered a deep understanding of the salient concepts of Agile PM, but considered also literature from Agile manufacturing when defining the context of Agile. However, the primary focus was on Agile IT and the values articulated by the Agile Manifesto (Agile Alliance, 2001) rather than those of Agile manufacturing, when providing a framework for further research (ibid.). Followed by this, the applicability of Agile in construction have been analysed by Owen et al. (2006). When analysing the applicability the predesign phase, design phase and the execution phase have been evaluated separately (ibid.). For the predesign phase, Owen et al. (2006) argue that Agile principles and methods show great potential for implementation, which might result consequently in performance improvement. When evaluating the design phase, Owen et al. (2006, p. 62) argue that Agile should be applied for projects “[...] *in which a considerable number of clients are involved, requirements are conflicting and constantly generate trade-offs, and early delivery of value is priority*”. For the evaluation of the execution, Owen et al. (2006) see potential for planning the construction execution but not for managing it on site. Building on this work, Chen et al. (2007) viewed on Agile from an interface management perspective, where they concluded that interface management could help Agile in construction to cope with the dynamics caused by the humans and to achieve small, self-organised teams who are acting efficient and effective.

On the flip side of the same coin, Ribeiro and Fernandes (2010) found out that Agile methods show high potential for implementation for managing the whole project, when applied by medium and small sized companies. In the framework of the same research, four enablers have been identified, which are the collection of individuals within the organisation, establishment of an appropriate Agile culture,

collaboration with clients and suppliers, and creating the required formalised and centralised structure (ibid.).

However, the previous studies so far did not show an explicit definition of Agile construction and did not provide a theoretical framework. An answer to this is provided by Daneshgari (2010, p. vii-viii), who defined Agile construction as an

*“[...] engineered process designed to respond to the owner’s and general contractors’ specific needs to become more efficient, more productive, and, ultimately, more profitable. Time, cost, and quality are the focus of the Agile Construction process design. Agile Construction exemplifies the following characteristics: Visibility, Responsiveness, Productivity, and Profitability.*

Daneshgari (2010) introduced in his book *“Agile Construction for the electrical contractor”* tangible principles and methods, through implementing those for several case studies in the form of electrical contractors. However, the provided system for managing construction projects shows many similarities with the LPS.

To sum up, a tabular list of key publications about Agile in construction is shown in the following table.

**Table 2-1 list of Agile construction publications**

Author	Purpose of research	Method	Findings
Owen and Koskela (2006a)	Explore Agile Theory for construction. Introduce research project which aims to benefit from Agile methods.	Literature review.	A theory of Agile Construction has to be developed. Agile shows potentials for managing construction projects.
Owen and Koskela (2006b)	The relationship between Agile and Leadership has been explored.	Literature review	Agile PM does indeed offer potential improvements and that the construction industry might potentially benefit, subject to structural change of the industry.
Owen et al. (2006)	Applicability of Agile theory to construction has been analysed	Literature review	Agile seems more applicable for the pre-design, design and the planning of the execution. Managing the execution with Agile seems too complex.
Chen et al.(2007)	The relationship between Agile and interface management	Literature review	Interface management can help Agile PM in coping with human dynamics.
Ribeiro and Fernandes (2010)	Applicability of Agile theory for medium and small sized companies	Literature review and 12 case studies	Agile shows great potential for medium and small sized companies.
Daneshgari (2010)	Suggestion of Agile Construction principles and tools	Case study (number not clear)	Several principles and tools have been proposed. Shows many parallels with LPS.

The above table shows that publications about Agile in construction can be divided into theoretical research and practical application. A few authors have also discussed the application of Agile to construction in combination with Lean, which will be discussed in the next section.

## **2.4 Combining Lean and Agile – “Leagile”**

In this section, a combined alternative will be explored, where it has been tried to benefit from both, Lean and Agile paradigms at the same time. First, a more generic background will be provided. Then, the developments in construction will be shown.

### **2.4.1 Background of Leagile**

The core strength of Lean management lies in efficiency and effectiveness (Naim and Barlow, 2003). Hence Lean production seems to be limited for variation in the volume and mix of products; consequently it is most effective for relatively standardised products (Barlow, 1999). In spite of this fact, Lean Production has been adapted to the construction industry (Green and May, 2003; Green and May, 2005; Jorgensen and Emmitt, 2008). The approach for implementing it was to reduce the complexity of the construction projects through creating a standardised work flow, which will end up in an operation (Ballard and Howell, 1997). However, Agile manufacturing concepts are focused on embracing change, which results in the ability to deal with uncertainty and high customer satisfaction (Barlow, 1999; Naylor et al., 1999; van Hoek, 2000; Mason-Jones et al., 2000; Wang et al., 2002; Naim and Barlow, 2003; Lim and Zhang, 2003; Lim and Zhang, 2004; Goldsby et al., 2006; Zhang et al., 2007; Akanle and Zhang, 2008; Nambiar, 2009; Zhang, 2011). Considering now that an effective PM plan needs to be focused on value for the client and performance driven (i.e. focused on effective and efficient processes) (Winch, 2006), this means clearly that a good PM plan should allow the implementation of both (Lean and Agile) paradigms at the same time. The idea of combining Lean and Agile paradigms together is not a novel approach.

The early advocates of Agile manufacturing saw Agile as a further developed methodology of Lean (Iacocca Institute; 1991a; Goldman and Nagel, 1993; Kidd, 1994; Barlow, 1998; Barlow, 1999; Christopher and Towill, 2000; Maskell, 2001), which can be illustrated with the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at:  
Barlow, J. (1999). From Craft Production to Mass Customisation. Innovation Requirements for the UK Housebuilding Industry. *Housing Studies*, 14(1), p. 30.

Figure 2-26 the evolution of Agile production (Barlow, 1999, p. 30)

Figure 2-26 describes the sequential developments of the production industry, in which CP stands for Craft Production, MP is Mass Production, LP is Lean Production and AP describes Agile Production.

However, a formal distinction between the Lean and Agile paradigms took place through the work of Naylor et al. (1999), who first coined the term “Leagile” (Goldsby et al. 2006). Naylor et al. (1999, p. 108) defined Lean and Agile as follows:

*“Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place. Leanness means developing a value stream to eliminate all waste, including time, and to ensure a level schedule”.*

Leagile is the sequential combination of Lean and Agile on the entire supply chain (Naylor et al., 1999). The demand for Leagile came through viewing the whole supply chain (van Hoek, 2000), with the conclusion that the current market place within which organisations are operating consists of two different supply chain characteristics at the same time, namely, on the one hand where demand is relatively stable, predictable and variety is low (Atiken et al., 2002), on the other where demand is volatile and the customer requirement for variety is high (ibid.). Therefore researchers who are involved in supply chain management disciplines tried to benefit from Lean and Agile management paradigms through combining them with each other sequentially (Naylor et al., 1999; van Hoek, 2000; Mason-Jones et al., 2000; Goldsby et al., 2006). Out of that, Naylor et al. (1999) developed the decoupling point model. The decoupling point is the point where

the supply chain switches from one paradigm to the other sequentially (Mason-Jones et al., 2000). The concept of the decoupling point model can be illustrated with the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Christopher, M., & Towill, D. (2001). An integrated model for the design of agile supply chains. *International Journal of Physical Distribution & Logistics*, 31(4), p. 240.

Figure 2-27 the decoupling point model (Christopher and Towill, 2001, p. 240)

In addition to Figure 2-27, Naylor et al. (1999, p. 114) define the upstream and downstream of the decoupling point as follows:

- *The Lean paradigm can be applied to the supply chain upstream of the decoupling point as the demand is smooth and standard products flow through a number of value streams. Downstream from the decoupling point a number of products flow through one value stream.*
- *The Agile paradigm must be applied downstream from the decoupling point as demand is variable and the product variety per value stream has increased.*
- *The decoupling point is also the point at which strategic stock is often held as a buffer between fluctuating customer orders and/or product variety and smooth production output. This fact is critical when to adopt Agile or Lean manufacturing techniques.*

Another approach, which is principally the same as the decoupling point, is the “Pareto Curve Approach”.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Christopher, M., & Towill, D. (2001). An integrated model for the design of agile supply chains. *International Journal of Physical Distribution & Logistics*, 31(4), p. 240.

**Figure 2-28 Leagile Pareto Curve approach (Christopher and Towill, 2001, p. 240)**

The Pareto Curve approach, illustrated in Figure 2-28, suggests that for the first 20% of the total volume, Lean should be implemented, as it will deliver 80% of the total demand, and the rest with Agile (Christopher and Towill, 2001; Goldsby et al., 2006).

Hence, Lean and Agile paradigms should not be seen as competing, but rather as overlapping paradigms, when considering the whole supply chain (Narasimham et al., 2006).

Attempts to implement Leagile have been made in computer manufacturing (Naylor et al. 1999; Qi et al., 2007), in telecommunications (Robertsen and Jones, 1999), in construction (Naim and Barlow, 2003; Court et al., 2009), in the banking and finance sector (Parnell-Klabo, 2006) and in a heating, ventilation and air conditioning manufacturer (Goldsby et al., 2006).

### 2.4.2 Developments in construction

“Agile” is immature for construction (Owen et al., 2006) and therefore Leagile construction is in the very early stages of development. This is reflected within the existing literature, which considers the potentials of and approaches to combining Agile and Lean management methods. These are shown in the following table.

**Table 2-2 literature about combining Lean and Agile**

Author	Purpose of research	Method	Findings
Lu et al. (2011)	To develop a Lean and Agile model for housing construction	Literature review and case study research	The decoupling point model can be applied to construction through using simulation tools.
Ndihokubwayo (2010)	How waste minimisation arising from variation orders can be achieved through Lean and Agile thinking.	Literature review and questionnaire to project managers in South Africa to validate	The hindrances of the application of Lean and Agile in the case of variation orders have been identified. Findings suggest that the adoption of Lean and Agile principles would reduce waste.
Court et al. (2009)	To design and implement a Lean and Agile construction system for mechanical and electrical projects in order to improve health, safety and productivity.	Literature review and case study to validate	The developed system causes higher productivity (when comparing the case study with similar projects) and improvements in health and safety.
Chen et al. (2007)	To establish and clarify the close relationships between interface Management, Lean Management and Agile Management.	Conceptual Paper, literature review	Interface Management can improve the implementation of Lean Management and Agile Management
Court et al. (2006)	Introduction of the field of research from a doctoral thesis	Conceptual paper, literature review	A conceptual model has been presented which will be tested with a case study.
Naim and Barlow (2003)	Application of Lean and Agile paradigms for prefabricated housing.	Conceptual paper, literature review	Application of the decoupling point model is possible to customised housing.
Naim et al. (1999)	Application of Lean and Agile paradigms in the total supply chain.	Conceptual paper, literature review	The concept of “leagility” is presented, and the potential for the application of “leagility” in house building is described, in order to increase performance.
Barlow (1998)	To outline the principle features of Lean and Agile and how the UK construction industry can benefit out of it.	Literature review, interview and case study to validate	Besides the outlined principal features, barriers for adopting Lean and Agile paradigms have been presented.

Table 2-2 shows that many of the papers are conceptual. The publications which used some sort of primary data did not claim universality, as their data was collected from a particular context (i.e. country, segment).

Barlow (1998; 1999) introduced the use of Lean and Agile methods for the UK house building industry. The research followed the approach that Agile already covers Lean, but is able to increase its attraction to the clients for house building. Hence, the approach was to improve Lean. Barlow (1998; 1999) analysed the potential barriers and limits for Agile manufacturing attributes in the house building industry and introduced a research project which will undertake an implementation of Agile manufacturing to UK house building. A holistic view was followed for construction, i.e. the whole project life cycle has been considered, when introducing this work. However, no further publications have been made, which tried to benefit out of Lean and Agile at the same time, through transferring the Agile manufacturing approach to construction.

Further study focused on the Leagile paradigm, which reflects a clear distinction between Lean and Agile. Naim et al. (1999) as well as Naim and Barlow (2003) proposed a decoupling point model for housing, where a switch from the Lean to the Agile paradigm, or vice versa, takes places; combining these methods sequentially. This research delivered an approach for managing the supply chain in construction mainly focused on execution and not on the whole project lifecycle (ibid.).

Court et al. (2006) and Court et al. (2009) used a different way of implementing the decoupling point model in the supply chain of a mechanical and electrical contractor, which is illustrated in the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Court, P., Pasquire, C., Gibb, A., & Bower, D. (2006). Design of lean and agile construction system for a large and complex mechanical and electrical project. *International Group for Lean Construction* (p. 8). Santiago: IGLC.

Figure 2-29 Leagile construction management model (Court et al., 2006, p. 8)

The approach of Court et al. (2006) (see Figure 2-29) suggests that the execution on site is managed using the LPS, and the elements of the supply chain before are managed with Agile manufacturing attributes.

Chen et al. (2007) pointed out the importance of interface management for the implementation of Lean and Agile practices for construction. However, this work was more focused on interface management rather than on the implementation of Lean and Agile at the same time. Ndiokubwayo and Haupt (2010) focused on how Lean and Agile paradigms can cope with variation orders, with the conclusion that Agile methods seem not as ready for implementation in construction as Lean methods do. Based on the decoupling point model, Lu et al. (2011) developed a computer simulation, which analysed the inventory level of the Leagile paradigm and compared it with Even Flow Construction and Sales-Driven Production, with the conclusion that Leagile seems more beneficial for house builders in regard to inventory.

## 2.5 Conclusion of the literature review

The management of construction projects is the most complex of all production undertakings (Winch 1989; Winch, 2000; Winch, 2006). The increasing dynamics in the nature of construction results in large amounts of project complexity over time (Winch, 2000). Hence, practitioners within PM have historically understood that bringing “[...] a project to its successful end requires an integration of numerous management functions such as controlling, directing, team building, communication, and many others, and it requires cost and schedule management,

*technical management, risk management, conflict and stakeholders management, life cycle management and again more”* (Shenhar and Dvir, 1996, p. 608). Universal PM systems, such as those from the PMI (2008) or APM (2000), have been established in order to fulfil this need. The integrated tools, methods and techniques never competed against each other; the focus is more on providing a set of tools, methods and techniques for the PM, to allow appropriate situational usage of them. Furthermore situational leadership as well as situational management styles have been acknowledged by those professional bodies a long time ago. As the project environment is dynamic in its nature (Bertelsen, 2003), the PM style needs to be dynamic as well in order to be able to meet the contemporary needs of the project (Ancona and Caldwell, 1992).

However, to be able to cope with today’s complex construction projects, several different management paradigms have been promoted by the industry or are immature in their use, such as Lean (Koskela, 1992; Egan, 1998; Howell, 1999), Agile (Owen and Koskela, 2006a) and Leagile (Naim et al., 1999). All of these paradigms provide a lot of benefits, if applied. However, all of these paradigms are also associated with weaknesses. Advocates of universal PM systems, Lean construction and Agile compete with each other, with the confidence that their paradigm suits best to construction. Leagile shows clearly that all of these paradigms can be applied at one time. Nevertheless, Leagile keeps the weaknesses and sets the focus more on maximising the strengths.

The main focus of work relating to Leagile in construction, was on the adoption of the decoupling point model. Current studies about Leagile did not focus on the whole project life cycle. Furthermore the focus was more on Agile manufacturing rather than Agile IT. Therefore a more holistic perspective encompassing all the stages of the project life cycle has not been considered so far. It has been also identified that there is a lack of empirical studies about Leagile, as the focus is more conceptual papers.

However, none of these studies tried to merge PM, Lean and Agile together to a unifying strategic framework. There are no developments, which want to

maximise the strengths and eliminate the weaknesses of PM, Lean and Agile at the same time. To conclude, the attempt to synthesise PM, Lean and Agile, which is conceptualised as “Agile PM”, is an ideal approach for resolution, as it will benefit from the strengths and eliminate the weaknesses of these paradigms.

## **2.6 The need for the Agile PM framework**

Today’s construction projects face increasing cost pressures, shorter project life cycles and a dynamic as well as globalised environment. Hence the construction environment is changing, and so does also the management of construction projects.

In search for alternative management methodologies to manage construction projects, two different management paradigms have been promoted by the construction industry or are in immature in their use. On the one hand, there is Lean construction, and on the other there is Agile PM. Lean construction is good in dealing with static or predictable environments. Agile PM, in turn, is focused on coping with dynamic and uncertain environments (Burlereaux et al., 2013; Sheffield and Lemetayer, 2013).

A project, however, faces different environmental characteristics over its project life cycle. Sidwell (1990) found out that in construction the project dynamics decrease towards the end of a project’s life cycle. Hence a construction project faces two environmental typologies at the same time, namely predictable and uncertain environments. The result is that PM needs to become more strategic (Labelle and Leyrie, 2013). This potentially draws upon elements of each paradigm for its effective management. As such, Leagile combines Agile and Lean through using the decoupling point model, where a switch from one paradigm into the other takes place sequentially (Naim et al., 1999; Mason-Jones et al., 2000; Goldsby et al., 2006).

Nevertheless, Leagile has been developed in production supply chain management. A project environment differs from that of production supply chain management in its complexity, because the outputs of project processes are large

and many activities are occurring at the same time (Slack et al., 2008). If there is a task or situation which does not enable a clear decoupling from one paradigm into the other then Leagile becomes limited in use. Hence the sequential implementation of Agile and Lean methodologies in construction seems to be a complex task.

This is the rational for the development of a new approach, which is investigated in this thesis. It is proposed that PM, Lean and Agile methodologies should be merged into one unit. This approach is conceptualised as “AgiLean PM”. AgiLean PM eliminates waste in the processes and is able to react to change. It is underpinned by universal management systems. Hence AgiLean PM, is taking advantage out of PM, Lean and Agile at the same time. This new innovative management method could be the best way of dealing with the complexity in construction projects in order to achieve maximum performance in future.

## 3 Research methodology

The literature review chapter provided the theoretical background and knowledge to enable answering the research question, how can a unifying strategic framework based on PM, Lean and Agile be generated? In this chapter, first, an understanding about the terminologies of theory and research will be provided. This will deliver the required background for the philosophical considerations, which will be discussed next. This chapter will be concluded with the derivation of the research strategy for the AgiLean PM framework.

### 3.1 Terminology of theory and research

According to Clough and Nutbrown (2002) as well as Saunders et al. (2009), a methodology refers to the theory of how research should be undertaken to answer a particular research question. Hence, it is worth getting an understanding of the terminologies “theory” and “research” before exploring the philosophical issues, as these terms will occur or have already occurred several times within the body of this thesis.

Friedman (2003) found out that the term “research” is derived from the term “search”. The prefix “re” came to this word to emphasise and strengthen the word “search”. Hence, the Oxford Dictionary Thesaurus (2001, p. 1098) defined the term “research” as *“the systematic study of materials and sources in order to establish facts and reach new conclusions”*. Saunders et al. (2009) argue that even if each conducted research is different, they have all similar characteristics, namely that data are interpreted systematically and that there is a clear purpose for the investigation (to find things out). Remeny et al. (1998) concluded that there are two reasons why one should do research. First, it might be related to the fact that there are many issues and subjects where incomplete knowledge exists (ibid.). The second reason is related to the *“Homo sapiens’ compulsive need for growth”* (Remeny et al., 1998, p. 25). Therefore, in the framework of this thesis, research can be defined *“as something that people undertake in order to find out things in a systematic way, thereby increasing their knowledge”* (Saunders et al., 2009, p.

5). According to Remeny et al. (1998) there are two different ways to approach research, one is empirical and the other is purely theoretical. The purely theoretical research approach is done through using only secondary data, which are the writings of others and draws conclusions by using the researcher's intellectual capabilities (ibid.). The empiricist researcher draws conclusions through gathering primary data and analysing those (ibid.). This research uses the empirical approach. Even though secondary data has been reviewed in order to ground the problem in theory and to gain a deep understanding of PM, Lean and Agile. The conclusions, which will be drawn, will be mainly based on the primary data collected.

The relationship between theory and research, is whether theory guides research (deductive theory) or theory is an outcome of research (inductive theory) (Remenyi et al. 1998; Bryman and Bell, 2007; Fellows and Liu, 2008; Creswell, 2009; Saunders et al. 2009; Gill and Johnson, 2010; Bryman, 2012), which is illustrated in Figure 3-1.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Bryman, A. (2012). *Social Research Methods* (4th ed.), p. 26. New York: Oxford University Press.

**Figure 3-1 deductive and inductive theory (Bryman, 2012, p. 26)**

Deductive theory develops a clear theoretical position before collecting the data (Saunders et al., 2009). This theoretical position (also called “hypothesis”) will be then validated or rejected (Bryman, 2012). Hence, deductive approaches are more likely to test theory rather than generating new theory (Remenyi et al., 1998; Bryman and Bell, 2007; Fellows and Liu, 2008; Creswell, 2009; Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012), and are therefore more appropriate with quantitative methods (ibid.), as the aim is to seek generalisations (Saunders et al., 2009; Bryman, 2012). In contrast, there is also the inductive approach,

where first the data will be collected and out of the findings a hypothesis will be generated (Remeny et al., 1998; Bryman and Bell, 2007; Fellows and Liu, 2008; Creswell, 2009; Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012). Inductive approaches are more in use with qualitative methods, because they aim to explore more the specific, rather than to explain the general (ibid.).

Friedman (2003) argues that theory is in its most basic form a model. *“It is an illustration describing how something works by showing its elements in relationship to one another”* (Friedman, 2003, p. 513). Therefore a *“[...] theory might appear in a research study as an argument, a discussion, or a rationale, and it helps to explain (or predict) phenomena that occur in the world”* (Creswell, 2009, p. 51). Another contribution to the view of theory is shared by van Aken (2004), who distinguishes between organisational theory, which results in a description driven research with a more explanatory nature and is used in a conceptual way; and in management theory, which results in a prescription driven research and is used in an instrumental way to design specific solutions for management problems. Koskela (1996, p. 2) argues that theory can have also the meaning of “foundational ideas”, which is illustrated in the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Koskela, L. (1996). Towards the theory of (lean) construction. *4th Annual Proceedings of the IGLC* (p. 2). Birmingham: International Group for Lean Construction.

**Figure 3-2 meaning of theory as foundational ideas (Koskela, 1996, p. 2)**

In regard to Figure 3-2, Koskela (1996) argues further that the development of theory might occur in two directions. Namely, bottom up, where first the methods and methodologies have been developed and a theoretical framework has been created out of that (ibid.), such as happened with the Agile Manifesto (2001); top down, where first the concepts will be developed, then the principles will be derived to show the rationale of the concepts and finally methods and

methodologies will be proposed (ibid.). This research will not propose new methodologies and methods, which could be used to act under the umbrella of AgiLean PM, as this shows fields of further study and investigation. However, this research will still use a bottom up approach for developing the AgiLean PM framework. First, the principles will be developed. Then the developed principles will lead to the concepts of the AgiLean PM framework. The aim is to develop a new form of organisational theory, which is more description driven and used in a conceptual way.

However, it is still required to review the underlying assumptions of the research philosophy, because “[...] *research methods cannot be viewed in isolation from the ontological and epistemological position adopted by the researcher* (Dainty, 2008, p. 3). The umbrella term for such considerations is called “paradigm” (Bryman and Bell, 2007; Creswell, 2009; Saunders et al. 2009; Bryman, 2012), which is a “[...] *term deriving from the history of science, where it was used to describe a cluster of beliefs and dictates that for scientists in a particular discipline influence what should be studied, how research should be done, and how results should be interpreted*” (Bryman, 2012, p. 714).

### **3.2 Philosophical Considerations**

Philosophy is defined as “*the study of fundamental nature of knowledge, reality, and existence*” (Oxford Dictionary Thesaurus, 2001, p. 964). The failure to think through philosophical issues will have a negative impact on the quality of the research, as it is the crucial enabler to derive the research strategy (Easterby-Smith et al., 2012).

To facilitate this, the author will use the tree metaphor of Easterby-Smith et al. (2012, p. xv), which is shown below.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Easterby-Smith, Thorpe, R., & Jackson, P. (2012). *Management Research* (4th ed.), p. XV. London: SAGE Publications.

Figure 3-3 Research Tree (Easterby-Smith et al., 2012, p. xv)

In Figure 3-3, represents the core the ontology, which is the basic assumption about the nature of reality (Easterby-Smith et al., 2012). The next ring shows epistemology, the assumption about the best way of discovering the phenomena (ibid.). The third ring represents methodology, which gives an overall view about the research techniques and methods (ibid.). The last ring shows the specific methods and techniques, which will be used for this particular research. The reason for this sequential order of the tree rings is related to visibility. The most visible parts are on the outer ring. Hence the more one is getting to the core, the less visible is the part, but the more important (ibid.).

### 3.2.1 Ontological considerations

Ontological considerations are the starting point for most of the debates among philosophers (Runeson and Skitmore, 2008; Easterby-Smith et al., 2012). The term “ontology” consists on a combination of two Greek words, namely “ontos” and “logos” (Gill and Johnson, 2010). The term “ontos” refers to “being” and “logos” refers to “knowledge” (ibid.). Hence when putting the terms together it means the knowledge of being. This etymological derivation of the term, has resulted in that several researchers have articulated ontology differently but with the same meaning. For instance, Runeson and Skitmore (2008, p. 75) and Saunders et al. (2009, p. 110) as well as Easterby-Smith et al. (2012, p. 17) state that ontology is concerned with “[...] *the nature of reality* [...]”. Further Bryman and Bell (2007, p. 716) as well as Bryman (2012, p. 714) define ontology as a “[...] *theory of the nature of social entities*”. Therefore ontology is a different part of philosophy which deals with the nature of phenomena or reality (Bryman and

Bell, 2007; Fellows and Liu, 2008; Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012; Easterby-Smith et al., 2012). Scientists generally had two contrasting ontological orientations when deriving their research methodology (Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012; Easterby-Smith et al., 2012). On the one hand there is the view of an objective reality (Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012; Easterby-Smith et al., 2012), which exists independent of its environment (Runeson and Skitmore, 2008). On the other, there is the view that reality is subjective (Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012; Easterby-Smith et al., 2012), which is “[...] *a social construct, changing depending on who views it and existing only in our minds as our constructs*” (Runeson and Skitmore, 2008, p. 75). This distinction has been articulated by Gill and Johnson (2010) as that the ontological existence can be real or illusory.

Ontological views on science have been debated for many centuries (Easterby-Smith et al., 2012), actually since humans have started thinking about science (Runeson and Skitmore, 2008). This can be also reflected through the different terminologies, which have been used to describe the objective and subjective ontological views. When reviewing the literature about ontology, the researcher faced the problem that several authors (Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012; Easterby-Smith et al., 2012) are using different terms to describe the same issue, which was perceived at the beginning as a farrago of different ontological perspectives. However, to create a deeper understanding of the terms used and to select the most suitable ones for the framework of this research, the author made the following table.

**Table 3-1 ontological view points**

<b>Author(s)</b>	<b>Objective reality</b>	<b>Subjective reality</b>
Saunders et al. (2009)	Objectivism	Subjectivism
Gill and Johnson (2010)	Realism	Subjectivism
Bryman (2012)	Objectivism	Constructionism
Easterby-Smith et al. (2012)	Realism	Relativism

Hence, Table 3-1 points out that the different terms, which have been used by different authors have basically the same meaning. For instance, on the one hand Gill and Johnson (2010) and Easterby-Smith et al. (2012) talk about realism, on the other hand Saunders et al. (2009) and Bryman (2012) use objectivism, to describe the reality, which is there and cannot be influenced by external social actors. On the flipside of the same coin, Saunders et al. (2009) and Gill and Johnson (2010) refer to subjectivism, Bryman (2012) uses constructionism, and Easterby-Smith et al. (2012) talk about relativism, for describing the reality which is out there but influenced by its social actors. The researcher will use in the framework of this research the terms “objectivism” and “subjectivism”. However, it is not an issue of deciding, which is the right term for the thesis, but rather it is about understanding the ontological viewpoints. The reason why these two terms have been preferred by the researcher, is simply related to the fact that at the beginning of this chapter ontology has been derived by subjective and objective reality. Therefore subjectivism and objectivism seemed more favourable.

### **3.2.2 Epistemological considerations**

In the previous section, ontology was discussed, with the conclusion being made that it is a different part of research philosophy, which deals with views on the nature of reality (Bryman and Bell, 2007; Fellows and Liu, 2008; Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012; Easterby-Smith et al., 2012). Hence, after knowing how to view the world, next is to identify the best way of enquiry into the defined reality (Easterby-Smith et al., 2012). These considerations are called “epistemology” (Johnson and Duberley, 2000; Bryman and Bell, 2007; Knight and Turnbull, 2008; Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012; Easterby-Smith et al., 2012). The term “epistemology” is derived from two Greek words (Johnson and Duberley, 2000; Knight and Turnbull, 2008), namely “episteme” and “logos” (ibid.). Episteme means “knowledge” or “science” (Johnson and Duberley, 2000); and logos means “knowledge”, “information”, “theory” or “account” (ibid.). There is no universal definition of epistemology, as it has been defined differently by several researchers (Bryman and Bell, 2007; Knight and Turnbull, 2008; Saunders

et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012). For instance, Bryman and Bell (2007, p. 714) as well as Bryman (2012, p. 711) defined epistemology as a “[...] *theory of knowledge*”. Further Saunders et al. (2009, p. 591) defined it as a “[...] *branch of philosophy that studies the nature of knowledge and what constitutes acceptable knowledge in a field of study*”. A final definition of epistemology in the framework of this thesis, is provided by Neuman (2011, p. 93) as an “[...] *area of philosophy concerned with the creation of knowledge; focuses on how we know what we know or what are the most valid ways*”.

Hence considering the etymological derivation and the current definitions of the term “epistemology”, it can be understood as the knowledge about knowledge. According to Knight and Turnbull (2008) knowledge in philosophy is defined as a justified true belief. Hence, the aim of epistemological considerations is to answer questions about the nature of, the limits of, and the way of gathering the knowledge (Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012; Easterby-Smith et al., 2012). Knight and Turnbull (2008) found out that, when viewing epistemology chronologically, it can be classified into classical and modern epistemology. Classic epistemological considerations deal with more general problems such as ethics and politics (ibid.). Modern epistemological considerations are more value free and are used to derive knowledge within the natural sciences (ibid.). Hence the focus of this thesis is on modern epistemology. Similar to the ontological thoughts, epistemological viewpoints have been also in debate for many centuries between researchers and philosophers (Runeson and Skitmore, 2008; Easterby-Smith et al., 2012). Analogical to ontology, there are also two main modern epistemological views, which describe how knowledge should be warranted in a field (Johnson and Duberley, 2000; Bryman and Bell, 2007; Knight and Turnbull, 2008; Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012; Easterby-Smith et al., 2012). Hence, the researcher faced here also the problem, that several researchers are using slightly different terms to describe the same theme. An overview about this is provided with the table below:

Table 3-2 epistemological view points

Author(s)	Objective knowledge	Subjective knowledge
Saunders et al. (2009)	Positivism	Interpretivism
Gill and Johnson (2010)	Positivism	Subjectivism
Neuman (2011)	Positivism	Interpretivism
Bryman (2012)	Positivism	Interpretivism
Easterby-Smith et al. (2012)	Positivism	Social Constructionism

The researcher decided to use again the keywords objective and subjective to classify the two contrasting epistemological considerations, which are shown in Table 3-2. However, before discussing the epistemological thoughts further, the researcher wants to point out, that positivism and interpretivism will be used as terms in the framework of this research, as they are the most common ones.

As stated before, out of the classical epistemology, modern epistemology has been derived to deduce knowledge in the natural sciences (Knight and Turnbull, 2008), which will be called positivism, in the framework of this research. Saunders et al. (2009) describe people who use positivism as “resources researcher” and uses keywords such as “facts”, “real” and “objective” to describe the characteristics. Hence, positivist research prefers to be conducted in a direct observable reality, which has a separate existence to that of the researcher (Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012). Further, positivist research has the aim to generate theories, in a hypothetic-deductive way, where theories can be tested by their confrontation with facts, and the result is that the research is value free (objective) and can be through identifying an appropriate sample generalised (Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012; Easterby-Smith et al., 2012). This results in that the positivist approach is limited to developing knowledge through factual data, which is only reasonable through a prior ontological assumption of objectivism (Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012). The positivist epistemological thoughts are considered to belong to those of the natural sciences (ibid.). The application of positivist epistemological positions to social sciences could be facilitated through the usage of methods, which are common in natural sciences research (Bryman

and Bell, 2007; Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012; Easterby-Smith et al., 2012).

However, Gill and Johnson (2010, p. 192) found out that the application of natural sciences methods to social sciences is difficult, because “[...] (1) *it seems self-contradictory* (2) *the possibility of directly and objectively observing phenomena, and thereby accumulating the “facts” of the world so as to test the truthfulness of a theory seems dubious*”. Hence, Easterby-Smith et al. (2012) argue further that within the social sciences the interest is more on soft factors (behaviour, thoughts, human aspects etc.) rather than on inanimate objects. Thoughts like these have led to a debate about whether the assumptions of the positivist epistemological positions are appropriate for research undertaken in the social sciences (Bryman, 2012; Easterby-Smith et al., 2012). As a result, a new paradigm within the modern epistemology has been evolved during the last half century (Easterby-Smith et al., 2012), which will be further referred as interpretivism.

Interpretivism is the contrasting epistemology of positivism (Bryman and Bell, 2007; Saunders et al., 2009; Neuman, 2011; Bryman, 2012). The most common distinction between those two epistemological positions, which is made, is that positivism is focused on explaining the human behaviour and that interpretivism is focused on understanding the human behaviour (Johnson and Duberley, 2000; Bryman and Bell, 2007; Knight and Turnbull, 2008; Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012; Easterby-Smith et al., 2012). Saunders et al. (2009) describe people, who use an interpretivist position as “feelings researcher”, which are focused on attitudes, cultures and feelings of the humans rather than the objects around. Hence, interpretivist research has the view that reality is not objective and does not have a separate existence to that of the researcher (Saunders et al., 2009; Gill and Johnson, 2010; Bryman, 2012), but rather is determined and created through the people (Easterby-Smith et al., 2012). Further, interpretivist epistemological considerations claim that research cannot be generalised (Neuman, 2011; Bryman, 2012; Easterby-Smith et al., 2012), but rather it reflects the value laden subjectivity of an individual scientist or a community of scientists (Gill and Johnson, 2010, p. 192). The focus is more on

the identification of different experiences which people have, rather than searching for external causes to explain behaviour (Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012; Easterby-Smith et al., 2012). Therefore knowledge is derived through using qualitative data, which is only reasonable through a prior ontological assumption of subjectivism (Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012).

### 3.2.3 Methodology

It should be clear by now that there is relationship between ontology and epistemology (Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012). In the framework of this research, objectivism is related to positivism and subjectivism is related to interpretivism. Next, the missing puzzle pieces of methodology will be put in place. An overview about the different terms has been provided by Easterby-Smith et al. (2012, p. 18), which is shown in the table below.

Table 3-3 overview about philosophical considerations (Easterby-Smith et al., 2012, p. 18)

<p>The table originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The table was sourced at: Easterby-Smith, Thorpe, R., &amp; Jackson, P. (2012). <i>Management Research</i> (4th ed.), p.18. London: SAGE Publications.</p>
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According to Saunders et al. (2009, p. 595) methodology describes the “[...] *theory of how research should be undertaken, including the theoretical and philosophical assumptions upon which research is based and the implications of these for the method or methods adopted*”. Therefore methodology refers to the “[...] *the way research techniques and methods are grouped together to provide a coherent picture* (Easterby-Smith et al., 2012, p. xv); and the simple collection of data is called “research method” (Bryman and Bell, 2007; Neuman, 2011; Bryman, 2012). The terms “methodology” and “method” are closely linked to each other, but are still independent (Neuman, 2011). Methodological

considerations are important because they set the research strategy (Remenyi et al., 1998; Bryman and Bell, 2007; Bryman, 2012) and the derivation of specific research methods makes more sense, if one is aware about their logic and assumptions on which they are based (Neuman, 2011).

However, according to Bryman and Bell (2007) and Bryman (2012) methodological issues are distinguished between quantitative research and qualitative research. Denzin and Lincoln (2005) argue that the focus of qualitative research is on the quality of entities and processes as well as meanings which cannot be measured. Qualitative research emphasizes words rather than quantification in the collection and analysis of data (Bryman and Bell, 2007; Saunders et al., 2009). These characteristics result in that qualitative research is related to subjectivist ontological considerations and to interpretivism as epistemological orientation (Bryman, 2012). Further qualitative research is providing rich descriptions of the real world (Denzin and Lincoln, 2005). The result is that they are better for generating theories rather than testing them (ibid.). Methods for qualitative research are for instance interviewing, observing, artefacts, documents, and records, visual methods, data management methods, computer-assisted analysis, textual analysis, focus groups, applied ethnography, case study (Denzin and Lincoln, 2005).

In contrast, quantitative methods focus on the measurement and analysis of causal relationships between variables and not on the meanings of the processes (ibid.). Advocates of quantitative research claim that their work is value free and that qualitative research is unreliable, unstructured and not objective (ibid.). Further, rich descriptive data is not in the sense of quantitative research, because such details are interrupting the process of developing generalisations. Hence, quantitative research emphasizes quantifications, rather than words in the collection and analysis of data (Bryman and Bell 2007; Saunders et al., 2009). Therefore quantitative studies result in objectivism as ontological view on reality and positivism as epistemological orientation. Quantitative research has more the focus on testing rather than generating theories (Bryman, 2012). Methods for quantitative research are for instance precision measurements, statistical analysis,

repeatability researches, and comparisons (Denscombe, 2010). All of these methods are normally done with surveys (ibid.). The fundamental differences between quantitative and qualitative methodologies has been summarised by Bryman and Bell (2007, p. 27) and Bryman (2012, p. 36), which is shown below.

**Table 3-4 difference between qualitative and quantitative methodology (Bryman, 2012, p. 36)**

<p>The table originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The table was sourced at: Bryman, A. (2012). <i>Social Research Methods</i> (4th ed.), p. 36. New York: Oxford University Press.</p>
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The researcher slightly modified the Table 3-4 and placed the terms, which have been derived in the framework of this thesis. The use of a qualitative or a quantitative methodology tells more than the way of how data will be gathered. It shows the world view. The view on knowledge and the objective (i.e. to test or to define theory) of the study. This could lead to the conclusion that those methodological orientations have to be used always in isolation. The primary focus of the discussion so far, was mainly on the use and choice of one individual orientation.

However, several researchers argue that there are good reasons for combining methods with different orientations within one research project (Jick, 1979; Easterby-Smith et al., 1991; McNeill and Chapman, 2005; Bryman and Bell, 2007; Saunders et al., 2009; Creswell, 2009; Neuman, 2011; Bryman, 2012; Easterby-Smith et al., 2012). Hence there are several different ways of undertaking a research, an overview about those has been provided by Saunders et al. (2009) and is shown below.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5th ed.), p.152. Essex: Pearson Education.

Figure 3-4 research types (Saunders et al., 2009, p. 152)

In Figure 3-4, Saunders et al. (2009) distinguish on the highest level between mono methods, which stands for the use of a single data gathering technique and multiple methods, where more than one data collection technique is in use. On the multiple methods level are two distinctions. On the one hand, there are multi methods. Multi methods use more than one data collection technique, but are restricted to a qualitative or quantitative orientation. On the other hand, there is the broad area of mixed methods. Mixing in this sense means that the qualitative and quantitative methods are merged together, kept separate and independent or combined in some other way (Creswell, 2009). Mixed-model research uses a combination of different data collection and analysis techniques, for instance to “quantitise” the qualitative data into numerical values, so that it can be analysed statistically or to “qualitise” quantitative data so that it can be analysed in a qualitative manner (Bryman and Bell, 2007; Saunders et al., 2009; Neuman, 2011; Bryman, 2012). In contrast the mixed methods research uses qualitative and quantitative data gathering methods either sequentially (first one then the other) or at the same time (parallel or simultaneously) (Creswell, 2009; Saunders et al., 2009; Bryman, 2012).

In the context of sequential mixed method research, Creswell (2009) distinguishes between the sequential explanatory strategy and sequential exploratory strategy. The former describes the process of where in the first stage quantitative data will be collected and analysed followed by the collection and analysis of qualitative data in the second stage (ibid.). The use of qualitative data to support the quantitative data provides the following advantages (ibid.):

- Support in the explanation and interpretation of the quantitative data
- Qualitative data can be useful in examining unexpected quantitative results

Therefore the primary focus here is on the quantitative data, which explains the causal relationships. In the second stage these causal relationships will be explored to understand the reason behind them.

The sequential exploratory strategy starts with the collection and analysis of qualitative data in the first stage, followed by the next stage of quantitative data collection and analysis, which build on the results of the first stage (ibid.). According to Creswell (2009) this type of sequential mixed method research provides the following advantages

- Quantitative data supports the interpretation of qualitative data
- Exploring phenomena
- Generalize qualitative findings

Hence the primary focus here is on the qualitative data, where the data is mixed through connecting the results of the qualitative findings with the quantitative data collection (ibid.; Saunders et al., 2009). The difficulty which can be faced here is to decide, which findings from the qualitative data will be used for the quantitative (Creswell, 2009).

Mixed methods research in general may be employed to eliminate the disadvantages of each individual approach whilst maximising the advantages of each (Easterby-Smith et al., 1991; McNeill and Chapman, 2005; Fellows and Liu, 2008; Saunders et al., 2009). Furthermore mixed method research creates synergies, which allow a multidimensional view of the subject (McNeill and Chapman, 2005; Fellows and Liu, 2008). In addition Easterby-Smith et al. (2012) argue that a range of different methods within one research project will increase the validity and generalizability of the results and its theoretical contribution. Another advantage is that different data collection techniques can be used for different purposes (Saunders et al., 2009). Considering the straightforward concept of both sequential mixed method strategies, results in easy

implementation, because the steps fall into clear separate stages (Creswell, 2009; Saunders et al., 2009). Further Morris (2010) argues that people involved in PM research, who have been previously trained within the “positivist school”, have inhibitions with pure qualitative methodologies. Hence a sequential exploratory strategy might be supportive for researchers to break these inhibitions of their advisers or their research community (Creswell, 2009).

However, mixed methods also have been criticised by several researchers. For instance McNeill and Chapman (2005) and Fellows and Liu (2008) as well as Creswell (2009) argue that mixed methods have a huge resources (time, money etc.) consuming nature, which might be not available in the framework of a research project. Further mixed methods produce a huge amount of data (McNeill and Chapman, 2005; Fellows and Liu, 2008). The analysis of this data consumes a lot of time (McNeill and Chapman, 2005; Fellows and Liu, 2008) and the result is that the researcher has to be familiar with both, qualitative and quantitative data analysis techniques (Creswell, 2009). In addition the high amount of data might create contradictory findings (McNeill and Chapman, 2005). Bryman (2012) criticised the mixed method approach from the philosophical perspective, because a qualitative and a quantitative data collection technique are based on a methodology, which is based on an epistemology. An epistemology, in turn, is based on ontological considerations. These considerations have been in debate for centuries (Runeson and Skitmore, 2008), because they are different, contrasting and stand for two extremes (Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012). Therefore, the advantage that different methodologies might complement each other is in dilemma with the epistemological and ontological viewpoints (Bryman, 2012).

#### **3.2.4 Linking ontology, epistemology and methodology - a construction perspective**

The management of construction is a complex task (Winch, 1989; Baccarini, 1996; Winch, 2003; Raiden et al., 2004; Winch, 2006), which makes it on the one hand difficult (Voordijk, 2009; Oyegoke, 2011), but on the other hand extremely

interesting (Harris, 1998). It includes the management of new projects, existing buildings and facilities as well as entire companies (Raftery et al., 1997; Harris, 1998). Various parties are involved with each having their own objectives and perceptions on the project (Li and Love, 1998). According to Boyd and Bentley (2012, p.441) construction is about changing the world, which “[...] *involves organizing and manipulating the physical and social world through design, management and craft*”. Therefore construction projects always have a long term impact on society (Harris, 1998; Boyd and Bentley, 2012), but have to be constructed in a short time framework (Harris, 1998), which is full of risks, crises and uncertainties (Harris, 1998; Tah and Carr, 2000). According to Voordijk (2009, p. 713) the PM of construction projects covers many different scientific disciplines, such as “[...] *information technology (product modelling), operations research (simulation), institutional economics and law (contracting issues), accounting and finance (project costing and corporate finance), human resource management (labour and personnel issues), and strategy and organization (internationalization)*”. This makes the management of construction a multidisciplinary undertaking (Li and Love, 1998; Collier, 2006; Rooke, 2007; Voordijk, 2011).

In the previous sections of this chapter, a more general overview about the different philosophical orientations has been provided, where the focus was on exploring the two different (main) philosophical orientations, namely that of natural science and social science. Given that the nature of construction PM is characterised by its complexity (Winch, 1989; Baccarini, 1996; Harris, 1998; Winch, 2003; Raiden et al., 2004; Winch, 2006; Voordijk, 2009; Oyegoke, 2011) and its multidisciplinary structure (Li and Love, 1998; Collier, 2006; Rooke, 2007; Voordijk, 2011), this raises a dilemma in deriving an appropriate methodology for researchers in the field of construction PM (Harris 1998; Collier, 2006; Smyth and Morris, 2007), because construction can be classified as the intersection of natural and social science (Love et al., 2002b; Dainty, 2008; Voordijk, 2009). Hence, unlike other fields, which have already established practices for doing research, the discipline of construction creates, due to its “bi-methodological” character, a great platform to debate about the different

methodological orientations (Dainty, 2008). There is still no single methodology, but several different approaches to research (Rooke, 2007; Voordijk, 2009), which show that a variety of methodologies are applicable for different problems (Rooke, 2007). This methodological diversity creates difficulties for selecting an appropriate research strategy (Smyth and Morris, 2007; Dainty, 2008; Morris, 2010); and further it leads to the conclusion that research in construction PM is different to research from other disciplines (Seymour and Rooke, 1995; Raftery et al., 1997; Dainty, 2008). Hence it is worth getting a deeper understanding of different methodological perspectives about construction PM before deriving the research strategy.

Dainty (2008) did a literature survey to identify the most common research approaches in construction, it was concluded that in 1<sup>st</sup> place are quantitative methods, 2<sup>nd</sup> qualitative methods, 3<sup>rd</sup> mixed methods and 4<sup>th</sup> review (no empirical research methods). Two methodological paradigms are dominating the discipline of construction PM (Love et al., 2002b; Smyth and Morris, 2007; Dainty, 2008; Morris, 2010; Oyegoke, 2011; Shepherd and Atkinson, 2011), namely positivist and interpretivist (ibid.). Even though there is no uniform type of research, different problems are perceived from different perspectives resulting in the development of schemes and interpretations with emphasis on different aspects (Li and Love, 1998).

The disciplines of PM and construction management emerged from engineering and became separate over time (Collier, 2006; Morris, 2010; Shepherd and Atkinson, 2011). Collier (2006) found out that PM and construction management are classed as a sub discipline of civil engineering at some universities. This engineering background of PM also has an influence on its methodological orientations. Even if there is no agreed theory of PM (Shenhar and Dvir, 1996; Koskela and Howell, 2002a; Koskela and Howell, 2002b; Morris, 2010), the epistemology of the PMBoKs is clearly positivism (Cicmil et al., 2006; Smyth and Morris, 2007; Morris, 2010; Shepherd and Atkinson, 2011). Smyth and Morris (2007) argue that the PMBoK is positivist, because it pursues generalisations, which allow the setting up of rules and principles for managing the object.

Another reason for why the PMBoKs are positivist is delivered by Cicmil et al. (2006) who state that they deal with an external objective world and focus on value free facts. Therefore considering the engineering background of PM and the positivist character of the PMBoK might result in that objectivism might be the right ontological orientation (Smyth and Morris, 2007).

Further Wing et al. (1998) found out that research issues in construction PM are mostly practical problems. These problems need to be solved and result in hypothesis which should be generalised and be testable (Runeson, 1997; Harris, 1998; Wing et al., 1998). Hence, Harris (1998) called the interpretivist approach “naive”, because different individuals can observe the same phenomena and derive different conclusions. This subjectivity of the research findings has been further criticised by Runeson (1997). Therefore promoters of the positivist paradigm argue that positivist epistemological considerations are more appropriate for construction PM, because they explain causal relationships, are generally replicable and generate knowledge, which is generalizable (Runeson, 1997; Harris, 1998; Wing et al., 1998).

Even if the PMBoKs are characterised by their objectivist ontological character, projects “[...] *are complex social settings characterised by tensions between unpredictability, control and collaborative interaction among diverse participants*” (Cicmil et al., 2006, p. 676). Accepting that projects are socially constructed (Cicmil et al., 2006; Smyth and Morris, 2007; Morris, 2010), the result is that projects do follow a subjectivist reality (ibid.). Consequently, advocates of subjectivist ontological considerations argue that a positivist epistemology is simply unsuitable for an interpretivist project (Pender, 2001; Smyth and Morris, 2007; Morris, 2010). A project is a unique endeavour (Association for Project Management, 2006; Project Management Institute, 2008; DIN, 2009; BSi, 2010). Hence knowledge gained from previous projects does not generalise well for future and other projects (Winch, 1989; Pender, 2001), consequently the opportunities for gaining statistical information are limited (Pender, 2001). As a consequence the solutions for a construction problem are always multiple (Li and Love, 1998). Furthermore, the result of such a view, is

that the focus should be not on general, but rather on particular explanations (Seymour and Rooke, 1995; Cicmil et al., 2006; Smyth and Morris, 2007; Morris, 2010). Hence Seymour and Rooke (1995; 1998) and Seymour et al. (1997) argue that in construction PM research, the concern should not be to find a single truth and explain causal relationships, but rather to investigate and understand why things happen as they do.

In addition Seymour et al. (1997; 1998) and Morris (2010) argue that management is not operating in the world of natural sciences, but rather of social sciences, because the objects of study are people (Seymour et al., 1997; Seymour et al., 1998; Sense and Fernando, 2011). People attribute meaning to that which they do and to the presence of the researcher (Seymour et al., 1997; Seymour and Rooke, 1998) and make the whole research process not value free (Seymour et al., 1997; Seymour et al., 1998; Collier, 2006), which is in contrast to the viewpoint of the positivist researcher (Seymour et al., 1997).

The contrast between a subjective project and an objective PMBoK (Cicmil et al., 2006; Smyth and Morris, 2007; Morris, 2010; Shepherd and Atkinson, 2011) resulted also in that several researchers argued that PM research should mobilise both views (Raftery et al., 1997; Li and Love, 1998; Wing et al., 1998; Love et al., 2002b; Smyth and Morris, 2007; Lehmann, 2010; Dainty, 2008; Morris, 2010; Shepherd and Atkinson, 2011; Boyd and Bentley, 2012). Morris (2010) argues that PM can be classified as a kind of “socio-technic knowledge”, which provides a need for mixed research methods (ibid.). In addition Smyth and Morris (2007) and Oyegoke (2011) as well as Shepherd and Atkinson (2011) claim that the combination of the particular, which is explored through a qualitative methodology, with the general, which is explained with a quantitative methodology, will enable one to gain a complete understanding of the PM research phenomena, because “[...] *it comprises of a blend of methods that are different from each other, it allows testing, or understanding of the research proposition, [...] and to present multiple perspectives upon the phenomenon being studied*” (Oyegoke, 2011, p. 577). Further, Wing et al. (1998) and Love et al. (2002b) as well as Dainty (2008) suggest that a qualitative method could be used

at the initiation to conceptualise and identify the problem, and then a quantitative method can be used to generalise the findings. They argue further that such an approach would be a robust methodology to solve the problems which construction is facing (ibid.). Therefore advocates of mixed research methods in construction PM see the field of research too wide and diverse to allow the use of a mono method (Raftery et al., 1997).

However, there is no universal research methodology for research in construction PM, as there is also no unified theory of PM (Shenhar and Dvir, 1996; Koskela and Howell, 2002a; Koskela and Howell, 2002b; Morris, 2010). Projects are context-specific (Smyth and Morris, 2007). Each research itself is a project (Fellows and Liu, 2008) and each project is a unique endeavour (Association for Project Management, 2006; Project Management Institute, 2008; DIN, 2009; BSi, 2010). Therefore different research projects require different research methods (Rooke et al., 1997). As a result and in accordance with Runeson (1997) and Wing et al. (1998) as well as Love et al. (2002b), this research will show that the research methodologies for construction PM have to be developed individually and depend on the nature of the problem. Therefore the research strategy for the AgiLean PM framework, which is tailored for the objectives of this particular research, will be derived in the next section.

### **3.3 The research strategy of the AgiLean PM framework**

The aim of this research project is to develop a unifying strategic framework for managing construction projects, which is conceptualised as “AgiLean PM”. AgiLean PM will eliminate waste, will be able to react to change and focus on the whole project lifecycle. Such an approach is a way of dealing with complex construction projects in order to achieve maximum performance. AgiLean PM builds on the strengths and addresses the weaknesses of Lean and Agile through synthesising those. AgiLean PM is unifying, because it is novel and such an approach has been not developed so far. It is strategic, because the focus of the AgiLean PM framework is on the whole project lifecycle. AgiLean PM is a holistic framework for managing construction projects and for that reason it

harnesses existing PM tools. It is underpinned by universal PM approaches on the strategic level. AgiLean PM is a framework and not a model or theory, because a model is a “[...] *way of looking at reality, usually for the purpose of abstracting and simplifying it, to make it understandable in a particular context*” (Association for Project Management, 2006, p. 144). However, as mentioned already, AgiLean PM is unifying, because it is a novel way of approaching construction projects, which does not exist yet. The mentioned “particular context” in the previous definition, which is in the context of this research the AgiLean PM framework needs to be established before models can be derived to explain issues. Hence, the AgiLean PM framework can have several models to explain issues within the framework, but cannot be a model by itself. Theory is minted with the characteristics shown in Figure 3-2 (see p. - 84 -). As mentioned previously the aim of this research is not to develop methodologies and methods, but rather to develop concepts and principles of AgiLean PM. This makes it not a complete theory, but a framework upon which the theory is based. A framework is a “*supporting or underlying structure*” (Oxford Dictionary Thesaurus, 2001, p. 505). Hence a framework provides base and support as an underlying structure (Sevilla et al., 1992). In this case the AgiLean PM framework is the foundation of the AgiLean PM theory, which is illustrated in Figure 3-5.

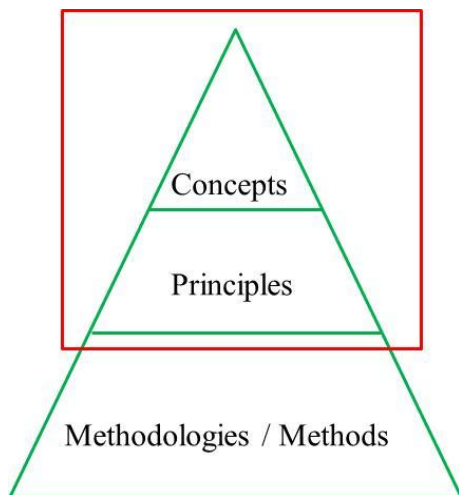


Figure 3-5 AgiLean PM framework (based on Koskela (1996))

Figure 3-5 shows that the aim of this research is to develop concepts and principles (the AgiLean PM framework), which will lead in future to the development of AgiLean PM methods, and complete the theory of AgiLean PM.

AgiLean PM will consist on the one hand on the elimination of waste through aiming for perfection in the internal processes, and on the other through being flexible and reacting to the change in the project circumstances. Several research studies (Latham, 1994; Ballard, 1994; Egan, 1998; Koskela, 2000; Ballard and Howell, 2003a; Ballard, 2000b; Wolstenholme, 2009) have tried to revolutionise the construction industry thus: “[...] *envisage alternatives; know of the talk that goes on about “stabilizing relationships”, “defragmenting” the industry, the need for attitudes to change and “get the culture right”, but for the present they have to work out ways of living with it*” (Seymour and Rooke, 1995, p. 519). The AgiLean PM framework wants to create a way of dealing with the complex construction projects through adapting itself into the environment rather than changing it.

As underpinning objective of this research, the suitability of Agile manufacturing and Agile IT needs to be assessed. However, both management paradigms are completely different from each other, even though they have the same nomenclature. Hence the research seeks to identify in the first instance on which of these two paradigms to focus. This identification has been facilitated through reviewing the literature, with the conclusion that Agile IT is more appropriate for the aim of this research. Therefore the research project explores the potential of Agile IT rather than Agile manufacturing.

To be able to develop the AgiLean PM framework the salient concepts of PM, Lean and Agile IT have to be understood. Furthermore the strengths and weaknesses have to be identified. This has been facilitated through reviewing the literature. In addition, the review of the literature ensured the awareness of existing publications within the field of research (Bryman, 2012). This will also help in identifying and analysing the theoretical contribution to knowledge (Saunders et al., 2009).

To gain a complete understanding about the different management paradigms, the perceptions amongst industry practitioners needs to be explored. This will create a link between theory and practice and will enable us to understand why things happen as they do (Fellows and Liu, 2008). To achieve this, semi structured interviews will be utilised, i.e. a qualitative data collection technique. The interviews will be undertaken with practitioners in the field of PM, Lean and Agile. The interviews will provide deep insights into these different management disciplines and support the exploration and understanding of certain aspects.

However, considering that the PM discipline has evolved out of the ghetto of engineering (Shepherd and Atkinson, 2011), and noticing that especially positivist advocates see the interpretivist methods “[...] *as unreliable, impressionistic, and not objective*” (Denzin and Lincoln, 2005, p. 26), leads to the conclusion that a solid basis of primary data should be used for the development of the AgiLean PM framework. This will test its universality, transferability and will increase the acceptance of the framework. Hence the data gained from the semi-structured interviews needs to be reinforced and may require partly generalisations, so that a solid basis of primary data for the discussion can be created. This will be facilitated through conducting a quantitative questionnaire. The questions will be formulated out of the findings from the interviews. The content of the questionnaire will be the major assumptions made, which will be used to develop the AgiLean PM framework. To warrant the practicality of the assumptions made, the questionnaire will be sent to the parties involved in construction. This is important, because “*a lot of the research issues in construction management are practical problems which involve the generalization of experience and formulation of hypothesis that can generate empirically testable implications*” (Wing et al. 1998).

Therefore, this research will use a sequential exploratory approach (Creswell, 2009), which involves a first stage of qualitative data collection and analysis, followed by a quantitative data collection and analysis, which builds on the findings and results of the qualitative stage (ibid.). Using such a strategy for undertaking research in PM has been proposed by Raftery et al. (1997), Wing et

al. (1998), Creswell (2009) and Easterby-Smith et al. (2012). This research approach can be illustrated with the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Creswell, J. W. (2009). *Research design- qualitative, quantitative, and mixed methods approaches*, p. 209. California: Sage Publications.

Figure 3-6 sequential exploratory strategy (Creswell, 2009, p. 209)

Using mixed methods seem to be the most appropriate research strategy, because research in PM should focus on the particular and the general (Morris, 2010; Shepherd and Atkinson, 2011). Even if the PMBoKs are criticised for having a positivist epistemology for a subjectivist project (Cicmil et al., 2006; Smyth and Morris, 2007; Morris, 2010; Shepherd and Atkinson, 2011), the author of this thesis argues that this partly reflects the truth. The PMBoKs are providing a collection of universally applicable concepts, principles and methods for all types of projects. The degree between general and particular is perfectly balanced, so that one can for instance use the PMBoKs differently for one's own circumstances. Therefore it is argued that the PMBoKs are at the break-even point between the specific and general. This issue is illustrated in Figure 3-7.

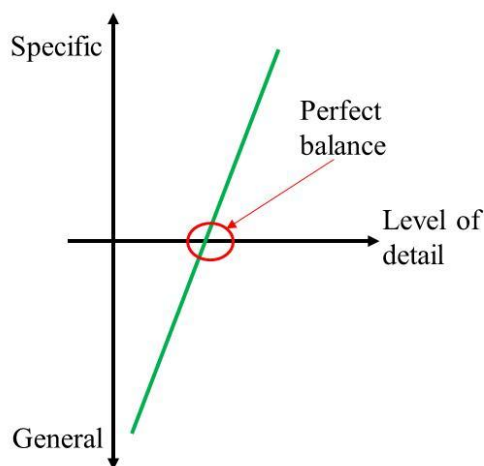
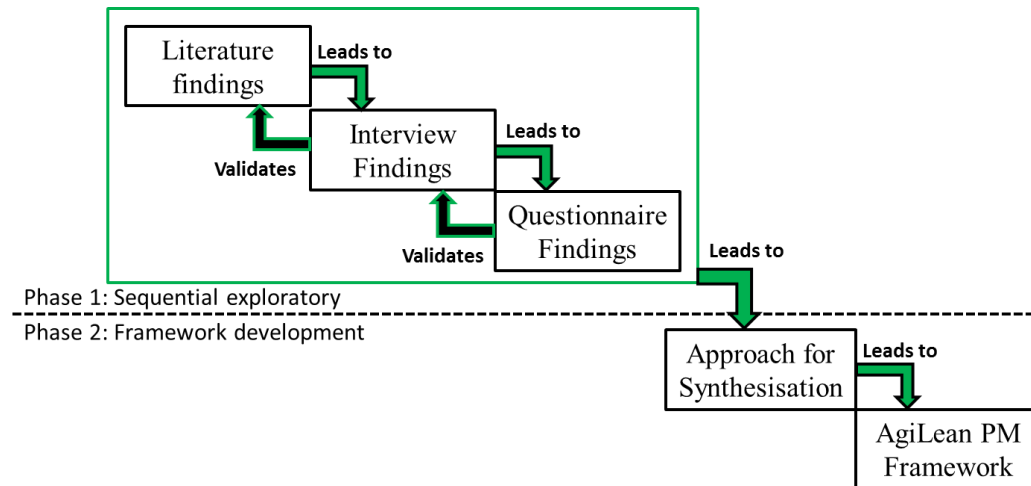


Figure 3-7 break-even point between specific and general

The AgiLean PM framework aims to reach the same balance between the specific and general, as shown in Figure 3-7. This will be done through levelling the right amount of detail. Another reason why mixed methods seem more appropriate for the purposes of this research can be reflected with the achievements of Womack et al. (1990), through publishing the book “*The machine that changed world*”, and by Womack and Jones (2003), through publishing “*Lean thinking*”. Both publications have been facilitated under the roof of the MIT and are related to one big research project. The former describes a positivist study with statistical data; the latter explores the reasons for the dramatic success. Both works have the same amount of value and are perfectly suited to describe the issue completely. Another perspective can be derived from considering the developments of the PMBoKs. Morris (2010) and Shepherd and Atkinson (2011) found out that the PMBoKs have been evolved through making experience accepted (generalizable) knowledge. Hence even if the epistemology of the PMBoKs is positivism, the developments can be related to the interplay of subjectivist and objectivist ontological orientations.

As a result, the sequential exploratory mixed method is the most suitable research strategy for developing the AgiLean PM framework, because it wants to explore the different management methods (PM, Lean and Agile), but it wants also to expand the qualitative findings, through a quantitative questionnaire. In addition, the argument that the findings are based on the views and perceptions of individuals can be counteracted (Wing et al., 1998).

The literature review shows already that PM, Lean and Agile are completely different in their nature and have been developed to deal with different problems. Hence, in the second phase of this research, an appropriate way of merging these paradigms needs to be derived. PM, Lean and Agile will be synthesised and the AgiLean PM framework will be developed through interpreting and discussing the collected qualitative and quantitative data in the second phase, too. An overview about the different research stages is provided in Figure 3-8.



**Figure 3-8 validation loops**

Figure 3-8 illustrates that with the use of a sequential exploratory method, the collected qualitative data will be validated through conducting the quantitative survey (Raftery et al., 1997; Wing et al., 1998; Creswell, 2009; Easterby-Smith et al., 2012). Hence the framework is validated, because the framework is based on the data collected, and the collected data is validated through adopting the sequential exploratory strategy (Creswell, 2009). So, the data is true, which leads to the conclusion that the framework will be true, too.

Therefore is this study inductive, as the framework will be an outcome of the research (Remeny et al. 1998; Bryman and Bell, 2007; Fellows and Liu, 2008; Creswell, 2009; Saunders et al. 2009; Gill and Johnson, 2010; Bryman, 2012). Within Phase one higher weight is given to the qualitative data, because the quantitative is used to validate and expand the qualitative findings. In the second phase the framework will be developed. Therefore this research project uses overall a mixed method approach, which consists of a sequential exploratory (higher weight on qualitative) method. As a result this research prefers a subjectivist ontological orientation and also interpretivist epistemological considerations, because the research project assumes that reality is something which is constructed by its social environment.

# 4 Research method

The previous chapter has ended with the definition of the research strategy for the Agile PM framework. This chapter will report the used techniques to collect the data. First the method used for the collected qualitative data will be explained. Then, the way how the quantitative data has been collected will be reflected.

## 4.1 Semi-structured-interviews

Saunders et al. (2009, p. 318) define an interview as “[...] *a purposeful discussion between two or more people*. Three different types of interviews can be distinguished, which are structured-, semi-structured- and unstructured-interviews (Naoum, 2007; Bryman and Bell, 2007; Saunders et al., 2009; Oyegoke, 2011; Bryman, 2012; Easterby-Smith et al., 2012). According to Naoum (2007) the structure of the interview is defined through the type, the wording and the sequencing of the questions.

The structured interview uses for all interviewees the same sequence and exactly the same wording of the questions (Naoum, 2007; Saunders et al., 2009; Oyegoke, 2011; Bryman, 2012). The questions are usually closed-ended (pre-coded), where the interviewee can select from a range of predefined specific answers (Bryman, 2012). The aim of this method is to create reliable answers through identical keywords (ibid.) and through quantifiable data (Saunders et al., 2009). Hence, structured interviews are classed within the methodology of quantitative methods (Saunders, et al., 2009; Bryman, 2012).

In contrast the unstructured interview uses no predefined questions and no detailed interview guideline (schedule where the questions have been sequenced), which results in that the interviewee is guiding this interview and not the interviewer (Naoum, 2007; Bryman and Bell, 2007; Saunders et al., 2009; Oyegoke, 2011; Bryman, 2012). It is informal (Naoum, 2007; Bryman, 2012) and has the characteristic of a conversation (Bryman and Bell, 2007; Bryman, 2012). The unstructured interview will get always, from interview to interview, a

different phrasing and sequencing of the questions (ibid.) and consequently also different outcomes (Naoum, 2007; Bryman and Bell, 2007; Saunders et al., 2009; Oyegoke, 2011; Bryman, 2012). The aim is to explore in depth the area of research interest (Saunders et al., 2009). Therefore the unstructured interviews are categorised within the qualitative methods (Saunders et al., 2009; Bryman, 2012).

This research project preferred to use semi-structured interviews, which are another type of qualitative interviews (ibid.). Semi structured interviews are more formal than the unstructured interviews, but are also less structured than the structured interviews. The interviewer works here with a guideline where the questions have been predefined and phrased (Naoum, 2007; Saunders et al., 2009; Oyegoke, 2011), but the questions are more general in their nature; the sequence of the questions can vary and new questions might evolve during the interview (Bryman, 2012). The aim of semi-structured interviews is to explore specific issues within the research project (Naoum, 2012).

In general, this research wants to benefit from the flexible nature of qualitative interviews (Bryman and Bell, 2007; Naoum, 2007; Saunders et al., 2009; Oyegoke, 2011; Bryman, 2012), because the interest is in gaining insights into how practitioners from the industry view and perform PM, Lean and Agile. The research had begun the investigation with a fairly clear focus on issues, rather than a very general view on a topic. According to Bryman (2012) research projects with such a characteristic tend to use semi-structured interviews, because more specific issues can be addressed. Furthermore, the chaotic orientation of unstructured interviews might be not seem an appropriate method to convince very well organised project managers and other experts from the industry. Therefore it has been decided to benefit from this “structured flexibility” of the semi structured interviews. This method is the most suitable for this research, because: it helped understanding why things happen as they do in practice, the researcher also received after each interview feedback about his research, the interviews led to new areas which have been previously not considered, and it gave the ability to collect a rich set of data.

Furthermore, when using semi structured interviews, the researcher has more control about who is taking part (Bryman, 2012), which results in quality assurance. A personal benefit gained from the one-to-one basis characteristic of the interviews, was that the researcher made also highly interesting contacts within the industry.

However, the method for gathering and analysing the interviews has several components. Creswell (2009, p. 183) thinks of this “[...] *like peeling back the layers of an onion* [...]”, where one creates a condensed meaning out of the large amount of qualitative data. The following sections will go through each performed single step.

#### **4.1.1 Sample and profile of interviewees**

One of the biggest advantages of semi structured interviews is that the researcher can decide who should be involved in this research project and who should not (Bryman, 2012). However, before having thoughts about who should participate, it is important to determine the number of interviews, which should be conducted. Considering that qualitative semi-structured interviews are not able to make statistical generalisations (Denzin and Lincoln, 2005; Bryman and Bell, 2007; Saunders et al., 2009; Bryman, 2012), the result is that it is difficult to find a small representative number of cases, which could be added to a whole sample in order to reflect a population. Nonetheless, Warren (2002) suggests that the minimum number of interviews shall be between 20 and 30, if the research wants to get published. This number has been also confirmed by Bryman (2012). Hence 22 interviews have been conducted with PM practitioners [PMPs], Agile practitioners [APs] and Lean Practitioners [LPs]. Another reason why it has been decided to be in the range of 20 to 30 interviews is, because the data gives insights into the different management methods from different perspectives and world views, but it is also at the same time not so large that it limits undertaking a deep and detailed interview analysis (ibid.).

The profile of the interviewees can be seen in the following tables.

**Table 4-1 profile PMP interviewees**

<b>Name</b>	<b>Organisation</b>	<b>Position</b>	<b>Background</b>	<b>Experience</b>	<b>Interview date</b>
PMP1	Construction PM	CEO	Civil Engineer	20 years	20.07.2011
PMP2	Construction PM	Founder and general agent	Civil Engineer and Professor	40 years	20.07.2011
PMP3	Construction PM	Authorized Representative	Project Management	12 years	21.07.2011
PMP4	Management Consultancy	Project Manager	Architect, Project Management, MBA	12 years	22.07.2011
PMP5	Construction PM	CEO	Civil Engineer	32 years	26.07.2011
PMP6	Design and Consulting	CEO	MEP Engineer	35 years	27.07.2011
PMP7	Construction PM	Director	Architect, Project Manager	15 years	28.07.2011
PMP8	None Profit Institution	Project Manager	Building Surveying	20 years	06.08.2012
PMP9	Construction Consultancy	Project Manager	Construction PM	17 years	14.08.2012
Key: CEO = Chief Executive Officer, MBA = Master of Business Administration, MEP = Mechanical Electrical and Plumbing, PM = Project Management, PMP = Project Management Practitioner					

Table 4-1 shows that a wide range of people from different hierarchical positions, different organisations, and different backgrounds have been interviewed. This ensures getting a broad and deep picture of the issue from different perspectives. The interviews with PMP8 and PMP9 have been conducted in the UK. The remaining interviews have been conducted in Germany.

The following table shows the profile of the LPs.

**Table 4-2 profile LP interviewees**

Name	Organisation	Position	Background	Experience	Interview date
LP1	Construction Consultancy	CEO	Psychologist	35 years	24.05.2011
LP2	Consultancy	Lean Project Delivery Manager	Architect	30 years	27.05.2011
LP3	Consultancy	Director	Production Technique	7 years	27.05.2011
LP4	Consultancy	Director	Civil Engineer	15 years	30.05.2011
LP5	Consultancy	Project Manager	Mechanical Engineer	10 years	27.07.2011
LP6	Social housing	Director	Quantity Surveyor	30 years	10.05.2012
LP7	Construction Consultancy	Founder and Consultant	Manufacturing Engineering	22 years	22.06.2012
Key: CEO = Chief Executive Officer, LP = Lean Practitioner					

Table 4-2 shows that most of the interviewed LPs are employed by a company, which is providing consultancy services. The interviews with LP6 and LP7 have been conducted in the UK. The remaining interviews have been in Germany.

The following table shows the profile of the APs.

**Table 4-3 profile AP interviewees**

Name	Organisation	Position	Background	Experience	Interview date
AP1	Consultancy	Founder and CEO	Economic Computer Engineer, Project Manager	23 years	23.05.2011
AP2	Consultancy	Founder and CEO	Economic Computer Engineer, Project Manager	16 years	25.05.2011
AP3	IT PM	Founder and CEO	IT-Technology, Sociology	19 years	30.05.2011
AP4	IT Consultancy	Project Manager	Politics, geography and IT (Doctor degree)	21 years	22.07.2011
AP5	Academic Institution	Senior Research Fellow	Information Systems Engineer	10 years (+ 4 years academia)	20.06.2012
AP6	IT PM	Project Manager	Business and finance	15 years	22.06.2012
Key: AP = Agile Practitioner, CEO = Chief Executive Officer, IT = Information Technology					

Table 4-3 shows that most of the interviewed APs are hired by organisations, which are acting in IT. The background of AP5 is also IT, but this interviewee started research on the application of Agile concepts to construction and started an academic career. AP5 and AP6 have been conducted in the UK. The remaining interviewees have been in Germany.

The semi structured interviews will identify the strengths and weaknesses of Agile, PM and Lean. Further the conducted interviews have the aim to give insights and increase the understanding of these different management methods. To warrant high quality research findings the persons who were interviewed and their organisations have to be highly experienced experts in those fields. Hence, an issue which should not be underestimated is to find the right people in the industry and convince them to participate into this research. The people interviewed are highly demanded consultants. Arranging interviews with these people was very difficult, because they could, instead of being interviewed, be earning money for their organisations. However, 16 out of the 22 interviews have been conducted in Germany. The researcher decided to undertake the interviews in Germany because existing contacts in Germany agreed to take part in this study. Those people interviewed proposed the researcher to other participants so that a “snowball effect” could be created and the interviews could be done in a quite fast time framework. The AgiLean PM framework shall be universal and not related to any particular country. Considering that the interviews have been undertaken in Germany might result in the argument that this framework is based largely on data from Germany, hence it is made for Germany and it is not universal.

However, the AgiLean PM framework consists only in concepts and principles yet. Therefore the analysis performed had to be on a more abstract and general level. Consequently, the assumption can be made that the concepts and principles of PM, Lean and Agile are universal and not related to any country, i.e. Lean in Germany is similar to Lean in the UK etc. To provide the required evidence for this underlying assumption, the researcher decided to also conduct interviews in the UK. Conducting the 6 out of 22 interviews in the UK took much longer than

all the other interviews in Germany. However, the researcher also managed to get well experienced practitioners from the industry interviewed.

#### 4.1.2 Preparation

Like any other project, or in that case method, a key success factor is always good work preparation. Saunders et al. (2009, p. 328) describe this importance with the “5Ps”, which means “[...] *prior planning prevents poor performance*”. A person who undertakes research needs to gain an appropriate level of knowledge about the subject before approaching the data collection (ibid.). Hence, given that this study wants to develop a framework for managing construction projects, which aims to combine PM, Lean and Agile, the result is that knowledge about these different management paradigms has to be gained first. This has been achieved through reviewing the literature. The reviewed literature has then been used to derive the interview questions, which is a common way to do this (Bryman, 2012). Three different types of interview schedules have been prepared, one for each group of practitioners. There have been questions which have been similar for each group of participants, but there were also questions which were different and just prepared for the PMPs, APs or LPs. An overview about the typology of questions is provided in Table 4-4.

Table 4-4 interview question typology

Interviewee	Question typology			
	Construction	PM	Agile	Lean
PMPs	X	X	X	X
APs	X		X	
LPs	X			X

Considering that qualitative research produces findings which are not quantifiable, this results in exploratory data being gathered mostly through open-ended questions (Naoum, 2007). The reason for this is that the research has no clear hypothesis to use pre-coded questions (ibid.). The researcher started the interview with asking each interviewee an open introducing question about their personal

background and about some overview of their organisation. This question provided on the one hand profile data about the interviewee, but on the other hand it “broke the ice” between the interviewer and the interviewee. This is according to Saunders et al. (2009) and Bryman (2012) very important, because the better the relationship between these two parties, the better will be the research outcomes for the interviewer, as the interviewee might be more open in giving insights. Other reasons, why interviewees might not want to share information, can be related to the uncertainty about how the data, provided by the interviewees, will be treated afterwards (Saunders et al., 2009). Here, a prepared consent form and participant information sheet helped to melt the remaining ice so that the researcher did not face any difficulties in obtaining the required information.

Next more specific questions have been asked, but in a way that they are still open ended. This is because new avenues of research are then not closed off (Bryman, 2012). Further, this ensured that the mode of research was compatible with a qualitative methodology and its ontological as well as epistemological orientations. The researcher followed here a top-down approach, i.e. from abstract to detail. A detailed overview about the questions which have been asked during the interviews can be found in Appendix 1.

The PMP interviews were divided into eight and the APs as well as LPs interviews were divided into 6 parts. First the personal background was identified. Then, questions about the construction industry were asked.

For the case of the PMPs, the researcher asked first general questions about the characteristics of the construction industry, then about the challenges of managing construction projects. Finally the researcher explored their perspectives and perceptions in comparison to other industries with the particular focus on manufacturing (production) and IT. The APs who were professionals from the IT industry faced questions where they had to compare their industry with the construction industry. Of course, the APs have limited insights about construction, but the researcher wanted to explore their current perspective about the construction sector. The LPs were asked questions about construction, and then

they were prompted to compare it with production, as they are all familiar with the manufacturing industry, because of the origins of Lean.

Hence the overall aim of these questions was to gain insights into how different practitioners view the construction industry, through looking on it independently and in comparison with IT or production.

The third domain of questions focused on exploring the different definitions of PM, Lean and Agile. The interviewee had to provide their own definition first. Then this definition has been used as a basis to ask follow-up and interpreting questions to identify the conceptual strengths and weaknesses of the respective management paradigms.

The next pool of questions looked on getting a theoretical understanding. To facilitate this, direct questions such as “Why implement Agile?” were asked. The different management methods were further explored through asking questions about the personal experience made by the interviewees. During this part a lot of new questions evolved and several probing questions were asked, too. Those were not in the interview schedule, but this is the advantage of semi-structured interviewing (Bryman and Bell, 2007; Naoum, 2007; Saunders et al., 2009; Oyegoke, 2011; Bryman, 2012).

After this, the APs, LPs and PMPs were asked specific questions about tools and methods which they are using or which are available in their organisations. Questions about implementing those tools and methods were asked, too. These questions were again a combination of open-ended and follow-up questions. The aim of these questions is also to get practical insights, about how professionals are implementing the concepts and principles through tangible tools and methods into practice.

At the end the PMPs also faced general questions about Lean and Agile. Two presentations (one for Lean and one for Agile) have been prepared. This warranted that all the interviewed PMPs had at least the same minimum knowledge about those paradigms. The aim is here to get the perceptions about

Lean and Agile and to see if the PMPs can identify any potential fields of applying Lean and Agile in PM, which would result in additional benefit.

Finally, a last open ended question was asked to all interviewees. This was about any other feedback or any other comments. This last question gave the interviewee the opportunity to leave the semi-structured interview and to talk about their (own) thoughts in an unstructured way. In the framework of this last question, conclusions have been drawn and areas for further research have been identified together.

In general, a combination of open-ended and follow-up questions was utilised. The probing questions have been recorded and can be found in the interview transcripts.

After the development of the interview questions, next was to prepare standardised interview schedules for the different interviewee groups. Three different types of interview schedules have been developed. Those have been shown to the members of the supervisory team. This is according to Remeny et al. (1998) a powerful way to check if the questions addressed in the interview schedule are in line with the objectives of this research. Microsoft Power Point has been used to create the interview schedules. Those Power Point presentations have been sent in advance to the interviewees, so that they had enough time to prepare themselves. In addition, a conference paper has been sent in advance to the interviewees (the first listed publication in Appendix 5). This gave an overview about this research project. Initial contact with each prospective interviewee was made through email and/or phone. Before starting the interview, a ten minutes presentation about the research project was hold. In the framework of this presentation first interactions took place and the interviewee got a richer picture about this research.

#### **4.1.3 Recording and transcribing**

A voice recorder was used. The benefit of using a voice recorder is that the researcher is able to concentrate on questioning and listening during the interview.

Further, once the interview is completed, one is able to re-listen to the interview. When writing down the interview findings direct quotes can be used, too.

However, once a background about the research project had been provided, the researcher read together with the interviewee through the participant information sheet. After this, the interviewee got enough time to read and fill the consent form, where the person interviewed also had the opportunity to decide if the interview should be voice recorded or not.

All of the interviewees agreed to be voice recorded. To talk through the presentation about the research project, the participant information sheet and consent form took about 15 minutes, where the researcher was able to build up a closer relationship and to increase the confidence. Then an easy open ended question has been asked, where the interviewee gets the opportunity to talk about his/her personal background so that he/she became more confident with the voice recorder. This helped in overcoming Bryman's (2012, p. 483) detected threat, where he argues that even if voice recording brings a lot of advantages, "[...] *there will be some who will not get over their alarm at being confronted with a microphone*", which might result in that the interview might not fulfil the expectations of the researcher.

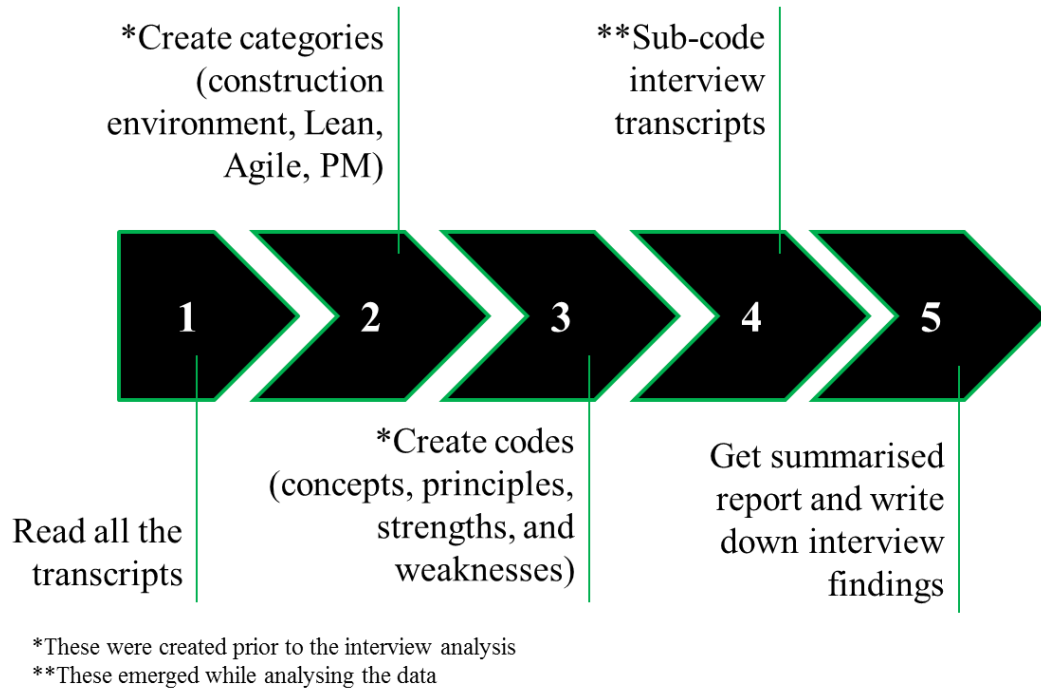
The voice recording did not mean for the researcher that there was no need any more for being alert during the interview, because during the interview it is important to be a good listener, i.e. to be concentrated, focused, active and alert (Saunders et al., 2009; Bryman, 2012). This also helped in increasing the motivation of the interview participants to share information.

After the interview had been audio recorded, subsequently the interview was transcribed. The finalised transcripts were sent to the interviewees, so that they had the opportunity to check through their transcripts and make required modifications. Two interviewees (LP7 and AP5) wanted to have minor changes in their transcripts (spelling, grammar, and technical terms). The changes had no impact on the analysis. All other interviewees did not complain about the transcript and did not want to have any modifications.

The interviews which have been conducted in Germany, have been also done in the German language. However, the data analysis needs to be done in English language, because direct quotes will be used for reporting the interview findings. Therefore the German interview transcripts have been translated to English language by the researcher. The translated interviews have been sent to a proof reader so that spelling and punctuation faults could be mitigated. The final translated transcripts have been sent again to the interview participants, so that they had again the opportunity to check through their transcriptions.

#### **4.1.4 Analysis**

Even if the transcription process has the advantage of documenting what has been said to the researcher by the interviewee, the transcripts highlight also a main disadvantage of interpretivist research. Namely that the researcher is flooded with rich, large, complex and context bound data (Bryman and Bell, 2007; Naoum, 2007; Creswell, 2009; Saunders et al., 2009; Bryman, 2012; Easterby-Smith et al., 2012). Hence the challenge was to bring the interview transcripts into a more transparent format, which would allow the analysis of the findings appropriately. *“Data analysis involves collecting open ended data, based on asking general questions and developing an analysis from the information supplied by the participants”* (Creswell, 2009, p. 183). Naoum (2007) argues that the best way for analysing interview data is to code the information, because coding reduces the large amount of individual data down to a few more general categories. The following steps have been undertaken when analysing the interviews:



**Figure 4-1 interview method**

Figure 4-1 shows that the first step was to read through all the transcripts. This gave the researcher a general sense of the data. Then the data has been categorised into “construction environment”, “PM”, “Lean” and “Agile”. The structure for categorising the data has been defined prior to the data analysis. Within this step, all statements, which were related to these categories have been put together. After categorising the data, the next step was to code it. In the context of this research, coding means: “*the process of organizing the material into chunks or segments of text before bringing meaning to information*” (Creswell, 2009, p. 185). The codes for the category “construction environment” have evolved while analysing the data. The codes for the categories “PM”, “Lean” and “Agile” have been defined prior to the data analysis, as “concepts”, “principles”, “strengths”, and “weaknesses”. These were established to put the data into broader segments. The aforementioned coding structure has been chosen, because it is in line with the research objectives. The Sub-codes evolved while analysing the transcripts and are presented in section 5.1.

The interview analysis has been facilitated through using Computer Assisted Qualitative Data Analysis Software [CAQDAS]. The use of CAQDAS takes over

physical task of making codes, copying those and pasting small pieces of paper together (Remeny et al., 1998; Creswell, 2009; Bryman, 2012). A CAQDAS program called “NVIVO” has been used. NVIVO enabled the researcher to review the data in an objective rather than subjective way.

#### **4.1.5 Validity**

Validity does not mean the same in an interpretivist study as it does in a positivist study (Remeny et al., 1998; Bryman and Bell, 2007; Creswell, 2009; Bryman, 2012). The concepts of internal validity, external validity reliability and objectivity (Bryman and Bell, 2007; Bryman, 2012) originated in positivism and therefore in a completely different perspective on research. Hence most of the validation concepts which are appropriate in positivism are not directly transferable to a subjectivist study (Remeny et al., 1998; Bryman and Bell, 2007; Creswell, 2009; Saunders et al., 2009; Bryman, 2012). However, Bryman (2012) argues that the new evolved concepts of validation for qualitative research studies are different in their nature, but are comparable with quantitative ideas. The concept of validity is related to the trustworthiness in a qualitative research project (ibid.). The concept of trustworthiness consists of four criteria, which are as follows (Bryman, 2012, p. 390):

- *Credibility, which parallels internal validity;*
- *Transferability, which parallels external validity;*
- *Dependability, which parallels reliability;*
- *Confirmability, which parallels objectivity.*

Credibility is related to the question of how believable is the interview data (Bryman, 2012). Remeny et al. (1998), Creswell (2009) and Bryman (2012) propose that the credibility of a qualitative research can be facilitated through sending the transcripts back to the interviewed persons, so that they can check if all has been typewritten adequately. The researcher followed this recommendation, to warrant the credibility of the study. The transcripts have been sent via email to the interview participants. For the case of the interviews

conducted in Germany, this has been done before and after translation. The interviewees have been prompted to notify the researcher if they want to have anything modified within their transcripts.

Transferability deals with issues about the applicability of the findings to other contexts (Remeny et al., 1998; Bryman, 2012). Given that qualitative research deals with focusing on the particular rather than the general (Morris, 2010), this means that the concept of transferability has limited application in a subjectivist study. However, Creswell (2009) and Bryman (2012) suggest here that if a research seeks to claim transferability, it might take advantage of a sequential exploratory research method, as it is applied in this research. Hence through conducting a questionnaire survey (see section 4.2), which will be based on the interview findings, this research claims also transferability.

Reliability is concerned with issues whether a quantitative research study is repeatable (Remeny et al., 1998; Bryman and Bell, 2007; Creswell, 2009; Saunders et al., 2009; Bryman, 2012). The parallel criterion for a qualitative research is its dependability (Bryman, 2012). However, considering that the concept of reliability is not in line with a subjectivist study, as the aim is to focus on particular cases rather than general, this means that the traditional positivist concepts are not practicable for an interpretivist study. Hence, the concept of dependability is related to the trustworthiness of the study. The idea behind this is that one cannot repeat an interpretivist study, but what one can do is to provide high transparency about the research approach and to allow auditing by external people (Creswell, 2009; Saunders et al., 2009; Bryman, 2012). This research followed the “Code of practice for research”, which is provided by the research institution of the researcher. Within this code, it is stipulated that all documents (emails, protocols, consent forms, etc.) and all interview transcripts have to be kept for a period of three years after the research project has closed (Spiers and Young, 2012). During this time, the data will be accessible for any third party, who wishes to do so, through contacting the author of this thesis or his supervisory team.

The last criterion of validating the qualitative findings is done through the concept of confirmability, “[...] *that is, has the investigator allowed his or her values to intrude to a high degree*” (Bryman, 2012, p. 49)? Even if the work has been criticised or the same viewpoints have been not shared during the interview, the researcher tried to not start a discussion. The aim was to focus on the perception and perspective of the interviewee. However, some debates between the interviewer and the interviewee could not be avoided during the interview. Those debates have been kept to the end, so that the questions, which had been scheduled, could be answered and an influence on the views of the interviewees could be avoided.

General objectivity cannot be reached in a qualitative methodology (Remeny et al., 1998; Creswell, 2009; Saunders et al., 2009; Bryman, 2012), but what the researcher can try is to not influence the interviewees when talking to them and try to get their perceptions and perspectives. Hence the variety of different attitudes and interpretations shows that the researcher had no or low influence on the interview participants.

## 4.2 Self-administered questionnaire

The benefits of combining the qualitative interview findings with the quantitative questionnaire findings have been discussed in section 3.2.3, but are summarised below. Hence the questionnaire will:

- allow a complete understanding of the phenomena in a PM context
- support the interpretation of the qualitative data
- reinforce or even partly generalize the qualitative findings
- cause transferability of the qualitative findings and increase the validity

This research has used the suggested approach of Wing et al. (1998), Love et al. (2002b) and Dainty (2008) as well as Creswell (2009), where they have argued that a questionnaire could be used after the qualitative findings to achieve the above mentioned. The questionnaire type depends on the way it is administered.

Saunders et al. (2009, p. 363) have detailed different types of questionnaires, which are shown in the following figure.

The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5th ed.), p.363. Essex: Pearson Education.

Figure 4-2 types of questionnaires (Saunders et al., 2009, p. 363)

Figure 4-2 shows that in general questionnaires can be distinguished on the highest level into two types, namely self-administered and interview administered questionnaires. Self-administered questionnaires are directly filled from the respondent. Whereas interview administered questionnaires are recorded by the interviewer. Interview administered questionnaires are facilitated through a phone or a face to face communication between researcher and respondent. There is no direct contact when utilising a self-administered questionnaire.

Even if the interview administered questionnaires provide higher response rates and more detailed answers, those types of questionnaires are not suitable for the purposes of this research. One reason for this is that, interview administered questionnaires depend also on availability of interviewees and field workers to assist. The researcher wants to collect as much questionnaire data as possible to create transferability and increase the validity of the qualitative findings. This might be not feasible with interview administered questionnaires, because of the limited time framework and limited (mainly monetary) resources of this research. In addition, the interview validation criterion of confirmability (see section 4.1.5) should not be neglected, as there will be always an (small) influence on the respondents, when asking for their answers.

To counteract these arguments, an internet mediated questionnaire, which is a subgroup of self-administered questionnaires (see Figure 4-2, p. - 125 -), has been used. This is the most suitable type of questionnaire for the purposes of this

research, because it is possible to invite respondents from all around the world, for low costs, in a limited time framework to participate in this research, collect their answers and enter them with low effort into the software program which will be used for data analysis. Internet mediated questionnaires, are the only type of questionnaires, which have all these characteristics (Saunders et al., 2009).

#### 4.2.1 Sampling

Before determining the appropriate sampling strategy and sampling size it is worth getting an understanding about the terms “population” and “sample”. Easterby-Smith et al. (2012, p. 222) define population as “[...] *the whole set of entities that decisions relate to [...]*”. They describe further that “[...] *the term sample refers to a subset of those entities from which evidence is gathered*” (Easterby-Smith et al., 2012, p. 222). This can be illustrated with the following (own) figure:

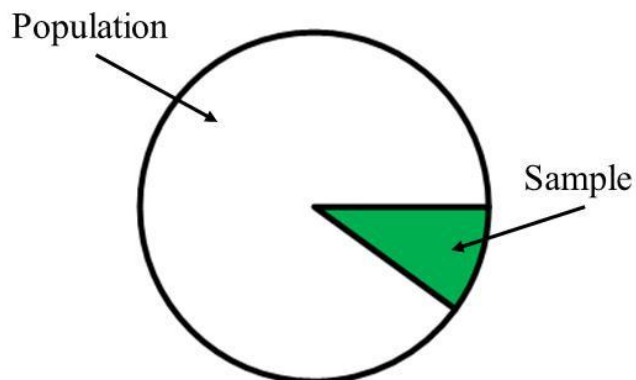


Figure 4-3 difference population and sample

Therefore population describes “*basically, the universe of units from which the sample is to be selected*” (Bryman, 2012, p. 187), and sample explains the segment, which has been selected for investigation (Creswell, 2009; Saunders et al., 2009; Bryman, 2012; Easterby-Smith et al., 2012).

First the whole population needs to be identified, i.e. the whole number of potential respondents, which would need to be considered in the framework of this research. In some cases, it might be possible to collect data from each single

respondent, but more often this is not the case (Easterby-Smith et al., 2012), because populations tend to be too large to be covered in one research project (Fellows and Liu, 2008). Therefore researchers need to think about an appropriate sampling strategy (Saunders et al., 2009; Bryman, 2012; Easterby-Smith et al., 2012), where “[...] *the size and structure of the sample is sufficient to yield enough reliable data for inferences to be drawn about the population at a required and specified level of confidence*” (Fellows and Liu, 2008, p. 152). Therefore, if the population is known, then a sample can be selected, which will enable one to draw generalisations about the identified population. Sampling strategies, which have this characteristic, are called “probability samples” (Fellows and Liu, 2008; Creswell, 2009; Saunders et al., 2009; Bryman, 2012; Easterby-Smith et al., 2012).

This research wants to develop a management framework which is universal. In addition, the research findings shall be evaluated by the parties involved in construction. Universal means in this sense that the developed concepts and principles are not related to any country and its working culture. Parties involved in construction are the main parties involved in a construction project, namely clients (or clients’ representative project managers), designers, and contractors. Consequently, the population for this research are all the parties involved around the world. Identifying all the parties involved in construction from all around world seems like a task, which is not feasible within the framework of this thesis. Especially the categories owner and project manager are groups, which are not easy to identify, because these are professions which could be delegated/given to anyone. As a result, the population cannot be identified, which results in that an appropriate sample cannot be selected, too. Even if the population could be identified the number of the sample would be too high to be covered in one research project. Further this research aims to make generalisations to the AgiLean PM framework rather than about population. Fellows and Liu (2008), Saunders et al. (2009) and Bryman (2012) argue that if it is the case that the sample is too huge and the focus is more on generalising theory rather than about population, then non-probability sampling techniques are appropriate.

There are three main non-probability sampling techniques, which are quota sampling, convenience sampling and snowball sampling (Fellows and Liu, 2008; Creswell, 2009; Saunders et al., 2009; Bryman, 2012; Easterby-Smith et al., 2012). Quota sampling is normally used for interview administered questionnaires (Saunders et al., 2009; Bryman, 2012). The population needs to be known, so that it can define quotas for a category of the population (ibid.). However, given that the population is not known and given that this research has conducted an internet mediated questionnaire, leads clearly to the conclusion that this type of sampling will not lead to the achievement of the research objectives.

This research used a mix of convenience and snowball sampling. When conducting convenience sampling, the researcher selects those respondents which are easiest to obtain (ibid.), i.e. which are convenient for the researcher (Fellows and Liu, 2008). To facilitate this, the questionnaire has been sent to the personal contacts of the researcher in the first instance. Those contacts are known from the professional career (contacts from work), academic career (contacts from diverse conferences, such as ARCOM, ASC, CCC), and contacts from internet based social network platforms (i.e. LinkedIn® or XING®). Out of this a total number of approximately 600 questionnaires have been sent out. In addition to this, the questionnaire has been published on different internet platforms. The following table gives a transparent overview about the webpages where the survey has been published.

**Table 4-5 webpages where the survey has been published**

<b>Provider</b>	<b>Published period</b>	<b>Internet link</b>
UK Association for Project Management (APM, UK)	January 2013 till February 2013	<a href="http://www.apm.org.uk/Research">http://www.apm.org.uk/Research</a>
German Association for Project Management (GPM, Germany)	January 2013 till February 2013	<a href="http://www.gpm-ipma.de/know_how/laufende_pm_studien/agile_pm_eine_neue_strategische_methodik_fuer_das_bauwesen.html">http://www.gpm-ipma.de/know_how/laufende_pm_studien/agile_pm_eine_neue_strategische_methodik_fuer_das_bauwesen.html</a>

Table 4-5 shows that this study has received great support from the German and UK Associations for Project Management (both belong to IPMA). In addition to the above webpages the survey has been published also on the personal blog-web

page (<http://agilean-pm.blogspot.de/>) of the researcher from December 2012 until February 2013.

Besides those, the researcher also took advantage of social network platforms, such as LinkedIn® and XING®, where the survey has been published on a diverse range of groups. The XING® groups are listed in Table 4-6.

**Table 4-6 XING® groups where the survey has been published**

Group name	Published period	Internet link
Alumni Bauingenieurwesen Universität Stuttgart	December 2012 till February 2013	<a href="https://www.xing.com/net/pri2870a5x/bau_uni-stuttgart/allgemeines-37755/umfrage-zur-studie-agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-42953142/42953142/#42953142">https://www.xing.com/net/pri2870a5x/bau_uni-stuttgart/allgemeines-37755/umfrage-zur-studie-agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-42953142/42953142/#42953142</a>
Alumni Hochschule (HTWG) Konstanz	December 2012 till February 2013	<a href="https://www.xing.com/net/pri2870a5x/almunihtwgkn/ideen-vorschlaege-feedback-379986/agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-umfrage-42953140/42953140/#42953140">https://www.xing.com/net/pri2870a5x/almunihtwgkn/ideen-vorschlaege-feedback-379986/agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-umfrage-42953140/42953140/#42953140</a>
Bilfinger Berger b. connected	December 2012 till February 2013	<a href="https://www.xing.com/net/pri2870a5x/bbingbaubconnected/ideen-vorschlaege-feedback-544711/umfrage-agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-42953134/42953134/#42953134">https://www.xing.com/net/pri2870a5x/bbingbaubconnected/ideen-vorschlaege-feedback-544711/umfrage-agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-42953134/42953134/#42953134</a>
Bauwesen	December 2012 till February 2013	<a href="https://www.xing.com/net/pri2870a5x/bauwesen/controlling-produktivitaets-und-prozessmanagement-qualitaets-und-riskmanagement-54177/umfrage-agilean-pm-eine-neue-managementmethodik-fur-das-bauwesen-42953129/42953129/#42953129">https://www.xing.com/net/pri2870a5x/bauwesen/controlling-produktivitaets-und-prozessmanagement-qualitaets-und-riskmanagement-54177/umfrage-agilean-pm-eine-neue-managementmethodik-fur-das-bauwesen-42953129/42953129/#42953129</a>
GPM Deutsche Gesellschaft für Projektmanagement e. V.	December 2012 till February 2013	<a href="https://www.xing.com/net/pri2870a5x/gpm/umfragen-studien-bucher-69883/umfrage-agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-42953102/42953102/#42953102">https://www.xing.com/net/pri2870a5x/gpm/umfragen-studien-bucher-69883/umfrage-agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-42953102/42953102/#42953102</a>
Lean Construction	December 2012 till February 2013	<a href="https://www.xing.com/net/pri2870a5x/lc/lean-construction-vortraege-und-praesentationen-27227/agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-42953091/42953091/#42953091">https://www.xing.com/net/pri2870a5x/lc/lean-construction-vortraege-und-praesentationen-27227/agilean-pm-eine-neue-strategische-methodik-fur-das-bauwesen-42953091/42953091/#42953091</a>

The groups listed in the above table have been mostly German groups.

The LinkedIn® groups are listed in Table 4-7.

**Table 4-7 LinkedIn® groups where the survey has been published**

Group name	Published period	Internet link
Last Planner Users	December 2012 till February 2013	<a href="http://www.linkedin.com/groups?home=&amp;gid=3069827&amp;goback=%2Enmp_*1_*1_*1_*1_*1_*1_*1_*1_*1&amp;trk=NUS_UNIU_SHARE-grpName">http://www.linkedin.com/groups?home=&amp;gid=3069827&amp;goback=%2Enmp_*1_*1_*1_*1_*1_*1_*1_*1_*1&amp;trk=NUS_UNIU_SHARE-grpName</a>
Lean Construction EUROPE	December 2012 till February 2013	<a href="http://www.linkedin.com/groups/Lean-Construction-EUROPE-4645254?home=&amp;gid=4645254&amp;goback=%2Enmp_*1_*1_*1_*1_*1_*1_*1_*1_*1&amp;trk=NUS_UNIU_SHARE-grpName">http://www.linkedin.com/groups/Lean-Construction-EUROPE-4645254?home=&amp;gid=4645254&amp;goback=%2Enmp_*1_*1_*1_*1_*1_*1_*1_*1_*1&amp;trk=NUS_UNIU_SHARE-grpName</a>
Lean Construction Institute	December 2012 till February 2013	<a href="http://www.linkedin.com/groups?home=&amp;gid=931137&amp;goback=%2Enmp_*1_*1_*1_*1_*1_*1_*1_*1_*1&amp;trk=NUS_UNIU_SHARE-grpName">http://www.linkedin.com/groups?home=&amp;gid=931137&amp;goback=%2Enmp_*1_*1_*1_*1_*1_*1_*1_*1_*1&amp;trk=NUS_UNIU_SHARE-grpName</a>
Lean Construction Institute UK	December 2012 till February 2013	<a href="http://www.linkedin.com/groups?home=&amp;gid=1179447&amp;goback=%2Enmp_*1_*1_*1_*1_*1_*1_*1_*1_*1&amp;trk=NUS_UNIU_SHARE-grpName">http://www.linkedin.com/groups?home=&amp;gid=1179447&amp;goback=%2Enmp_*1_*1_*1_*1_*1_*1_*1_*1_*1&amp;trk=NUS_UNIU_SHARE-grpName</a>
The Real Estate Networking Group	December 2012 till February 2013	<a href="http://www.linkedin.com/groups?gid=121300&amp;trk=myg_ugrp_ovr">http://www.linkedin.com/groups?gid=121300&amp;trk=myg_ugrp_ovr</a>
project & construction management group	December 2012 till February 2013	<a href="http://www.linkedin.com/groups?gid=2804537&amp;trk=myg_ugrp_ovr">http://www.linkedin.com/groups?gid=2804537&amp;trk=myg_ugrp_ovr</a>
Lean Construction Network	December 2012 till February 2013	<a href="http://www.linkedin.com/groups/Lean-Construction-Network-2622826?trk=myg_ugrp_ovr">http://www.linkedin.com/groups/Lean-Construction-Network-2622826?trk=myg_ugrp_ovr</a>
European Group for Lean Construction :: [eglc]	December 2012 till February 2013	<a href="http://www.linkedin.com/groupItem?view=&amp;gid=3009022&amp;type=member&amp;item=196718917&amp;qid=fdd3b07f-d1bd-4c62-abdd-36c073a50217&amp;goback=%2Egmp_3009022">http://www.linkedin.com/groupItem?view=&amp;gid=3009022&amp;type=member&amp;item=196718917&amp;qid=fdd3b07f-d1bd-4c62-abdd-36c073a50217&amp;goback=%2Egmp_3009022</a>
Spanish Group for Lean Construction	December 2012 till February 2013	<a href="http://www.linkedin.com/groups/AgiLean-PM-new-strategic-framework-3683995.S.196718853?qid=b7645c52-e692-4808-afc7-9e120d83cb3f&amp;goback=%2Egmp_3683995">http://www.linkedin.com/groups/AgiLean-PM-new-strategic-framework-3683995.S.196718853?qid=b7645c52-e692-4808-afc7-9e120d83cb3f&amp;goback=%2Egmp_3683995</a>
German Group For Lean Construction	December 2012 till February 2013	<a href="http://www.linkedin.com/groupItem?view=&amp;gid=4574009&amp;type=member&amp;item=196557089&amp;commentID=115118208&amp;goback=%2Egmp_4574009&amp;report%2Esucess=8ULbKyXO6NDvmoK7o030UNOYGZKrvdhBhypZ_w8EpQrQI-BBjkmxwKEOwBjLE28YyDIxcyEO7_TA_giuRN#commentID_115118208">http://www.linkedin.com/groupItem?view=&amp;gid=4574009&amp;type=member&amp;item=196557089&amp;commentID=115118208&amp;goback=%2Egmp_4574009&amp;report%2Esucess=8ULbKyXO6NDvmoK7o030UNOYGZKrvdhBhypZ_w8EpQrQI-BBjkmxwKEOwBjLE28YyDIxcyEO7_TA_giuRN#commentID_115118208</a>

The above table shows that the survey has been published mostly on a wide variety of Lean construction groups. The reason for this is, because people involved in these communities are familiar with the field of the study and are in general very supportive.

Additionally the respondents have been asked to forward the survey to any further persons, who might be interested in and eligible in taking part, this is called “snowball sampling” (Easterby-Smith et al., 2012).

Considering this wide variety of platforms where the survey has been published, given that the population is not known, the result is that the response rate cannot be identified in detail. The reason for this is that the researcher has no overview about which of the eligible people has seen the survey on the internet and did not respond to it. Furthermore, it is also not known, which respondent did forward the survey to somebody else. Hence because of the fact that the researcher has no transparent overview about how many questionnaires have been sent, the identification of the response rate is not possible.

The not known number of the population, results also in that the used sampling strategy does not allow a generalisation based purely on statistical calculations (Saunders et al., 2009; Bryman, 2012). However, generally the aim of the survey is to validate the interview findings, through showing that the gathered interview data is not only the opinion of single individuals, but rather that it can be transferred to a wide range of different individuals. Hence the conclusions which will be drawn will be not based purely on statistical calculations; rather it will be a comparison of the qualitative and quantitative findings. Even though, Bryman and Bell (2007) as well as Bryman (2012) argue that in some cases it might be possible to claim generalisations, one case is if the statistical calculations of the survey give quite obvious results (*ibid.*), i.e. if the large majority has selected the choice, which results in the same opinion.

Therefore needs to be the sample size big enough, to be able to perform sufficient statistical calculations. Fellows and Liu (2008) found out that it is important to collect as many data as possible when doing a convenient sampling technique, but the minimum is to have at least 32 usable questionnaires for most of the statistical calculations (*ibid.*, Saunders et al., 2009), and if one wants to conduct factor analysis the minimum is to have at least 100 usable sets of data (Fellows and Liu, 2008). The researcher collected 213 usable sets of data, which is clearly more than the required minimum.

### 4.2.2 Development

The aim of the questionnaire is to validate the transferability of the interview findings. Hence existing survey instruments of other researchers cannot be used in this research, as those would not reflect the interview findings. Consequently the interview findings have to be used to develop the questionnaire. Creswell (2009) found out that it is a difficult process to identify the findings from the qualitative data to the quantitative. In fact, Appendix 3 shows that a rich set of qualitative data has been collected, which leads to the difficulty of which findings have to be used to develop the questionnaire. An innovative approach has been derived to support this issue, which is illustrated in the following figure.

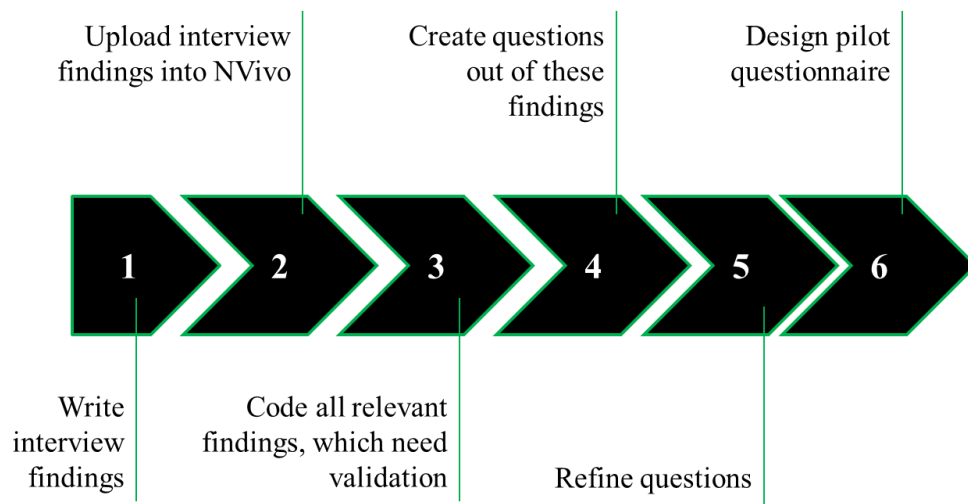


Figure 4-4 questionnaire development process

Figure 4-4 emphasises that the initiating step is to write down the interview findings. Hence the questionnaire could not be developed before the interview data has been analysed and reported. As a result the reporting of the interview findings (see section 5.1 approx. 16,500 words) is a fundamental prerequisite for the questionnaire development. Those findings have been uploaded into NVIVO. The use of NVIVO allowed the identification of the key findings in an objective manner. Out of these findings a set of 105 initial questions, which reflect the written interview findings, has been developed. Those questions had to be refined and prioritised, because they are too many. The process of refining eliminated the

questions, which appeared more than one time within the set of initial questions. Finally, the pilot questionnaire was designed.

#### **4.2.3 Design**

The questionnaire was designed through using an online survey system, which is called “Bristol Online Surveys” [BOS]. Saunders et al. (2009) found out that it is also important to have an appealing survey layout, because this will be supportive in achieving higher response rates. The online software used allowed choosing an appropriate layout for the survey. In addition, BOS allowed distinguishing between obligatory and non-obligatory questions. If an obligatory question is not answered, then the respondent cannot continue with the survey until an answer to the missing question has been provided. This is a great advantage, because Saunders et al. (2009) and Bryman (2012) argued that it happened in some cases that survey participants might forget to answer all questions, which consequently means missing data. The researcher did set up all questions as obligatory, so that the surveys were filled completely. Further, Saunders et al. (2009) and Bryman (2012) as well as Easterby-Smith et al. (2012) argue also that it is important to give clear instructions for the respondents and use clear wording for articulating the questions and the answers to those. This is very important, because the participants need to understand the question well, so that they can provide their perspective on the answer and can proceed through the questionnaire quickly. Easterby-Smith et al. (2012) found out that it is important to not use negatives (using no or not to give the opposite meaning) and to avoid leading questions which might lead the respondent to the answer. To address this issue, the survey was piloted to a small group (see section 4.2.4). The Final questionnaire consists of four parts and can be seen Appendix 2.

The first part is concerned with research ethics. The respondents did get a summarised overview about how the data collected will be treated and used. The researcher included also his contact details and affiliation to increase the reputability. To continue with the survey the respondents had to accept these conditions. If they did not click on accept, the survey just did not continue and the

respondents were asked to contact the researcher if they had doubts about these conditions.

The second part is concerned with the validation of the interview findings. The idea behind this can be related to the words of Wing et al. (1998, p. 103), where they have argued that:

*“[...] there is a cupboard opposite the desk. We do not know what is in the cupboard. We go to look, and discover that it contains an old coffee machine, no longer in use. Can we conclude that all cupboards in university offices contain old coffee machines? Of what use to me is the knowledge of the content of this particular cupboard? Could we describe the act of discovery of the machine as research?”*

Hence, this research wants to find out if the interview findings are concerned with the opinion of single individuals or if they can be transferred to a wider population. Therefore this part uses questions about opinions. The most common scale for obtaining the opinion of the respondents is the Likert Scale (Fellows and Liu, 2008), which is a five or seven point rating scale (Saunders et al., 2009; Bryman, 2012), named after its developer Rensis Likert (Easterby-Smith et al., 2012). A closed matrix question was used, where on the left side statements from the interviewees have been placed and on the right side a five point scale has been positioned. The right side covered the scales strongly agree, agree, neutral, disagree and strongly disagree. When putting the statements together for the left side the researcher bore in mind that not all respondents are familiar with PM, Lean or Agile. The focus was more on general statements, which are principal issues. Those more general statements can then be related to the relevant management paradigm in the discussion of the findings. However, two questions required more detailed knowledge about Lean construction, namely question 4.d (Lean production techniques can be directly transferred to the construction context) and question 4.q (Lean construction is more useful for builders) (see Appendix 2). Hence a probing question has been included, to measure if the survey respondent has heard about Lean construction (question 4.a: I have heard

about Lean construction). The cases of those respondents, who have selected for question 4.a “disagree” or “strongly disagree” as answer, have been excluded for questions 4.d and 4.q.

Next, the survey continued with the collection of personal factual questions, where the respondents were asked about personal information. The aim of this part was to create a profile of the survey participants. Closed questions have been mostly used for this part, where the answers were provided in advance for the survey participants. According to Bryman (2012) the usage of closed questions allows easy processing and greater comparable transparency of the answers. In addition closed questions may make the question more intelligible for the respondent (*ibid.*). However, the researcher included also optional open questions within the closed question, as it might happen that not all potential answers have been covered.

Within the third part, the respondents did get the opportunity to provide feedback and to share potential supportive ideas. This has been facilitated with one open question. Additionally the researcher offered the respondent to get a soft copy of the PhD Thesis once it is finished. If the participants were interested in getting a soft copy, they were asked to place their email address in the foreseen field.

The survey closed at the end with a thank you message. The questionnaire has been designed in a way that it was able to collect as much information as required and to ensure a high response rate by keeping it as short as possible.

#### **4.2.4 Preparation**

Bryman (2012) found out that the preparation phase can help improve response rates of self-administered questionnaires. The aim of the pilot survey or pre-final survey is to identify how long the survey lasted, how clear the instructions have been formulated, clarity of the questions and the attractiveness of the selected questionnaire layout. Hence the focus of the pre-final survey is on the feedback about the questionnaire itself. The instructions of Saunders et al. (2009) have been followed for the pilot survey, who argued that within the pilot a set of additional

questions should be placed. As a result, the following additional questions have been adapted from Saunders et al. (2009, p. 394):

- How long the questionnaire took to complete?
- Was the layout clear and attractive?
- How clear were the instructions?
- Which, if any, questions were unclear?
- Which, if any questions were you unsure about answering?
- Do you have any other comments?

The pilot survey participants were notified at the beginning of the survey that they have to answer the above questions at the end, so that it would be appropriate to check the time before starting the survey and maybe make notes while responding. At the end of the pilot survey, the participants had to answer those questions.

The pilot survey wants to benefit from the experience and knowledge of other academics, who have dealt with or are aware of questionnaire development and administration. To facilitate this, the pre-final survey was piloted within the Built Environment and Sustainable Technologies [BEST] Research Institute at Liverpool John Moores University [LJMU]. Access to all members of the BEST Research Institute was provided by LJMU, which covered 54 people. The pilot survey resulted in the following response rate:

$$\text{Response Rate Pilot Survey} = \frac{14}{54} = 26\%$$

According to Fellows and Liu (2008) this response rate is appropriate. The pilot survey was conducted via Email, where an initial and a reminder email was sent to the potential participants, which is illustrated through the diagram below.

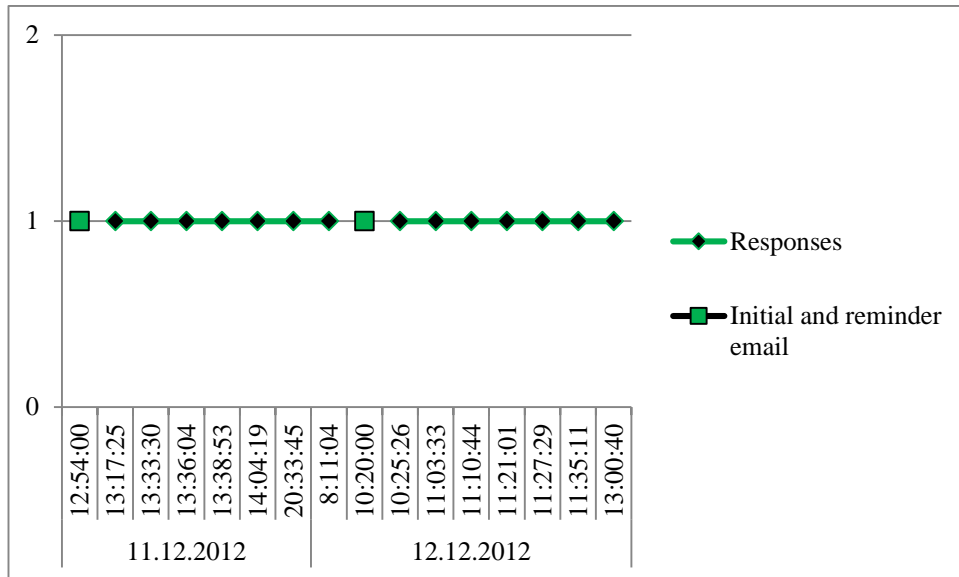


Figure 4-5 overview pilot survey administration

What stands out in Figure 4-5 is that 50% of the responses were completed after the friendly reminder email was sent. Hence, this confirms that a lot can be achieved with sending friendly reminder emails (Saunders et al., 2009).

The following figure gives an overview about the profile of the survey participants.

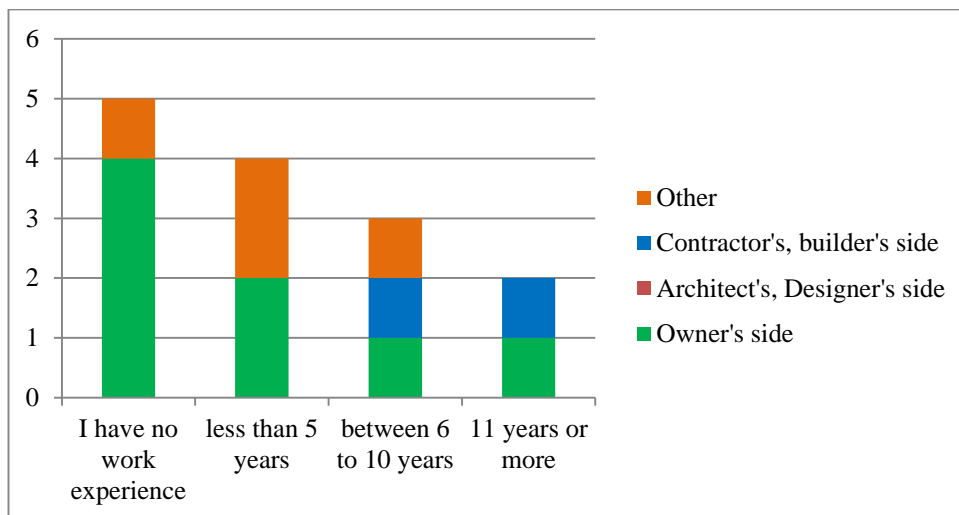
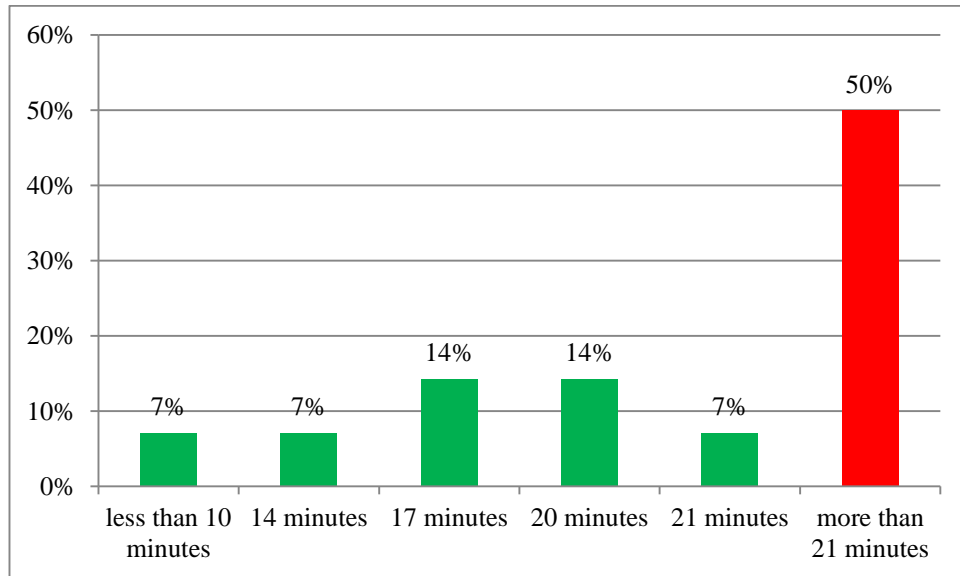


Figure 4-6 profile of pilot survey participants

64% of the participants have also practical work experience. 36% have no practical work experience and there is no one involved from the architect's or

designer's side. However, the feedback about the survey itself is more important than contextual feedback, because the content has been gathered through the interview findings.

The questionnaire shall be completed within 20 minutes. The following figure illustrates how long the respondents took to complete.



**Figure 4-7** pilot survey how long took the questionnaire to complete

50% of all the respondents took longer than 21 minutes to finish the survey. This is too long, as it might cause low responses within the final survey period. To allow the questionnaire, to be completed more quickly, a number of questions have been taken out.

In general, the pilot survey received positive feedback. This can be confirmed through statements, such as *“WELL done. Overall it is okay.”*, *“very concise questions”*, *“I think it is well structured”* or *“I think the layout and presentation is fantastic”*. This can be illustrated with the following figure.

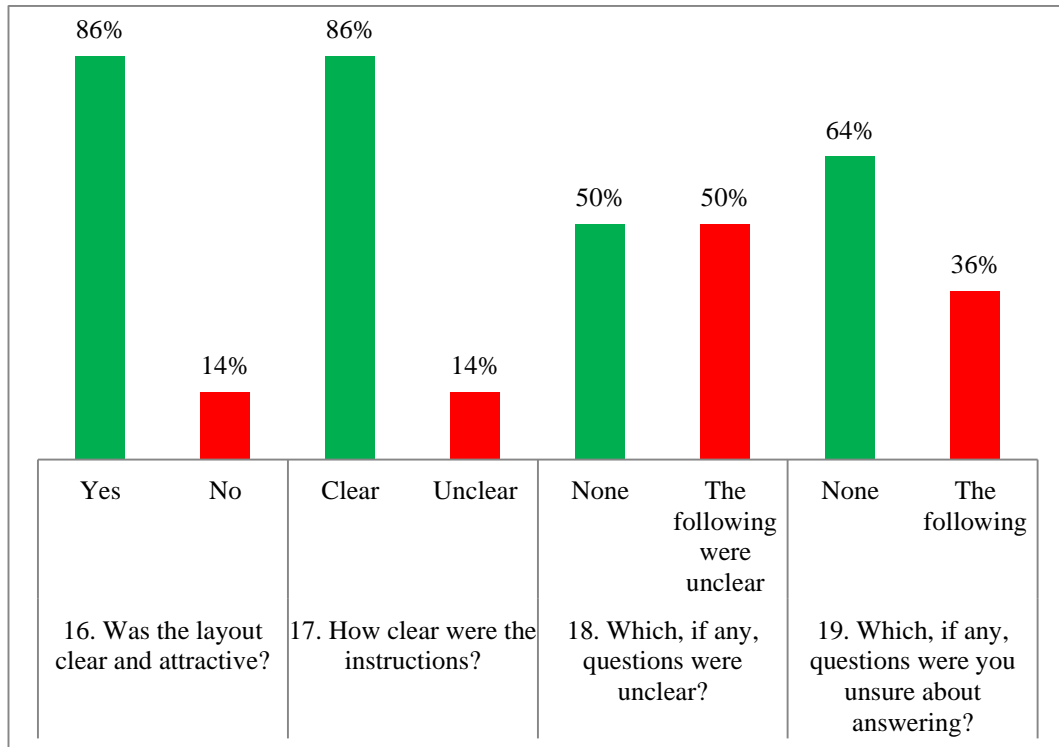


Figure 4-8 pilot survey general feedback

However, there is still room for improvement. The respondents had to answer open ended questions if their feedback was not positive on any of the questions shown in Figure 4-8. All of the given feedback has been taken into account. The pilot survey is not attached to this thesis.

#### 4.2.5 Administration

Once the final questionnaire was designed and piloted, the next step was the administration. Administration of the questionnaire means in the context of this thesis, the processes required to collect the data. BOS has been used to design the questionnaire. BOS provided a web link which can be placed into the communication vehicle (i.e. email, blog, groups etc.), which results with the advantage that it can be administered to low resources (time and cost) as all the administration is done online. In addition, participants can fill the questionnaire whenever they feel like it is an appropriate time for them.

First the identification of the potential respondents, and the identification of the platforms where the survey has been published (blog-web page, social network

groups etc. see section 4.2.1) took place. Then a covering letter was prepared where the potential respondent was invited to take part in this study. This was placed in the relevant communication vehicle. Each potential respondent did get an individual email with a link for the survey. This ensured that the survey was not moved automatically to the spam folder. A standard covering letter was used for publishing the link on the web platforms. Saunders et al. (2009) found out that the advantage of the internet mediated questionnaire is that there is lower respondent contamination in comparison with other types of self-administered surveys. Respondent contamination takes place when the survey has been filled while having a group discussion or even has been delegated to be filled by someone else (ibid.). In total, the potential respondents have been three times invited to take part in this study. The first was the initial invitation. The second was the “friendly reminder”. Finally, a “final call” has been sent when the survey was going to be closed. According to Saunders et al. (2009) this process results in more response.

In addition, to increase the response, the questionnaire was translated into German language, too. The translation was done through using the “back-translation” technique (Saunders et al., 2009), where the questionnaire has been translated first from English to German, and then from German to English. This warrants that the questionnaire has the same meaning for all respondents (ibid.).

#### **4.2.6 Analysis**

To analyse the gathered data, statistics software called “SPSS” has been used.

Before the data can be analysed and interpreted, it has to be quantified, so that it can be typed into SPSS and appropriate analysis can be undertaken. Quantitative data can be divided into two groups. Bryman (2012) distinguishes here between indicators and measures. Saunders et al. (2009) describe these two groups as categorical (which parallels indicators) and numerical (which parallels measure) data. Measures are quantities, i.e. data or things which can unambiguously be counted (Saunders et al., 2009; Bryman, 2012). Therefore measures can be typed in to SPSS as they are. Indicators refer to those types of data or things which

cannot be measured numerically (ibid.), i.e. “[...] *concepts that are less directly quantifiable*” (Bryman, 2012, p. 164). The designed questionnaire (see Appendix 2) consists only of indicator or categorical data.

When this type of data needs to be analysed through using statistics, it needs to be coded. The researcher pre-coded the whole questionnaire through putting numerical values to each answer option. For instance, for the used Likert scale, the options have been coded as follows: strongly agree = 1, agree = 2, neutral = 3, disagree = 4 and strongly disagree = 5. Excluded cases have been defined with the number “666”.

After the coding process, the types of variables need to be identified. A variable is an “[...] *Individual element or attribute upon which data have been collected*” (Saunders et al., 2009, p. 603). Fellows and Liu (2008) made the following table, to show the variable types and the belonging type of data analysis.

**Table 4-8 variables and data analysis (Fellows and Liu, 2008, p. 168)<sup>3</sup>**

The table originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The table was sourced at: Fellows, R., & Liu, A. (2008). *Research Methods for Construction*, p. 168. West Sussex: Blackwell Publishing.

According to Table 4-8, the questionnaire in part two (see Appendix 2) contains interval data, as those are the variables gathered from the Likert scale and are concerned with opinions. In part three (see Appendix 2), the questionnaire contains nominal and ordinal variables. The variables in part two are dependent variables. The variables in part three are independent variables.

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<sup>3</sup> The term “variable” has been used instead of the term “scale” to create consistency.

After the data was typed into SPSS and the type of variables were determined, the next step was to undertake the statistical analysis, which was performed in four major steps:

1. Central tendency test for independent variables
2. Internal consistency analysis
3. Central tendency test for dependent analysis
4. Multivariate Analysis of Variance [MANOVA]

The first step was to calculate the central tendencies of the independent variables. The “years of experience” independent variable (part three of the survey, question nine) has been used to refine the survey participants. Those participants who stated that they have no work experience have been excluded from the survey. The respondents have been asked to choose their level of experience in relationship to different types of projects (part three of the survey, question seven). The project basic life function (see Figure 2-2, p. - 17 -) has been used to categorise the different project types. The results of this question will associate the collected interview data to project types. This in turn, will lead to the conclusion as to which particular project types the AgiLean PM framework can be applied. The project context and their involvement within the parties involved in construction have been identified in this step, too. All statistics made within this first initial step, have been undertaken through count and median calculations and have been illustrated with pie charts.

Next, was to do the internal consistency analysis, which will be explained in section 4.2.7.

Once the internal consistency has been approved, then central tendency tests for the dependent variables have been performed. The central tendency tests for the dependent variables covered count, mean, median, mode, and standard deviation calculations. The aim of these central tendency tests is to show that the assumptions, which will be made out of the interview findings, are not the opinions of single individuals, but rather can be transferred to a wide range of people. To facilitate this, the mean values will be compared with the interview

findings. The mode and median values will be used to interpret any potential differences. The results have been illustrated with error bar charts, because those provide a high transparency.

After proving the internal consistency and looking if the tendencies between the survey results are in common with the interview findings, next was to explore if there are statistical significances between the different groups of survey participants (independent variables) and the groups of contextual answers made (dependent variables). These calculations are important as they will show if the derived AgiLean PM framework can be applied universally, i.e. in each continent and within each party involved in construction. This is objective four of this study, which aims to analyse the influence of moderating variables, such as country context and party involved in construction, on PM, Lean and Agile

To facilitate this following hypotheses have been derived:

- H1: There is no relationship between a respondent's attitudes towards the construction environment and the project context in which they work.
- H2: There is no relationship between a respondent's attitudes towards PM and the project context in which they work.
- H3: There is no relationship between a respondent's attitudes towards Lean construction and the project context in which they work.
- H4: There is no relationship between a respondent's attitudes towards Agile PM and the project context in which they work.
- H5: There is no relationship between a respondent's attitude towards the construction environment and their involvement in construction.
- H6: There is no relationship between a respondent's attitude towards PM and their involvement in construction.
- H7: There is no relationship between a respondent's attitude towards Lean construction and their involvement in construction.
- H8: There is no relationship between a respondent's attitude towards Agile PM and their involvement in construction.

To test these hypotheses the MANOVA statistics have been undertaken. MANOVA is able to analyse the statistical significance between one independent variable and several dependent variables (Field, 2005). Therefore this is the appropriate statistical calculation for testing the above mentioned hypotheses. The statistical significance level has been proven at the 5% significance or probability [p] level. Hence if the outcomes of the MANOVA test are  $p > 5\%$  then the derived Hypothesis has been accepted. There are also debates about which statistic is more appropriate for undertaking a MANOVA analysis (Sparks et al., 1999). The used MANOVA statistic is called “Wilks’ Lambda”. This statistic has been chosen, because it gives the closest approximations about the statistical significance (Anderson, 2003) and is the most widely used MANOVA statistic (Upton and Cook, 2002; Hancock, 2007).

For the case that a hypothesis will be rejected, the reason for this rejection needs to be identified. To be able to identify this, pairwise comparisons can be performed, which are designed to compare all different groups with each other (Field, 2005). This is called Post Hoc test (ibid.). There are several different ways of undertaking a Post Hoc test. However, this research has used the “Hochberg’s GT2”. This statistic is appropriate, if the different samples of the independent variable show different populations (ibid.). This applies within this research, as the “project context” and “involved party” independent variables show different populations (see section 5.2.1.3 and 5.2.1.4).

The pairwise comparisons of the eventual Post Hoc tests for H1, H2, H3 and H4 will be reduced down to the comparisons between Europe and other continents. The reason for this is that the interviews have been conducted in Europe and therefore it is more important for the purposes of this research to compare the differences between Europe and other continents.

The pairwise comparisons of the eventual Post Hoc tests for H5, H6, H7 and H8 will be reduced down to the comparisons between the owner representatives and the other parties involved in construction. The reason for this is that this study is designed to be applied by the owner’s side. Therefore seems it more relevant to

analyse which involved party does not share the same opinion as the owner representatives.

#### **4.2.7 Reliability and validity**

This section provides issues regarding the reliability and the validity of the quantitative data collected. Reliability is concerned with whether the survey “[...] *would produce the same results if the study was repeated with a similar sample* [...]” (Hoxley, 2008, p. 124). Therefore reliability is about the consistency of the findings at different conditions and in different times (Saunders et al., 2009; Bryman, 2012). There are three approaches to assess the reliability of the collected data from the questionnaire.

Those are (Saunders et al., 2009, p. 169):

- *Test re-test*
- *Internal consistency*
- *Alternative form*

The test re-test technique administers the questionnaire to the respondents and sends the same questionnaire to the same respondents some time later (Saunders et al., 2009; Gill and Johnson, 2010; Neuman, 2011; Bryman, 2012). The aim is to compare if the results of the respondents are similar. Normally all forms of reliability cannot be achieved within one research project (Gill and Johnson, 2010). In the case of this particular research project, assessing the reliability through the test re-test technique was not feasible, too, because it is already difficult to gain responses within a survey and the difficulty doubles when people have to respond to the same set of questions twice (Saunders et al., 2009; Bryman, 2012). Bryman and Bell (2007) provided a case study where this assessment has been performed through conducting first a self-administered questionnaire (test) and then a semi structured interview was performed to re-test. This research project performed first semi structured interviews (test) and conducted then a self-administered questionnaire (re-test). Hence the comparison if the results of the

interview participants are similar to the participants of the self-administered questionnaire is provided in section 5.2.3.

Internal consistency “[...] *involves correlating the responses to each question in the questionnaire with those to other questions in the questionnaire*” (Saunders et al., 2009, p. 374). This was done through using the Cronbach’s alpha [ $\alpha$ ] test. The Cronbach’s  $\alpha$  has been performed for all dependent variables together and for the groups “construction environment”, “PM”, “Lean construction”, “Agile PM” of dependent variables. The calculation of the Cronbach’s  $\alpha$  for those is an iterative process, which is described in section 5.2.2. The minimum value is for Cronbach’s  $\alpha = 0.700$  (Field, 2005). This  $\alpha$  value is sufficient for the purposes of this research, because it is a new scale (ibid.). For the case Cronbach’s  $\alpha < 0.700$ , the “item total statistics” have been used to identify, if there are potential dependent variables, which could be deleted to increase the  $\alpha$ -value.

The last approach for testing reliability is the alternative form. This can be achieved through formulating so called “*check questions*” (Saunders et al., 2009, p. 374). However, check questions have not been used, as those would increase the time for filling the questionnaire.

Another thing which is close to reliability is the issue of replication. Replication can be only reached if a clear documentation of the undertaken research is provided (Bryman, 2012). This research followed the “code of practice for research”, which is provided by the research institution of the researcher. Within this code, it is stipulated that all documents (emails, protocols, consent forms, etc.) and all interview transcripts have to be kept for a period of three years after the research project has closed (Spiers and Young, 2012). During this time, the data will be accessible for any third party, who wishes to do so, through contacting the author of this thesis or his supervisory team.

Validity “[...] *is concerned with whether the survey is measuring what the researcher intended it to measure*” (Hoxley, 2008, p. 124). There are three approaches to assess the validity of the collected data from the questionnaire. Those are (Saunders et al., 2009, p. 373):

- *Content validity*
- *Criterion validity*
- *Construct validity*

Content validity is about if the derived questions do provide adequate coverage of the field of investigation (Neuman, 2011). Content validity can be reached through allowing the judgement of the questionnaire by others (ibid.; Saunders et al., 2009; Bryman, 2012). As mentioned in section 4.2.4, this research utilised a pilot. Hence the content validity is achieved through piloting the initial questionnaire.

The criterion related validity is concerned with the ability of the indicators to make appropriate forecasts (Saunders et al., 2009; Neuman, 2011; Bryman, 2012). The construct validity is concerned with “[...] *the extent to which your measurement questions actually measure the presence of those constructs you intended them to measure*” (Saunders et al., 2009, p. 373). However, both reliability criteria have not been considered within the framework of this research, because the aim of this research is to validate the transferability criterion of the interview findings. Therefore those two reliability criteria are not within the scope and objectives of this research.

### **4.3 The method for creating the AgiLean PM framework**

PM, Lean and Agile are based on completely different concepts. Hence an appropriate way of merging these paradigms to a holistic unit needs to be developed. To this point, however, there is no systematic approach which allows the development of tailored management methodologies for the context of construction. The focus of construction scholars and practitioners is more on the straight adaptation of methodologies from other industries to construction.

Construction itself is interdisciplinary in its nature, as the discipline of constructing projects covers a wide range of different scientific disciplines (Voordijk, 2009). Out of this background, the researcher followed the approach of looking into other disciplines for gathering inspiration. While doing this, the

followed approach was the notion of discontinuous thinking, of recognizing and breaking away from outdated rules and fundamental assumptions that underlie operations (Hammer, 1990).

The outcome is that the concept for synthesising Lean, Agile and PM has been derived out of nuclear physics. Such an approach does not exist so far in current literature. Therefore, first some background about nuclear physics will be provided and then this background will be translated into the context of this research.

### 4.3.1 Background about nuclear physics

The earth is created through the basic combination of different elements (U.S. Department of Energy, 1993). These elements consist in their smallest unit of atoms (Murray and Raymond, 2000). An atom consists of electrons, protons and neutrons (U.S. Department of Energy, 1993; Murray and Raymond, 2000). This can be illustrated with the following figure.

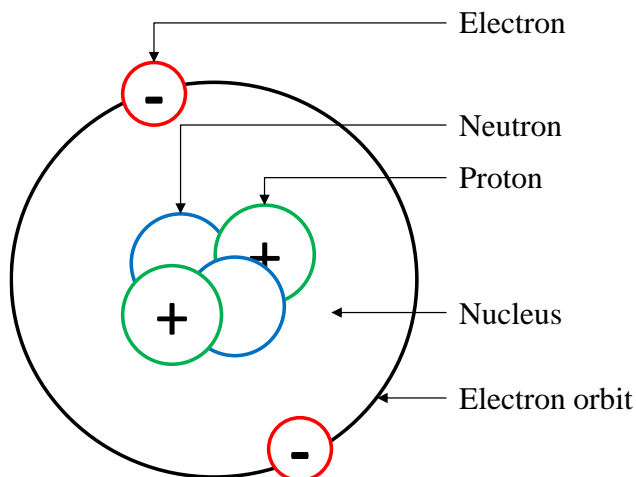


Figure 4-9 structure of an atom (own figure, content: U.S. Department of Energy, 1993; Murray and Raymond, 2000)

The core of the Atom is called “nucleus” and consists of protons and neutrons. Protons are positively charged, electrons are negatively charged and neutrons are neutral (Murray and Raymond, 2000).

Two main reactions can be distinguished within nuclear physics. On the one hand there is the concept of fission, which is illustrated with the figure below.

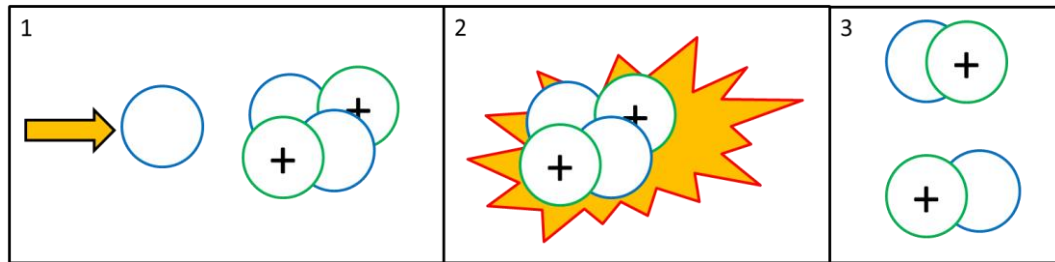


Figure 4-10 the concept of fission

Figure 4-10 shows that an additional neutron will be targeted to the nucleus (U.S. Department of Energy, 1993). The nucleus will be divided into its fragments (ibid.). Hence the separation or the splitting of the atom nucleus is called “fission”.

On the other hand there is the concept of fusion, which is illustrated through the following figure.

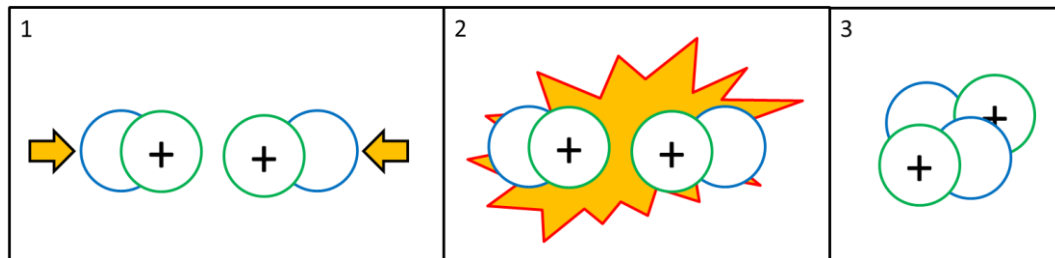


Figure 4-11 the concept of fusion

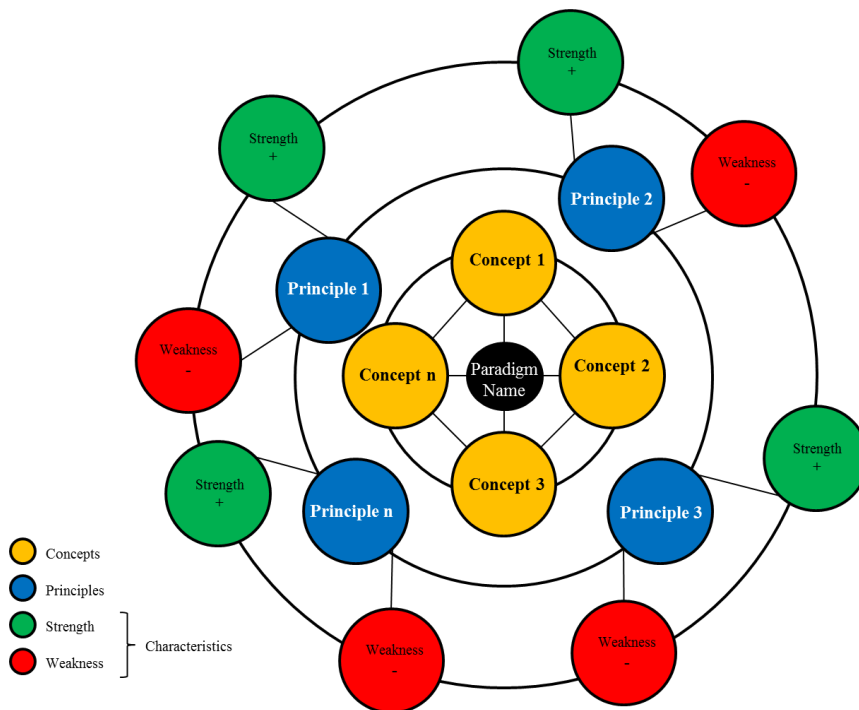
Figure 4-11 displays that two nuclei are targeted to each other (Murray and Raymond, 2000). The nuclei will merge together and become one fragment (ibid.). Hence the synthesis of atom nuclei is called “fusion”. A fusion reaction takes normally only place after a fission reaction (Bellis, 2012).

#### 4.3.2 Derivation of the approach for framework development

The aim of this section is to derive the approach for framework development. The presentation of how the framework was developed has taken some inspiration

from the nuclear physics approach, which has been described in section 4.3.1. In particular it is used as tool for visualising the framework development. As such, principles of nuclear physics are not applied to develop the framework, but rather have been used more in an inspirational manner to synthesise Lean, Agile and PM with each other, to develop the AgiLean PM framework.

However, before being able to construct the framework, the different atom components of Lean, Agile and PM have to be defined. For the purposes of this research this is called “paradigm atom”. A paradigm atom is a nomenclature for new paradigm or aggregated paradigm. Koskela (1996) found out that theory with the meaning of foundational ideas consists of concepts, principles and methodologies/methods (see Figure 3-5, P. - 103 -). The focus of the AgiLean PM framework is on concepts and principles (see section 3.3). Out of this background, the paradigm atom can be derived as shown in the following figure.



**Figure 4-12 paradigm atom**

The black circle in the middle of the atom (in Figure 4-12) is purely illustrative and not functional. The reason for having the paradigm name (i.e. PM, Lean and Agile) is related to transparency. The concepts and principles create the nucleus of

the paradigm atom. The concepts cannot be related to any particular principle, because they are generic and have to be in line with all principles. However, for each principle, strengths and weaknesses can be identified. The strengths and weaknesses show also the characteristic of the principle. Each paradigm atom can have its individual count of concepts, principles and characteristic items. Those will be identified through the literature and collected data. The derived concepts and principles of the paradigm atom might vary from that which exists in literature, because of the influence from the primary data collected.

The aim of the AgiLean PM framework is to build on the strengths and address the weaknesses of PM, Lean and Agile through combining them with each other. The strengths and weaknesses can be related to each principle. Therefore “separation” will be applied to split the principles of the paradigm atoms. In the case of this research there will be three paradigm atoms, namely one for PM, Lean, and Agile. This can be illustrated through the following figure.

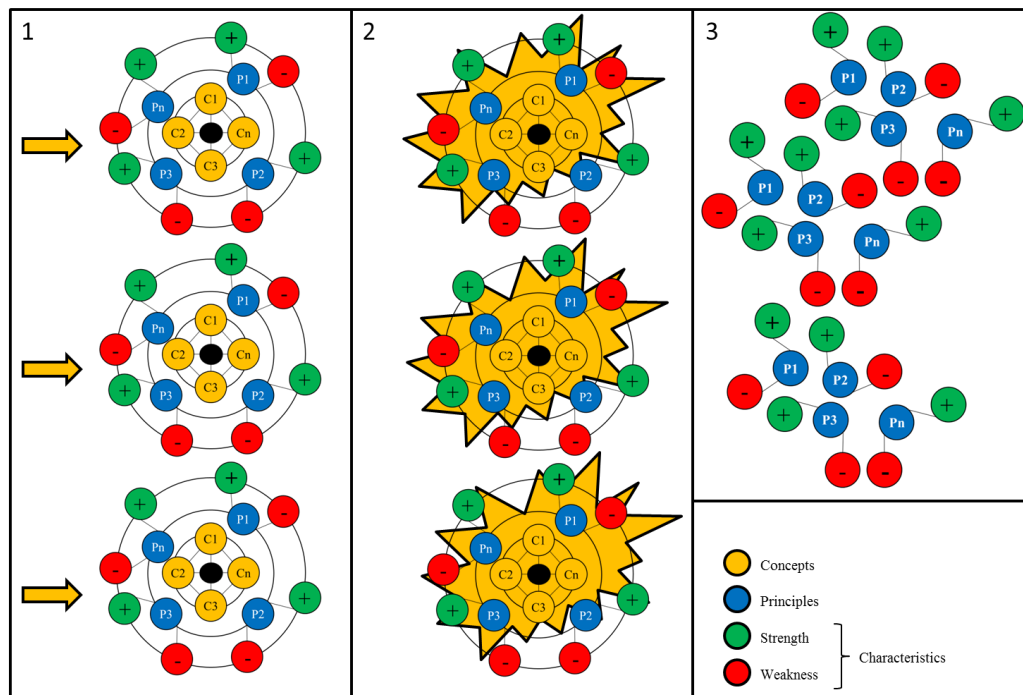


Figure 4-13 separation of the paradigm atom

Figure 4-13 shows that the application of “separation” to the paradigm atom results in what is quite common in practice, namely those individual principles of

different paradigms are applied to certain problems. This is quite powerful, because it will show improvements in the short term. However, through doing this the weaknesses of each principle is not eliminated and only few principles will be applied. It is unstructured and it is more like a sort of “tool box”.

A more powerful weapon is to synthesise the principles with each other. The strength of a Lean principle could be for instance used to eliminate a weakness of an Agile and/or a PM principle. This will be facilitated through applying “merger”, which is illustrated through the figure below.

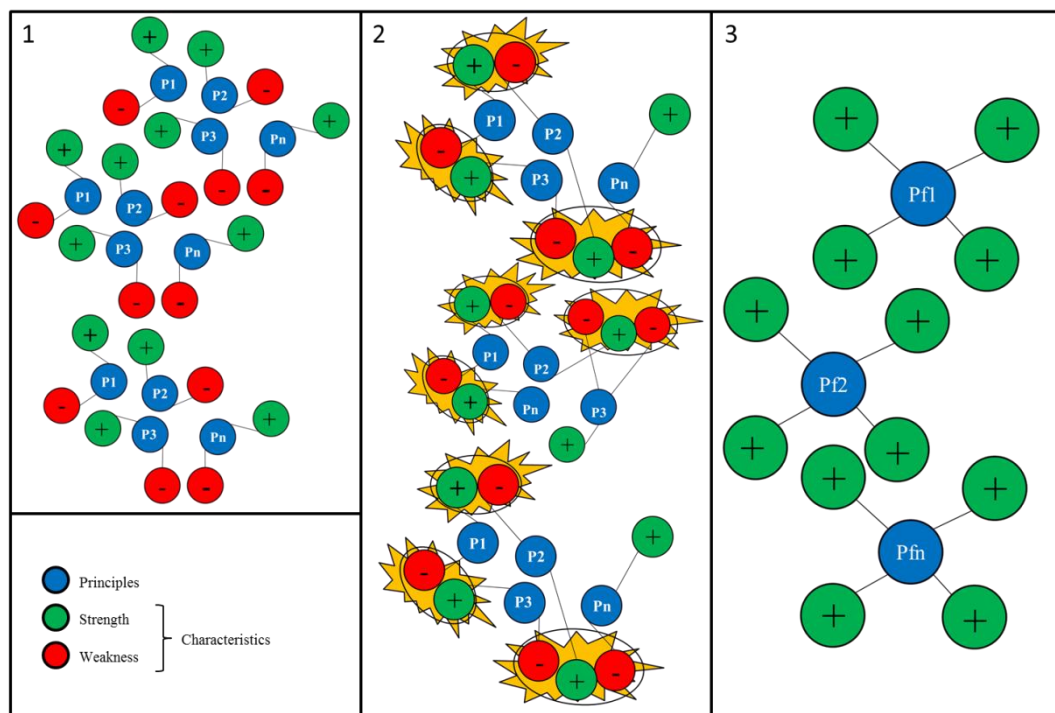


Figure 4-14 merger applied to paradigm atom

Figure 4-14 shows that each weakness of a paradigm’s principle will be eliminated with the strength of another paradigm’s principle. The only rule for applying this is that “merger” cannot be applied to principles of similar paradigms, i.e. the strength of an Agile principle cannot eliminate the weakness of another Agile principle. Nevertheless, the strength of a Lean principle can eliminate the weakness of an Agile principle, and so forth. The reason for this is that if the weakness of a paradigm could be eliminated with the strength of the same paradigm, than this would have been happened already and there would be

no indication for a weakness. The outcome will be new principles which consist only of strengths (in theory).

When deriving the AgiLean PM framework, the merger approach had to be applied again to refine the principles. In this case, principles with similar characteristics have been summarised. This approach is called “re-merger”. The outcome of applying the separation, merger, and re-merger approach, to synthesise Lean, Agile and PM, will be the AgiLean PM atom, which consists of concepts, principles and only strengths (in theory).

#### 4.4 Research ethics

The researcher has received ethical approval for this study by LJMU. This is a prerequisite for undertaking research at the institution of the author of this thesis. The “code of practice for research” (Spiers and Young, 2012), which is also published by the institution of the researcher, has been followed, too. Given that the ethical guidelines of the research institution of the researcher have been followed, and considering that this thesis is restricted to a limited word count, further issues on research ethics will not be explored.

#### 4.5 Summary of the research process

The following process map summarises the key steps in the research.

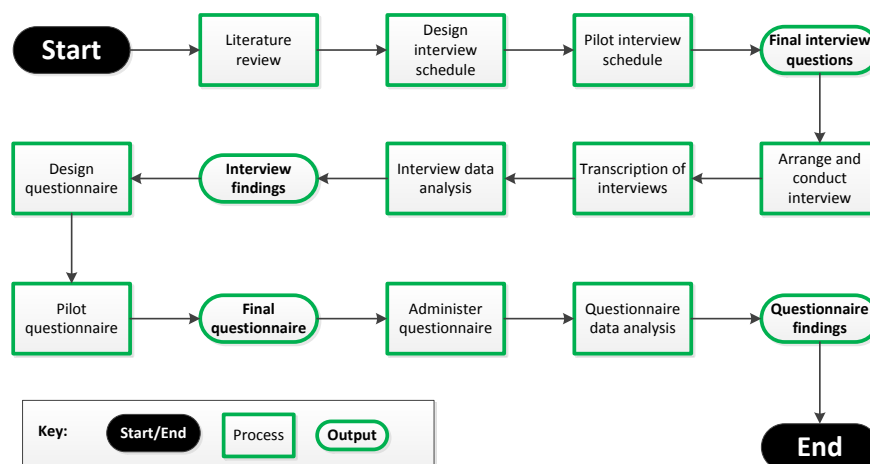


Figure 4-15 summary research method

Figure 4-15 illustrates that each process step builds on the outcomes of the previous one.

The literature review will help achieving objective one, which is to assess the suitability of Agile manufacturing and Agile IT paradigms to construction. The literature review in combination with the interviews will facilitate the achievement of objective two where the strengths and weaknesses of PM, Lean and Agile will be identified. To explore the perceptions of traditional PM, Lean and Agile among industry practitioners will be achieved through conducting the interviews and the questionnaire. This objective will also provide a solid basis of primary data for the discussion. The questionnaire will help in accomplishing the fourth objective, which aims to analyse the influence of moderating variables, such as country context and party involved in construction, on PM, Lean and Agile. The last objective, which is to develop a framework for the management of complex construction projects based on PM, Lean and Agile principles, will be achieved through the derived nuclear physics approach. The outcome, will be the AgiLean PM framework.

# 5 Findings

The findings can be divided into two parts. First the interview findings will be shown and discussed. Second, the questionnaire findings will be presented and interpreted.

## 5.1 Interview findings

First the initial situation of the construction environment will be described, which will be used as foundation for developing the AgiLean PM framework. After this, PM, Lean and Agile have been analysed in the same way, where first the concepts, second the principles, third the strengths and finally the weaknesses have been investigated and discussed. A general overview about the collected qualitative data is provided in Appendix 3.

### 5.1.1 Initial situation of the construction environment

Figure 5-1 shows the coding structure for the category “construction environment”. The findings out of this data, will describe the environment for which the AgiLean PM framework will be developed. All codes evolved after the data has been categorised. In total eight codes have been derived.

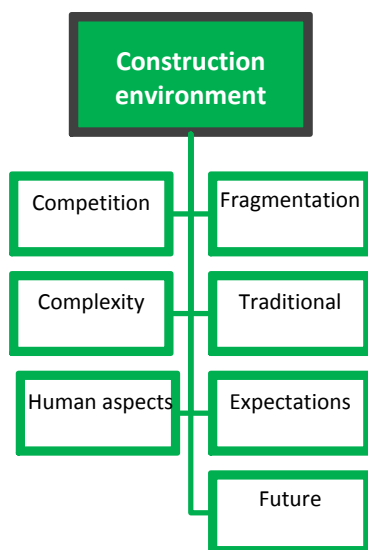


Figure 5-1 coding structure for the category "construction characteristics"

In the opinion of the interviewees the environment in which construction projects are established is characterised with tradition, complexity, competition, fragmentation, individual expectations and with different types of other human impacts. However, *“one has fairly well settled in this chaos”* (LP4). A general concern about the bad perception and the image of the construction environment was stated by PMP2 and PMP8, where PMP2 argued that *“the construction industry has not recognised that they must bring them to a different position with marketing. That means that they have to make themselves more attractive”*. The industry is perceived as highly competitive and very price driven by LP1, LP2, LP5, PMP4, PMP5, PMP7 and PMP8.

In general, all the PMPs stated that the construction environment is focused on the “lowest price wins” attitude. This has brought the issue of subcontracting to the fore. *“The main contractor is basically a management team from that organisation. Once they have won the project, they then start to appoint their supply chain”* (PMP8). *“After some time the sub-contractors started working with sub-contractors too, because they have realised the same effect”* (PMP5). The benefits of using subcontractors are more flexibility with the work force and price advantages (LP1, LP5, PMP5 and PMP8). This generated a differentiation where small companies are doing the minor works and the overall is delivered by the big general contractors (PMP7), which also resulted in a very specialised and fragmented construction industry.

However, this very price oriented and competitive character did according to PMP5 result in that ethical issues, such as *“are they productive? Can they be permitted? Are they qualified? Do they have social insurance? Are they registered”*; have been fairly neglected. LP1 argued further that this issue has resulted also *“in that the construction works are too cheap per hour”*. This created a claim management culture, where one first provides an offer with a low price and tries to make the profit afterwards during the project with claims (PMP5).

This relates the construction environment to another characteristic, namely the focus on the short term, as stated by LP7 *“very much is short term focused”* or

stated by AP5 as follows: *“if you want to deliver projects to customers you want those customers to come back to you and there is very much a mind-set in construction where the project is the only thing you think of and you also only think of yourselves”*. *“That means that one tried to keep away the strong competitive situations in the market, partly through acting with dumping prices [low offers], acted out of the substance [in this context it means that they have acted reactively i.e. not in a way which will solve the problem in the long term]; and thanks to this the built environment has changed completely”* (PMP5). Hence there is a dilemma between price competition and long term orientation.

This leads to the culture and behaviour, which *“is a big issue”* (LP7). The construction industry is characterised with its aggressive and rude language (LP2 and PMP9), *“which is a different one in comparison to that when you would talk to researchers and to teachers”* (LP2). The temporary nature and unique character creates changing involved parties in a construction project, as stated for instance by AP5 as: *“you don’t have an integrated team”*, by LP2: *“there are also no fixed partners”*, LP4 as: *“we have every time new companies, a different constellation of firms with new problems”*, or by PMP2 *“we have many participants, which are not under one roof”*. Putting the *“mistrust within the industry”* (PMP8) on top and considering that *“the people are not used to working together”* (LP2) creates communicative difficulties and conflicts during the project life cycle between all parties involved in construction (LP1), which results in that *“construction is today a fight from the beginning on and this makes it in principle much more difficult in comparison with other industries, where one is already working in partnership”*.

Construction is described as classic, traditional or conventional. It was described as an industry which is resistant against change. Especially the LPs stated that construction did not manage to make the shift from craft construction to industrialisation (AP5, LP1, LP2, LP4 and LP6). There was change within the industry (AP5), but according to LP6 the further development took place in a very limited manner, as described as follows: *“in the old days, we used to come to site and joiners would make windows on site or after a little while they would have a joiners shop and make them from scratch in the joiners shop and then take them*

*to site and they would make them fit and they would make stairs and they would cut things and the roofs would be made up on site with joints and all that sort of stuff. Nowadays we bring them or we drop them into place, but the concept is, there is a lot of cutting, shuffling, fitting and shaving and soiling rather than simple assembly”.*

AP1 stated that *“construction is not only a construction project, but rather it is also an expectations management of the parties involved”*. *“Each project has a different customer with their own personality and own business needs and different circumstance in which that product is then delivered”* (PMP9). This results in changes which happen during a construction project (PMP3) and in different quality expectations (PMP5).

However, even if the *“customer still has the feeling, construction is stone on stone”* (PMP2), today’s construction projects show increasing levels of complexity. This starts with the separation of planning and execution, which *“makes a lot of things in principle more difficult also already for contracting issues”* (LP1). *“Many trades and partners are involved”* (LP5). It is based in a temporary environment. *“A construction project goes to an area for a time. You know it is there and then it disappears and then it goes somewhere else and it is there and it disappears”* (PMP8). Each construction project like any other project is unique resulting in that *“consequently we have to create a unique solution for the problem”* (LP4). The *“demands on the projects have increased; that means that we have highly complex projects”* (PMP2). *“In the past one had for instance 250 construction products which could be performed by the engineers and also the labourers together. But today we have 30,000/40,000 construction products. That does not work anymore. So the whole construction issue gets more and more complex – that is the message here”* (LP2). Therefore highly complex tasks are managed, but given the traditional and conservative character leads to the problem that these complex tasks *“are still managed with a mind-set, and also structures and organisations, which are no longer up-to-date”* (PMP2).

### 5.1.2 PM

Figure 5-2 shows the coding structure for the category “PM”.

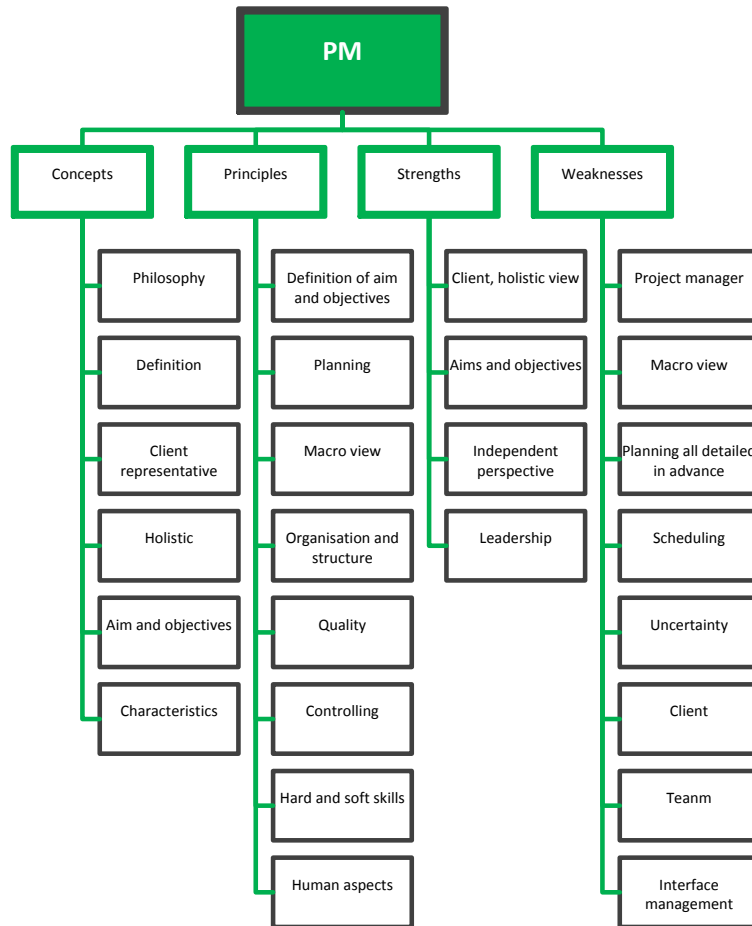


Figure 5-2 coding structure for the category "PM"

The first two levels of Figure 5-2 have been defined prior to the data analysis. The following sub-codes evolved while analysing the data in detail. Sub-codes with the name “introduction” have been derived, where statements will be used to introduce a code when writing the findings. In total four codes and 28 sub-codes have been derived for this category.

#### 5.1.2.1 Concepts

It has been found out that there are two main distinctions behind the philosophy of PM. On the one hand there have been interviewees who advocated that PM is something universal, i.e. it does not depend in which industry the project evolves

(project is project), as for instance stated by AP1 *“I am representing actually the philosophy, which is also represented by PMI, that it is in principle the application, if it is now a construction project, or an IT project, or a business project, reorganisation, cost contain project or anything else, that plays principally no role”*; or by PMP4 *“there’s not a real big difference between construction project management and other project management, I think what you’re doing is just the same it’s just for another industry”*.

On the other hand there have been interviewees who argued that PM is not universal and that it matters in which industry the project has evolved. This has been stated for instance by PMP2: *“My experience is, you need a portion of expertise and specific knowledge of the branches, otherwise it will not work, or it is difficult”*; or by PMP 8 who said: *“I think construction is unique”* because *“[...] you are up against a lot more external factors [...]”*. The reason why it makes a difference which type of project one is managing has been related to the quality objective by PMP3, who argued: *“a good project has to keep also the quality, and qualities are now very characteristic, very specific between a construction project and an IT project. Quality aims require also contextual knowledge, beyond project management methodology”*.

When defining PM the PMPs referred to the existing standards which cover the definition and scope. The PMPs explained PM through describing its role and its function. For example PMP3 said: *“Project management means for me, managing the project according to the requirements”*, it *“means basically to achieve the goal with limited resources”*; or PMP4 said that it means to: *“deliver the project for the client within time, everything scheduled and budget, with the defined quality”*; or PMP9 explained that: *“it is purely the delivery of the client expectations to enable them to deliver their operational requirements”*. All definitions relate the concept of PM to representing a client, defining the aims and objectives of this client and achieving those aims and objectives through managing the project holistically. Therefore PM basically seems as *“nothing else than a general management process”* (AP1).

The PMPs perceived two functions of PM. On the one hand the PM provides the required knowledge and insights to the clients or owners. *“It is like the extended workbenches of a construction client, who takes the tasks that are related to construction off him, because he is not able to do them by himself. He maybe builds only one time for himself in his life”* (PMP5). On the other the PM is representing the client within the parties involved in a construction project as for instance described by PMP5 as follows: *“I am the representative of its interests. I need to do all, as I would build for me, as it would be my money, which I am using”*. Therefore is the focus always on the client and the client’s interests, as for instance described by AP2 as follows: *“[...] it is about expectations management on the client’s side”*. The project manager has been described by PMP7 as someone *“who cares about everything, at the end it does not matter what the scope is”*.

Therefore a holistic view on the project is required. It goes from *“inception to completion and operation”* (PMP9) or *“from the first project idea until the handover”* (PMP7). Therefore also all PMPs distinguish between PM and construction management, as for instance articulated by PMP4: *“I think that there’s a big difference between construction project management and construction management”*. The focus within PM is not on a particular phase but rather on all phases within the project lifecycle. The project is managed from a macro level, as for instance described for the context of execution by LP1: *“the project management does not work externally in the execution, but rather has the focus more on controlling”*. Therefore the PM goes *“into costs, schedule and qualities, but from a macro perspective”* (LP4).

The PM deals in a holistic way with the objectives of the project. To facilitate this, the project needs to be planned, wherein planning can be defined *“as the mental anticipation of future action”* (PMP5), i.e. *“someone is planning there something, what another shall implement”* (PMP5). The holistic view on the project and the focus on the customer interests means also that the PM cares about the use of the building in the future, as for example confirmed by PMP6 *“what does the sustainability look like in 20, 25 years. What does the quality look like?”*;

or by PMP9: *“Building is one thing, building the fabric, but, you know, building what the building is supposed to do, you know, performance heat wise, ventilation wise, all the technical stuff [, is the other]”*.

However, being able to manage a project for the client requires that one knows what the client expectations are. All clients are different. Therefore all clients also have different aims and objectives and put different weights on those. LP7 explained for instance: *“if you are building a new hotel, it could be that maybe, certain requirements got to be high quality, as the driver. OK, quality is the driver. Someone might be driven by cost. Someone might be driven by delivery. And someone might be driven by a combination of all”*. All of the PMPs used the “Iron-Triangle” of PM (cost, time and quality) to describe the aims of the project. The PMPs stated also that the focus is more on cost and schedule because those are more objective, rather than the quality aim.

PMP2 distinguishes also between aims and facts, which has been described as follows: *“An aim is measurable, can be achieved, but might not be achieved. A fact is a fact, it has to be achieved. Today actually facts are more to the fore rather than the aims”*. PMP1 experienced that a lot of projects fail, when the PM is not able to articulate the aims and objectives to the parties involved, which has been described as follows: *“most of the failures are done because of an unclear definition of aims and objectives; that principally the parties involved in the project have no common vision about the aims, so that the aims which should be achieved through the construction project cannot be reached”*.

To conclude here so far, the concept of PM is based on representing the customer holistically over the whole project lifecycle, and matching the expected wishes of the customer with the achieved or actual.

#### **5.1.2.2 Principles**

Taking into account that a *“construction project manager must work in a way that [she/] he is the trustee of the client”* (PMP6), results consequently in that the first principle of PM is to understand what the expectations of the client are, as for

instance stated by PMP1 *“is defining first the aims and objectives”*, or by PMP5 *“go to the customer and ask, “What do you really want?””*. The PM must also involve the end-users of the facility because the objectives of the owner have to be in line with the objectives of the end-user (PMP7). The difficulty is here that *“many customers are not able, to articulate themselves, to explain what they want”* (PMP5). To counteract this problem, the PMPs explained that the definition of the client expectations is a cyclic process which has to take place constantly over the project life cycle. The client expectations have to be communicated with the project participants, so that everybody understands those. In addition the PMPs told also that it is important to judge if the set aims and objectives of the client are feasible, as for instance stated by PMP4 *“that his expectations actually are do-able or whether the schedule he has in mind is not feasible and the budget he has in mind is simply not make-able”*, or by PMP6 *“So a preconception, which is not matched, which is not coordinated, which is not signed by all areas, if that is not in place, it will never end with a positive closure”*. The outcome here should be a *“clear defined project brief”* (PMP9).

After the expectations have been identified, next is to define the structure which will support the achievement of the objectives. The PMPs explained that the project structuring should cover organisation charts, work flows (change management, design management, invoicing etc.), meeting schedules, communication management systems, documentation procedures, approval procedures, invoicing and many more. Hence PMP2 explained as follows: *“After the definition of the aims, I look, what is my scope, so PSP [Project Structure Plan], work breakdown structure. I build up my organisation. Through the organisation I can form my team. Through forming my team, I can estimate the resources and then I start with the contextual issues, scheduling, cost planning, risk management and whatever”*. Therefore one of the main principles of PM is to create a project organisation and structure which is in line with the client’s organisation.

Once this is done, the PM will start planning the contextual issues, as for instance explained by PMP3: to do the *“cost planning, scheduling, and at this point one*

*can detail the quality assurance*". PMP8 explained further that the brief has to be in line with the planning otherwise *"you will have a difficult time and end up with something what you don't really want"*. The planning will be not too detailed. It is more about providing the framework. This has been explained as follows by AP1: *"if a project manager is too much in the subject then he does not focus anymore on the management process, but rather on the subject; and that results always in that the project drifts away because the project management work is not done"*, or by PMP4: *"when I do a construction project management I really try not to care too much what is done on a given day and whether they can pull the concrete today or tomorrow or the week after tomorrow. I really have more look on the bird's eye view and make sure that they are in their general schedule"*.

Besides these sorts of hard skills, the PMPs indicated also that a range of soft skills are required to manage the project successfully, as for instance described by PMP7: *"70% of project management is psychology"*. The interviewees explained that a construction project consists on a high range of project participants and each party of participants has also a different occupational culture. It has been recognised that *"the success of a project is achieved or fails with people who are acting there"* (AP1). The PMPs explained that it is crucial to build up a team which works well together, as for instance explained by PMP2: the project manager *"has to deal with that, with the psychological profile of the humans, because he has to get to know does he fit into this team, can he do that, can he not do that"*. In fact team member motivation has been seen as a critical success factor. If the team is not motivated and if they just get their work done, then the performance will be lower. This has been articulated by PMP6 as follows: *"So that means that one has to manage the employee motivation, and if you have a bad working climate then you will get 8% lesser performance, which will come out"*.

In the case that there is a team member which does not fit to the project or into the team, the PMPs preferred to deal with it in an unspectacular way. The PMPs explained that because of the short term focus of a project, there is not enough time to integrate this person into this team, because she/he can threaten the

project. Therefore the person needs to be changed, as for instance explained by PMP5: *“if you detect somehow a weak point in a team, then you have to eliminate it, if required change it, because they cannot cope with the pressures within the project”*. Therefore another principle of PM is *“to get the people to work in the way that you want them to work”* (AP5) and the soft skills are required to facilitate this.

The last principle is controlling. Controlling the costs and the schedule, have been indicated as very strong elements. Important for the PMPs was that the cost or schedule controlling tools provide also forecasts, as for instance stated by PMP1 a *“cost controlling tool, which allows also to give forecasts”*, or by PMP3: *“I am thinking now about the execution phase. I start with the ground floor and go up and I see the results of the work immediately and can in this way, even before the project is completed, get clear better representations about what the result will be at the end”*. Hence controlling is perceived as a powerful tool to compare the expected with the actual and to create forecasts for the future status, so that one is able to generate counter actions. Therefore controlling seems as an important principle which allows the PM to act proactively.

### **5.1.2.3 Strengths**

In principle all PMPs stated that there is a need for PM in each type of project. The PMPs related it to the size, complexity and interfaces, if a PM should be adapted as a separate external function into the project, or not. PM is an accepted discipline by all parties involved in construction. The PMPs related it to the fact that they get directly hired by the client, as for instance confirmed by PMP1: *“we get usually contracted directly by the client and I think when the client has contracted a scope [of services], then of course the backing [support] of the client is there and if there is backing by the client then it will usually be also accepted by other parties involved in the project, because at the end the client is the one who is paying all”*. There are a lot of good reasons why external PM is perceived as important by owners, which have been indicated as the strength of PM.

The first strength that has been found is that PM creates a link between the client's organisation and the project. This issue has been described by PMP2 as follows: *"project management means at the end always more dependence on the customer and his system. That means that they cannot just build up their own tools and methods, but rather the customer tells them more and more, where his interfaces are and what you have to deal with"*. PMP5 confirmed basically also the same: *"There I have to say, project management has to be an element of the organisational structure related to the project"*.

All the structural and organisational elements, like change management, invoicing, documentation, are in line with the structures of the client's organisation. Decision management, in particular, has been emphasised by PMP7, who explained that these decision making structures are getting more complicated the more different departments get involved.

The holistic view on the project through all phases, which results in a more transparent judgement and follow up of the aims and objectives, have been identified as a main reason to use an external project manager in the project. The PM has the ability to see, judge or introduce decisions from a macro view, which will allow the achievement of the client expectations, as for instance described by PMP3: *"How much time is available for this project and what are the customer expectations"*; or by PMP2: *"we are actually always open for changes, because I say, if it helps the customer's goal, that he gets more value afterwards, we must change, does not matter when"*.

Another aspect is that PM is able to define clearly the aims and expectations of the project. On the one hand PM helps the client to articulate his vision. This has been for example articulated by PMP3 as follows: *"number one is the definition of the aims, to have a consensus with the customer, regarding the determination of the aims and in general to determine measurable aims at the beginning of a project"*. On the other hand, PM communicates these aims and objectives further to the other project participants, because other parties involved might perceive the aims and objectives differently, or set a different focus. This has been explained

by PMP1 as follows: *“Others see it different, because they have defined the aims differently, and that is actually one of our main tasks, to define clear aims and objectives at the beginning, so that all do speak about the same aims”*.

Another great strength of PM is that *“it is supporting the client directly and is independent on some design or supplier interests”* (PMP1). PM is independent and enriches the project with a different perspective, as stated by PMP2: *“the project manager is the one in contrast for instance to the architect or also to the civil engineer; civil engineering is facts-oriented, the architect is very creative - creative in regard to the object - and the project managers are actually creative in regard to the flow”*. PMP6 explained further that the other parties involved lack in PM, because they do not have this structuring and organising competency. Hence *“such an external view on such a project”* is perceived as helpful (PMP7).

According to PMP2 project managers have a completely different way of thinking, which is just project oriented. PMP2 compared a project manager with a production manager as follows: *“A production-line man must think in a wider sense. He has to say, “How do I develop my department that it will get to be the biggest in five years?” Then he builds himself up slowly. We want to achieve a goal for the day and we have to achieve this and for that we have to look that we have the right people. Now it could be, we have excellent specialists but that does not fit. So we have to change”*. Hence the strength of PM is that it is thinking in projects and that it is oriented more in a realistic manner.

The PMPs indicated also that a different strength of PM is the management of communication, which is in accordance with PMP4 *“a very challenging environment for project managers, because usually you are working with a very high number of contributors and stakeholders”*. The competency of PM is here to provide the right information to the right people with the relevant level of detail. This has been confirmed for instance by PMP4: *“it’s important, that the right people get the right information but that you also limit communication at some levels”*, or by PMP3: *“to have an aim oriented communication or result oriented communication”*. Hence, *“At huge complex and difficult things you just need a*

*project management, because someone has to be on top who is spreading all these things and tells how all that works”* (PMP6). It has been concluded that the general strength of PM lies in this macro view on the project, where the PM sets the framework or the playground for all other project participants, so that they can perform their tasks appropriately.

#### **5.1.2.4 Weaknesses**

The PM can be performed at small projects by the executing or designing authority. Therefore there is no need for PM. However these types of projects are not in the focus of this thesis. Therefore they will be not detailed further. A few criticisms have been expressed by the PMPs to the project managers. It has been criticised that today’s project managers are not experienced enough, that the business and finance aspects in education are not sufficient for practice, and that the project managers’ ego is too high, consequently resulting in that some project managers do not want to lose control over the project, i.e. not allow the team to work appropriately. However those are also things which cannot be generalised and which depend on the human personality and the background of the person. Therefore these weaknesses will not be further considered, as the AgiLean PM framework cannot provide improvements in these fields.

The aim of PM is to derive a plan and then to do all relevant actions that this plan can be followed, as for instance described by AP1 *“in construction projects one wants to detail at the beginning all in advance”*. When controlling the expected to the actual and future performance, the focus is mostly on cost and schedule, as for example said by PMP4: *“it’s usually, it’s very much focused on cost and schedule”*.

The identified problem here is that the third element of the iron triangle can vary or can change as it is not possible to estimate detailed quality expectations in advance. This has been explained as follows by AP5: *“typically you try and specify the value which you want and stick rigidly to it; as a result, both the cost and the time vary and typically slip”*, by AP6: *“a construction project could be five or six years, so obviously there are going to be some price increases during*

*that period, you know fuel costs, raw material costs, resources cost increase, wages etc., [...] people try and get, I think, the budget fixed down too early, not realising or not planning for its building cost increases, as you start implementing”, by PMP4: “I don’t think right that you should or can eliminate the change”, by PMP7: “there is just not such a defined product like a car, like a software program, that could be developed, I would say, easily with relatively little interruptions. Construction projects are characterised with interruptions, with changes and partly also with conflicts, which of course create difficulties, to go through a developed project management path until the end”, or by PMP9: “we get scope gaps, which become a risk, which become a problem”.*

To counteract this issue, the PM wants to stabilise the process through the trial to avoid changes, latest during the execution. To achieve this, the approach is to limit the desire to change. This has been described by PMP4: *“when construction starts everyone wants to make changes, if you don’t limit that communication then you’ll never get your project done in time or in budget, because the contractor just does things, because someone told him”, by PMP5: “the customer and the designer and the executing companies and all consultants, which belong to it, which have to be managed all by us, they have to allow that they will get a bit more disciplined because of us”, or by PMP7: “That is what all is about, isn’t it, do all your changes before you start”.*

However, this approach is in dilemma with the project environment. Even if the PM pursues to create a static environment with no changing expectations and conditions; it is simply not possible, as it is something where the PM has no control over it. Hence the “plan all detailed in advance” approach seems not appropriate for construction projects, as it does not allow changes.

It has been further indicated that there are in general two types of uncertainties, which construction projects face most. On the one hand there are uncertainties which are caused by the project environment, which will be detailed in the following sections. On the other hand the changing customer expectations create uncertainties. This has been for example explained by PMP6: *“There comes the*

*client and says, "Something else came in my mind or I have seen by accident in Nairobi something else'", or by PMP7: "That the client is sometimes not sure about what he wants, that he is changing his aims within the construction project under some circumstances, that he gets new ideas and comes with those to the project team very late".*

These uncertainties *"influence now here the management system and the structure, then finally it is not possible to have a solid flow, because these influences are so high that they damage the whole system"* (PMP2). Hence construction projects get more complex and the tasks face more uncertainties, but the problem is that those tasks are managed with methods and procedures *"which are no longer up-to-date"* (PMP2). Therefore one main weakness of PM is the management of changes caused by uncertainties, as for instance confirmed by PMP3: *"[...] solving change problems in projects. I do not know if that could be even solved with a tool, whether one could develop with an academic approach solutions and tools, but that is actually one of the biggest problems, changes in projects, to react to changes systematically"*, PMP4: *"there's lots of change and unsure processes and people doing things like they used to do them for the last twenty years"*, or by PMP7: *"the biggest challenge in our view is here, to manage this change"*.

What has been also identified as a weakness is that the project schedule is too complex, like for instance stated by PMP4: *"scheduling, because what you will very often see is that you have very elaborate project schedules which have one thousand line items and honestly I had projects where we had to dedicate a person just to taking care of the schedule and that person was the only one actually looking at the schedule, because it was so complex no-one could actually have a look"*. Hence the PM faces difficulties about providing a transparent overview of the schedule to the project participants.

An additional challenge is that the PM has low influence on the targets set by the client. The PMPs argued that the targets set appear to be unrealistic, but that they have no choice other than agreeing on them, because otherwise the project will be

given to the competitor. This issue has been described by PMP4: *“to really get the client to understand that we also have to focus on this part and not only look at the price, I think that’s a very, very critical thing”*, or by PMP9: *“[...] maybe the targets are unrealistic; target can’t be delivered that is a matter of fact based on the analysis. Other people would say, they don’t care, that is the target, if you can’t hit it goodbye and don’t speak to me”*. The PMPs explained further that the predefined and limited conditions of a project result consequently in that not always the best possible party can be contracted. This creates according to PMP2: *“a forced marriage for five to seven years. We have a forced marriage. That is not a love marriage but rather a forced marriage”*. The team members, who have to work together for this project *“follow their own economic interests”* (PMP5). Therefore the PM struggles in providing a team culture where the focus is on the project as a whole. This has been confirmed for instance by PMP8 who said: *“You need a good team approach. You need a collaborative approach from design team, project management, building contractor”*.

One of the strengths of PM is to mitigate the interfaces between the different project phases through a holistic view on the construction project. However, what has been identified is that the PM is not involved enough into the management process within the phases, as for instance stated by LP4 as follows: *“we are sitting in the office and changing claims, etc., but we are not outside on the construction site to control the process”*, or by PMP5: *“The process orientation goes in construction a bit more down”*. The interfaces within the phases are managed through contractual relationships. The interviewees indicated that this way is not sufficient, as for instance stated by LP4: *“that is exactly the change, which we see to say, that has to be linked with each other, this drawn line to say, that makes project management, that does the construction management, that is done by the firms etc. That does not work”*, LP7: *“the interface between the trades is not working”*, by PMP2: *“We have this structuring, controlling, managing, designing, executing and then only the specialists, and that results in that the interfaces are getting more difficult because of the technology, the innovations, that here this playing together does not work at the end”*, or by PMP3: *“the scope delimitation between the parties involved and the project management were not clearly*

*defined. Consequently this created here turf wars within the project, because the scopes were not clearly delimited*". Hence the contractual management of interfaces within the project phases seems a major weakness of PM, which has a direct impact on project performance.

### 5.1.3 Lean Construction

The following figure illustrates the coding structure for "Lean".

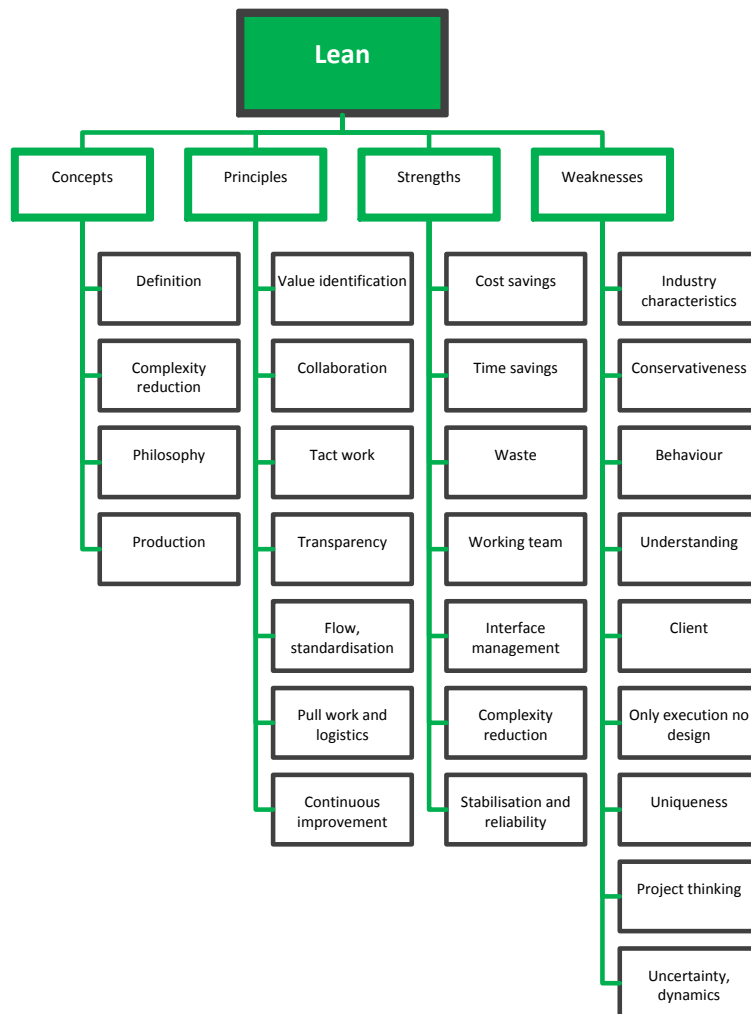


Figure 5-3 coding structure for the category "Lean"

Figure 5-3 illustrates that in total four codes (pre-defined) and 31 sub-codes (evolved while analysing the data) have been derived for the Lean category.

### 5.1.3.1 Concepts

The origins of the Lean approach are from manufacturing. *“So people begin to say, when it works for them why wouldn’t it work for us”* (LP6). The current practice in construction is seen as that one is more administering waste rather than avoiding it (LP2). This issue has been also articulated by LP1 as follows: *“I have no time for work preparation; I have no time mend the fence, because I have to hunt the chicken. So I jump always after things, because I did not do them in advance”*. The crucial enabler for Lean is to *“understand what Lean is”* (LP6).

There was no common definition about Lean. LP1 defined Lean as *“just slim (Lean) production, avoidance of waste that which is covered through Muda from all perspectives”*. For LP2 means Lean to *“manage the project in the shortest time, to the lowest cost and in the highest quality, save, with no delays, no waste and with no failures through the whole value chain”*. LP3 articulated Lean as that one is *“able to clearly separate between value adding parts from non-value adding parts and to make the non-value adding as small as possible, and to eliminate waste activities”*. Lean means for LP4 *“to align the process to the overall process and to create through that a slimmer overall process”*. A quite simple scheme was suggested by LP6 who stated *“working smarter”* as a synonym for applying Lean in construction. Hence the perception of what Lean is and especially for whom, changes from person to person.

One reason for that might be also that the current literature does not show any agreed definitions of Lean construction. The other reason might be that Lean is seen as a philosophy and *“it is difficult to put this philosophy from the background into words”* (LP5). This philosophy *“has to be lived”* (LP1, LP5). Getting this philosophy as a second nature is not a short term process. It is seen as *“a long journey”* (LP7). Therefore Lean is something which cannot be *“reduced down to tools”* (LP4). In the case that it is considered as a *“theory of tools”* (LP6); then *“there will be improvements for many years, but there will be no breakthrough”* (LP1). The philosophy seemed first as a non-tangible soft factor. As something

which exists, but which cannot be articulated. However, after getting deeper into the data, two main distinctions could be made.

On the one hand there are LPs (i.e. LP2, LP6) who argue that production is a sort of more advanced version of construction. Those LPs argue further that production and construction are quite similar. This has been for instance articulated by LP2 as follows: *“we do not call it anymore project management, but rather production management, because we understand all what we are doing as production”*; or by LP6 who stated: *“I think you’re wrong in your basic assumptions that there is too much difference between production and I am saying it, there is loads of similarities”*. The aim here is to make the construction environment like the production environment, as for instance further explained by LP6: *“Motor cars are not engineered and build, they’re assembled and houses need to be more thinking about being assembled and not constructed”*. Those LPs believe also that the Lean concepts, principles and tools can be directly transferred to the context of construction, as production is like construction.

On the other hand there are LPs (i.e. LP4, LP7) who believe that construction is different from production and that the Lean approach cannot be directly transferred to a construction context. This has been articulated by LP4 as follows: *“We think nothing of what others do, who just take it similarly and try to transfer it”*. Here the approach is to take Lean production as a foundation but to build upon it; Lean construction with its own principles and practices, as further explained by LP4: *“I can transfer certain things, but I cannot take this normal Lean approach. That does not work. That does not lead to success”*.

What both views have in common is that construction projects have to be seen as a kind of temporary production systems or process systems, where *“the focus is on the building and the building has to be seen as a product”* (LP4). Therefore one is moving from the project schedule down to the process model. LP5 explained: *“We want to develop a process system and through the process system we also want to create a problem solving culture”*. This process system view will be achieved through breaking the overall work down into smaller, more reliable and more

understandable processes. Each process has its own input, transformation and output. Where the focus is on how the value as an output can be maximised through optimising the transformation. Hence LP4 explained: *“the focus is on how value is created in it and how we optimise the overall process of this value creating process”*.

To conclude, the concept of Lean is based on a philosophy, which sees construction projects as temporary production systems, where the value has to be maximised, non-value has to be minimised and waste has to be eliminated from the processes.

### **5.1.3.2 Principles**

Looking back on the Lean principles from production or from Toyota (see section 2.2.1), which are quite sequential and linear, i.e. one follows the other; the LPs have realised that this does not actually work for construction, even if they keep referring back to it. This has been referred by LP2 as follows: *“Though it is always about, what is actually implementable. That differs from the organisation or client”*. LP3 argued that the effort for implementing the principles should be related to the gained benefit of using those, as stated: *“So I can reduce everything until the last second with a lot of effort; the question is: how much effort did I invest in advance for it?”*. There are no universal Lean construction principles defined in current literature. However in fact there have been a few principles found which are commonly used by the LPs, but those have been more independent rather than sequential elements.

*“To focus on value”* (LP5) is a common principle which has been highlighted. When defining value the focus was *“on the overall interest of the owner”* (LP4), which includes also the end user, as stated by LP6: *“what is it all about? It is all about the end user”*. *“Understanding customer value”* (LP7) or *“the need of the customer”* (LP2) has been identified as a Lean construction principle for the context of this research project. However, methods or techniques for identifying it have not been provided by the LPs.

Another aspect was human or team considerations, as indicated for instance by LP7 *“Lean also means for me the team”* or by LP2 who aimed *“to create an environment for humans, who then work with each other”*. LP2 explained further *“if you want to do Lean in the built environment then you need to take the people on board – that means that you have to create an environment that allows this, which does also eliminate this traditional “everyone against each other” [attitude]”*. To facilitate this sort of Lean human environment, two approaches came to the fore.

On the one hand there was the feeling by the LPs that Lean cannot work with all type of people. This has been articulated by LP3 as follows: *“It does not help anyone if we build an Allianz-Arena and we have no team who can play on Bundesliga or Champions League level”*. This has been confirmed also by LP2 who stated: *“you need the right people”*. To have the right people, they need to get training, need to get motivated and excited about this paradigm. Relational contracts have been also stated by the LPs as a crucial enabler, as for instance said by LP5: *“there is a profit sharing or bonus system in the background, because otherwise there will be not enough encouragement for someone”*; or for instance by LP1: *“relational contracting contracts and the type of team-working and relationships instead of requirements or joint risk management, where risks are shared with subcontractors, but also the profit”*. *“How to build the team? Build the collaborative approach, we build trust”* (LP7).

However LP6 stated that *“every time we change a site, change a project we have a changing team, change of contractor, change of consultant, big impact!”*. As a result argued LP5 that: *“So where we made very good experiences in the construction sector are really with those companies, which have more of this value chain below them and not only tendering, but rather, ok, we have fixed partners or fixed trades, with whom we want to work over the years, who is getting also closer, who is synchronising all these processes, to create more value for all those involved in the project at the end of the day”*. Therefore partnering is a crucial principle to create and maintain the team in the long term.

Another common principle which has been widely stated by the LPs is to divide the work into smaller segments. This has been articulated as “*quality gates*” by LP3 and LP5 or as a “*six to eight week window*” by LP7. The aim of performing this principle is according to LP3: “*I think if one is doing it too big, this black box, then it is too general*”. LP3 continued in explaining further: “*I think it is important [...] that one divides it into several quality gates. That just means that after which point, after which milestone, are which phases completed, which outputs are in these phases, which inputs are delivered then for the next phase*”. The purpose of this has been described by LP7 as follows: “*The reason for that for me is, design information you will always get told it takes two weeks. Lead time for materials is always four to six weeks, no matter where I ask. So building from a six to eight week program look ahead that is surely enough window, for us to start and to look at the process well*”.

Another principle which can be found widely within the qualitative data collected is the issue of creating “*transparency through the tools and methods*” (LP5). Transparency will be created through 3D and 4D modelling on the facility to construct, but transparency will be also created on the processes. The aim is here to get a better overview which will enable optimisations.

“*Standardised flows*” (LP5), “*flow production*” (LP2) or just “*standardisation*” (LP3, LP4, LP6) have been used in a quite similar fashion. The aim is to standardise as much as possible. This has been stated by LP6 as follows: “*the next would be standardisation. So we could standardise first construction and then design, materials, we could standardise in order to be able to do all sort of things*”. Standardisation will create “*an optimum smooth, no barrier, flow*” (LP4), which will result in no disputes.

Two distinctions could be made for the application of the pull principle. On the one hand it has been applied on the actual work, where one was planning from back to the front, i.e. “*vice versa*” (LP2). This has been explained by LP3 as follows: “*what information do you need from your suppliers, on the process, before the order processing starts*”. LP2 described the purpose of this: “*you have*

*to do that with the pull principle – that is demand oriented production. Then you will also get the waste out”*. On the other hand the pull principle has been also applied in a traditional manner with the focus on logistics. This has been explained for instance by LP6 as follows: *“Why not have runs on just the right amount of materials delivered to site when you need them, once in the morning, once in the afternoon then you eliminate problems with storage, security, damage through increment weather etc.”*.

Continuous improvement has been identified as the final principle by all the LPs, which is practiced in a quite similar fashion as it is done with Lean production. On the one hand it is practiced after the project, as stated by LP7 as follows: *“Let’s think about how we can improve the project with what experience we have from previous projects; and to me that is the true principle of Lean”*. On the other it is practiced during the project everywhere, where the aim is to find *“the best solution for the problem”* (LP5).

### **5.1.3.3 Strengths**

*“The strengths are surely that it has proven with evidence, also in the construction industry, to reach here enormous performance improvements”* [LP1]. In fact LP3 said that they have reached 20% cost reduction or LP4 indicated 30%. These significant cost reductions are mainly reached through time savings. The work has been done more quickly. Consequently time savings took place, like for instance ten month schedule catch up (LP7).

The reason for those savings can be related to the philosophy which covers the elimination of waste and the reduction of non-value. This has found widespread confirmation and acceptance within the PMPs interviewed, as for instance stated by PMP2 *“there is insane non-value on the construction site”* or by PMP4 *“I actually like the lean construction approach, because I think there’s a huge amount of waste in construction”*. The PMPs felt also that there is not only a huge amount of waste during the execution, but also during design phase of a construction project.

Those things are actually more the outcomes of Lean construction. More important is to find out why those savings did happen. One indication for that can be related to the factor team. Therefore “*the trades get involved at early project stages*” (LP1), through for instance partnering models (LP6). According to LP4 all depends on getting the participants excited for this way of managing projects, because once the contracted companies have understood “*that they really can earn money on this construction site and not only through contracts, then they can get quite quickly integrated into the system*”. LP7 seven explained further: “*if you want to make money, we have to perform well the project. If you want to have a stress less, stress free project, we need to perform well in the project. How do we reduce the stress? Reduce the confrontation, difficulties etc.? So what we need to do? We need to build the team*”.

Building the team means to create a “*collaborative approach*” (LP4). This collaborative approach is facilitated through high levels of communication, as described by LP6 as follows: “*Every time you did some work you knew exactly where the materials were, ready for the next day’s work and you were briefed with what work you have done, were stet you were ahead, were stet you were behind target and so it went on*”. Hence the idea behind the team principle is that “*the interface between the trades is not working, so this is what the collaborative planning process is about*”. What emerges from here is that one of the key strengths of Lean construction is interface management.

The respondents identified that Lean construction also reduces the complexity of the schedule. This has been also stated for instance by PMP8 as follows: “*I have had a talk on programming in particular and I think that is the biggest impact, if somebody understanding a project has to understand the program in the way the job is going and I think Lean makes you do that*”. In fact Lean makes all the project participants understand where they are in the program. This happens through dividing the work into smaller elements, where “*a detailed three to four weeks’ look ahead*” (LP4) takes place. The approach for facilitating this work has been articulated by LP7 as follows: “*forget what the process is and the complexity of the process, just think about, we want to plan these well, we want to do the*

*process well, we want to check our outputs and we want to act on the information required”.*

Then the process has to be made reliable. The program has to be made reliable. Here comes the team factor again into play, where LP7 explained: *“We build trust”*. Trust is important for reliability, because the agreements made have to be reliable, as for instance said by LP2 *“On this day I will be finished and the next can continue”*. Hence the reduction of complexity in combination with the establishment of reliability results in the creation of a stabilised program. The aim is to keep the program stable within this window. The aim is to *“bring the user to that point that he thinks already at early project phases about what he actually wants”* (LP2). The advantage here is that the PMPs agree also that there should be as few changes as possible during the execution, *“because one cannot afford it and it makes also no sense”* (PMP6). Therefore the strength of Lean construction is also to reduce the complexity of the construction program, make it reliable and then stabilise it.

Once the schedule is stabilised, bottlenecks can be identified and the whole process of producing this smaller element can be optimised. This has been described by LP4 as follows: *“That means that we are looking in advance always where the bottlenecks are, and we control these bottlenecks with that and the optimisation of these bottleneck resources”*.

#### **5.1.3.4 Weaknesses**

*“To apply the Lean approach from industrialisation to all fields, also in project management, failed, in my opinion”* (AP1). One of the reasons why it failed to implement Lean in construction, are the existing structures, as for instance stated by LP4 *“That is a bit like a shot through the chest to the knee; because I cannot implement Lean in the existing structures”* or by PMP2 *“We have to change actually the whole industry. We have to rise all over again. With the structures of now, how the industry thinks, you can forget about Lean”*. The current types of contracts have been identified as being not supportive, because they *“create a barrier for cooperation and innovation”* (LP1).

To overcome this issue of having non-supportive contracts, collaborative contracts with a profit sharing system or bonus system in the background have been introduced by the Lean movement to create a win-win situation. The aim is to get especially the contractor involved into early project phases so that the design can be improved and the interfaces between execution and design can be eliminated. Even if this sounds great in theory, practice is different, as described for instance by LP4 “*we had no single project where there was such a bonus regulation about it, which would actually fit in perfectly, but that does not exist anywhere, because owners and firms are against it*” or by LP7 “*it would be great to have all the different collaborative contracts in place, if we can get the industry there. But what I find at the moment is the industry itself is not quite ready for that*”. Hence the benefits of using collaborative approaches might be not that high for the practitioners in the industry as it is perceived by Lean advocates.

The contractors see higher returns in keeping the process. The reason for this might be the following scenario which is described by LP6: “*we are not trying to make the project not profitable for the builder, but if the builder doesn’t do some work, because we are eliminating the waste, he does not need to charge us for it. Therefore it is cheaper for us [owners], but it is still getting its margin on the work that he does do, and it means he can finish work quicker and get on to the next project*”. Hence the described win-win scenario is not as beneficial for the contractors as it is perceived by the Lean advocates. The contractor does not really want to finish more quickly through eliminating some tasks or improving some tasks from the scope, because for instance contractors might face already difficulties in acquiring jobs or because the more tasks are performed the higher will be the turnover and cash flow.

Another perspective on this is shared by LP1 who stated: “*A lot of things are wasted in the processes, but the cheap labour force is for me a very clear point, which does prevent a stronger industrialisation, automation of stronger technique usage [...]*”. Hence the desire to get the cheapest for the task results in that the contracted companies are those where the stuff has the poorest skills and the lowest capabilities to create a “*Lean environment*” (LP2) where the people need to

be taken on board. On the public site it is related to governmental regulations, where the competition is more price oriented rather than quality or qualification. The reason for this is that the price dimension is objective whereas the quality dimension might be related to subjective opinions. Hence *“At the public authorities, you cannot do any Lean, they do not understand this. They have their tendering procedures, like 100 years ago”* (PMP8). Therefore Lean is *“actually only possible in the private construction industry”* (PMP8). However, at the private side the problem what Lean faces there, is that the procurement departments *“are so powerful in such big corporation, [which] see their role in purchasing as cheap as possible”*.

What comes on top of this is that if you have a European tendering procedure. The challenge for Lean construction at such a tendering procedure has been indicated by PMP6, who argued: *“at a European tendering 150 people will take part and all of them come from several different countries”. “Now you have for instance 25 different European world occupants, so that one has there 25 countries, which are working there together. So, and bringing them down in such a scheme, you can forget that. That is impossible. They have already totally different philosophies”*. Therefore the construction industry must change in order to be able to implement Lean appropriately, as articulated by PMP2 as follows: *“One needs to throw this overboard and actually should define it from new”*.

But *“trying to change the industry, a traditional industry”* (LP6) is not easy. All the LPs and PMPs stated that the construction industry has a conservative character. Therefore it is difficult to introduce new methods or even new terms. For example, LP7 realised the issue with terms and stated the following: *“lot of the times what will come back is the language doesn’t fit, it doesn’t fit, it doesn’t feel right to me. You know, it sounds very much manufacturing [...]”*. LP1 sees the parallel of the development from Lean construction with quality management, where LP1 argued that in the early days of quality management they faced the same problem where people said: *“We do not need this, we cannot do this, and it does not work”* (LP1). Hence the construction industry seems resistant against change and the adoption of new methods, which would consequently end up with

a new way of constructing projects. PMP5 argued also that the current generation might not want to change, so PMP5 sees more potential for Lean in construction with the next generation of “*young people*”, who might be willing to adopt and implement new methods.

Hence the “*people’s mind-set*” (LP3) or the “*project culture has to be changed*” (LP4). In fact all the LPs, who struggled to implement Lean construction, related it to human aspects, because the first prerequisite for an appropriate Lean construction is that “*the philosophy of Lean management is implemented or lived from top down or from bottom up*” (LP1). If that does not happen, then it will result in failure, as confirmed for instance by LP3 “*we had to influence this mind-set and this did not happen well enough*” or by LP4 “*that was because of the humans*”. The fundamental requirement here is to create “*trustful relationships*” (LP1) and “*a certain degree of openness*” (LP4).

However, what Lean faces in construction, is an environment which consists of mistrust, which is selfish and which comprises a lot of conflicts. LP1 explained for instance that the designers think that they have to care about the client “*that the contractor is not ripping off the client*” and on the flipside of the same coin the contractors think that the designers “*have no idea anyway*” (PMP6) about the execution. Hence there is the “*everybody against each other*” (LP2) attitude, which is threatening team building, as everybody is following “*their own economic interests*” (PMP5). Hence these barriers need to be eliminated. Trust needs to be established and a team needs to be developed. But this is according to LP1 not easy: “*In the past shaking hands has ruled construction, today these times are unfortunately gone*”.

Another difficulty is to demonstrate the benefits of Lean construction. The LPs argue that the real benefits of Lean construction will be visible when the philosophy is lived and becomes second nature. However, understanding the Lean philosophy is not that easy. It takes up to 1.5 years according to LP3 and up to three years according to LP5 “*until the mind has changed*” (LP3). There is also more effort for setting it up at the beginning, which needs to be paid for by

someone (LP4 and LP7). This is in conflict with the short term orientation of the industry, which leads to questioning the benefits. PMP1 stated for instance *“Actually I think that the one or other process can get more Lean also in the construction sector, but I do not think that there will be that big breakthrough, but rather the improvements will be more in detail”*. The query here is, why do PMPs think that Lean construction will not cause big gains for them, even though a 20% cost reduction (LP3) could be referenced?

The reason for this is that it is seen as nothing special, but rather as something usual. For example PMP6 stated the following: *“especially over production, that what I have mentioned before: that people just do not do some meaningless activities there. But that is not for me Lean management; rather that is original management, what has to be done there, otherwise there is no management”*. Hence LP3 concluded the following: *“after we had a few conversations with a few construction companies and a contractor or an engineering, architectural office which do contracting, that the understanding is not really there”*.

However the key to success is still the owner. *“The owner has to push for that. He has to want it”* (LP4). But even if the owner wants to have it, she/he has to *“follow the playing rules”* (LP2), which are that the process has to be kept stable and static. This will be achieved through changing as little as possible and through working with the same partners from project to project in the ideal case, otherwise *“they [the clients] can’t really support the process well enough”* (LP7). Keeping the process stable and not changing or not reacting to customer wishes is in construction not possible, because in construction the relationship between client and other project participants is *“far more personal”* (PMP9) than in the production sector.

Besides this, Lean construction is perceived by the PMPs as an issue which is more for contractors. Even if some LPs stated that it has to cover the whole project life cycle, the examples which they did provide during the interview have been all focused on builders. This can be confirmed with the following quote: *“There are disadvantages and people said: oh I like this partnering because we*

*can do it quickly and it is easier and yeah yeah yeah, but [it is] 20% cheaper if we go out to tender” (LP6). Another example has been provided by PMP2 who experienced that customers sometimes do not allow a clear design, because their calculations showed them that it will be cheaper if the design runs at the same time with the execution and they are willing to pay the additional claims. PMP8 concluded for this example: “of course [...] with that a project management process [PMP8 emphasised process in the meaning of Lean] cannot be clearly structured. Although one knows [...] that the resources cannot be placed clearly, that finally a constant flow cannot be created, which would run according to some rules or some system. That is pretty clear”. Hence Lean is focused on the production of the building but not on the development. Project thinking is missing within Lean construction.*

This can be related to the distinction which takes place also within the production industry, where “*all that [what] is required until one arrives at the series production – is called ‘development’*” (PMP5). “*A production line man thinks completely different than a project man*” (PMP2). “*The stationary [i.e. manufacturing] industry is more characterised by the product and not by the project or the process*” (PMP2). Prefabricated houses have been notified as the further developed version of construction, but it has been also stated that those are limited in producing individuality. However LP2 argued further that a lot more could be done with using prefabricated elements, which will bring the construction environment closer to the production environment, so that this craft character can be mitigated. LP4 related this to something which has been called “*trade borders, who is doing what*”. LP4 explained further that one party will design something and this element will be built by several different groups. As a result, the high separation between design and execution, the involvement of several different trades, as well as the fact that those trades are mostly different companies, limits the usage of prefabricated elements.

Hence construction is completely in the prototype production. “*The Elbe Philharmonic Hall will be built only once. A Mercedes Benz Museum will be built only one time like this in the whole world, because it is related to architectural*

*design and it does not claim to be built several thousand times” (PMP5). This creates more difficulties for implementing Lean construction as for instance stated by LP4 “In this respect is the difficulty that we are building a prototype”, “because any change and optimisation, which you are doing, can be only used for this particular case and with that of course is getting the money more difficult, which you need to spend for such an optimisation as if you would produce now 100.000 pieces”. LP7 explained also: “We have to deal with it with much more creativity, because we do have only one chance”. The difficulty in implementing Lean into prototype production has been also recognised by the PMPs. For example PMP5 explained “construction projects are different, more unique driven, more result oriented, with more influencing possibilities also because I am not designing a car with a thousand people”.*

Hence the success of implementing Lean construction is related to the production type. The following explanation of LP4 will demonstrate the best environments for implementing Lean. *“You can put a range in place: on the left are the mass products like a pencil or something like that; then there are products, which are customised - a car – where the whole topic Lean is originated from; there are then some small series, productions, a ship, airplane, something in this direction. Then there is plant construction for us and on the far right are the construction projects. From the left to the right it will become more complex”.* A plant project has more demand on stable processes, *“it is like ‘a big puzzle’, which you have to put together” (LP4).* Therefore clear specifications and clear drawings are required, which will enable successive and sequential construction. LP4 argued further that the Last Planner System and other things have been developed out of such huge plant construction projects. This shows a mean weakness of Lean in construction.

Namely that Lean construction works pretty well in stable, linear environments, but it seems limited in iterative, dynamic project environments. Dynamism is created through uncertainty. These uncertainties create changes. The more uncertainty a project is facing the more changes will occur. On the one hand are changes not welcomed by the PMPs during the execution phase (see section

5.1.3.3), but on the other hand there are changes which can be caused by uncertainty or risks which are not preventable. Stabilising the program creates strong structures. These strong structures do not allow any uncertainties and risks, *“because the structure became so strong that one can just not react anymore”* (AP1).

Here always comes the question: *“How stable is the system?”* (LP5). Considering that *“you build things in a not defined environment somewhere in the world under unsure circumstances”*, the result is that *“it’s not really a closed and clearly defined process [...] like in manufacturing plant”* (PMP4). Hence the dilemma between Lean and construction lies in its environment. Lean construction is using a rigid, static system to cope with a dynamic construction project environment holistically which requires also flexibility and adaptability at some project stages, tasks or situations (LP3, LP4, LP5, PMP2, PMP3, PMP4, PMP5, and PMP9).

#### 5.1.4 Agile PM

The following figure shows the coding structure of the category “Agile”.

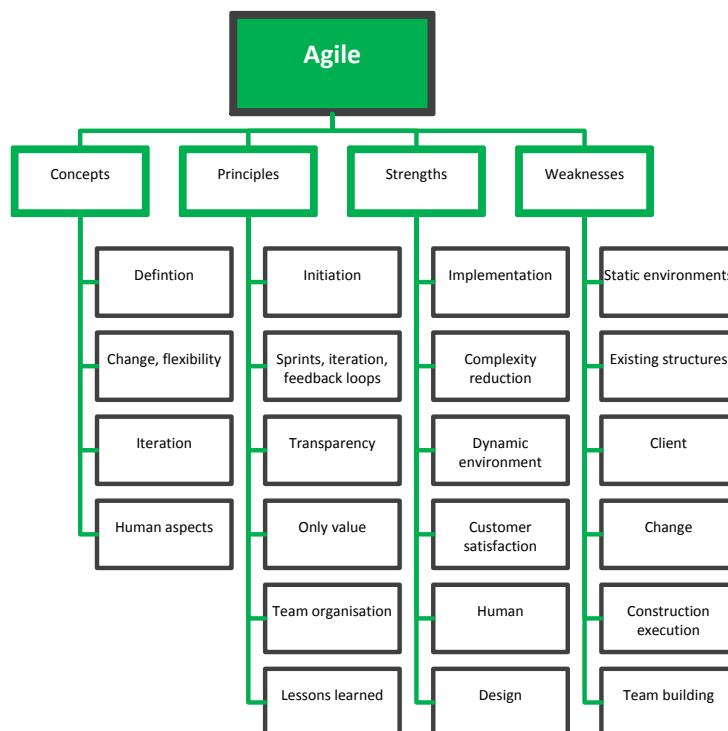


Figure 5-4 coding structure for the category "Agile"

Figure 5-4 illustrates that four codes (pre-defined) and 25 sub-codes (evolved while analysing the data) have been derived for the Agile category.

#### **5.1.4.1 Concepts**

Agile PM methods are described as an acting in between, where one uses “*as much formalism as required to make the project tangible and as much flexibility as possible to not get wiped out*” [AP3]. It is seen by some APs as the way without aim, but other APs state that it is a way to achieve a better aim. “*Both can be true*” [AP4].

Agile PM is more seen as a model, as a type of tool box, as for instance described by AP2 “*it is a model, but it does not say, that it is a different project management. That is just a model, which I am using in project management*”.

Different definitions have been articulated by the APs, but all of those had similar components. Agile means for AP2 “*to react to changes*”. A quite similar definition has been stated by AP6, who described Agile as “*being flexible in the implementation stage of a project*”. AP3 declared that “*Agile means basically that one acts flexibly and adjusts to each situation and not in the contrasting way through checklists and project forms*”. AP5 explained further “*that you use unexpected inputs as an opportunity for improvement and not as threat to delivery*”. AP4 defined Agile “*as a model to proceed, in which I am defining more the way instead the aim through rhythmic meetings*”. Hence all definitions covered changes and iterations. The reason for this clear picture about Agile might be related on the one hand to the fact that Agile is defined with the values expressed in the Agile Manifesto (Agile Alliance, 2001). On the other it is tangible because it is not seen as sort of philosophy, but rather as a model which can be used to perform projects in another way.

The Agile perspective views projects as dynamic endeavours. This dynamism is caused through changes. The changes have been categorised by the APs into two types. On the one hand changes have been related to the customer. The concept behind this has been explained by AP2 as follows: “*You cannot get into the*

*project and say, that is the contract, that is my scope statement that is that, what the customer wants at the end*". Hence Agile PM methods or models know that the customer is not able to know in advance what he wants, therefore they allow agility to happen during the project lifecycle. On the other hand changes have been also related to external influences, which are out of the control of the project, i.e. uncertainties and risks, *"like for instance employees who suddenly do not come to work, some foundation of the project that gives up, some prices that change, you have to be Agile"* (AP3). Hence projects require *"situation-related acting and not only planning"* (AP1) which can be gained with Agile methods.

The general principal behind has been explained by AP5 as *"turning the Iron-Triangle on its head"*. AP5 continued in explaining further that Agile PM methods understand that the scope or the quality objectives can change, which is tolerated. But Agile PM methods have zero tolerance to cost or schedule variations. Of course if it is not wished by the customer or if it is not caused through uncertainties.

Hence Agile is focused on putting *"a dynamic aspect to the fore"* (AP4). *"The agile factor is a dynamic or allows dynamics, even if the framework for this dynamics is given [...]"* (AP1). Agile breaks down the big aims into smaller sub aims or activities, but in a way that *"nothing can get damaged"* (AP3). Hence *"the typical idea is to cut it into single components, then I can put each of these single components into smaller groups and at the end I put them together, because I have also defined interfaces"* (AP4).

These smaller individual components are done within short iterations. Everything can be changed except the components which will be done, for that reason the interfaces need to be defined. The component can then be changed again afterwards. That is why the framework for dynamics is given, *"because one creates a certain basis, where one is freezing the scope in the short term, but then it is again open. That helps more the dynamic, as if I would freeze it for a half year or a whole year and [...] the requirements just change"* (AP1).

To conclude the concept of Agile “*is to do it iterative, small portions, involve the customer and allow changes*” (AP2).

#### **5.1.4.2 Principles**

The project aims and objectives have to be covered within a rough outline at the start of the project, “*but then shall the team decide through the project lifecycle with the gained information, how the architecture should progress*” (AP3). This is facilitated through dividing the project into smaller independent elements, which will be dealt with in the iteration. The iterations have also been called “sprints”, “cycles”, or “feedback loops”.

However, “*all these Agile methods are based on iterations and testing*” (AP3). At the end of the iteration, in the best scenario, a finished element should be the result. This cannot be performed always “*especially not in early sprints, but after sprint three it should be the case. That means that what you have produced in sprint three has to work by itself*” (AP3). Hence the project participants have to start thinking in sprints. Consequently the complexity of the project will be reduced, as for instance indicated by AP2: “*with that I am keeping also the complexity away from my team*”. Therefore the only question is – “*how long are these cycles?*” (AP1). The APs suggested iterations from two to four weeks.

These iterations are actually the only thing which is not flexible and not responsive to change within the Agile methods. These iterations stabilise the program for a short period. However, it is still flexible which has been described by AP2 with the following scenario: “*No, we are Agile, we allow changes, but not today. How? The next fourteen days there will be no changes. I thought you are Agile and ready for changes? Yes, but we do, if you want changes, you can do it anytime. You can come in and there is the wall for the project backlog. You can put your Post-it there, paper changes, take off some papers, scratch them, and burn them, whatever. But those papers which have been taken and with which we will work the next two weeks, those papers, they belong to us*”. Therefore the product owner can change anything she/he wants except what is currently performed within the iteration. Within these iterations are also daily meetings

taking place where there will be a quick discussion about the daily progress and about the tasks for tomorrow. As a result the main principle of Agile PM is to create and define iterations.

Another principle which has been found is the focus on value. The APs stated that the aim of these short iterations is to produce parts or elements of the project which create direct value for the client. This has been articulated by AP2 as follows: *“one needs to work in smaller steps, which are value adding in the ideal case, which adds more value for the customer”*. The added value has to be tangible and visible for the customer, therefore *“transparency is incredibly important”* (AP1). Also things like documentation effort will be kept as low as possible, because the aim of documentation is to make the project reproducible, which *“of course contradicts the project character in principle”* (AP2).

Agile PM methods need to enable the project participants to draw *“a very clear line, which distinguishes between management decisions and technical decisions”* (AP3). Management decisions are focused on those elements which are not performed currently within the iteration. Technical decisions concentrate on those elements which are currently performed during the iteration. The team has to be self-organised. *“The responsibilities are defined rightly. The roles were defined on a right level”* (AP1). Therefore assumes Agile *“that each individual colleague is fulfilling him/herself in the working process. It is like a not existing psychological alienation of culture”* (AP4). Within an Agile project the project manager gets more the role of the *“facilitator of management instead of top down management”* (AP5). Henceforth self-regulating or self-organising teams are another crucial principal.

The final principal identified is “lessons learned”, i.e. continuous improvement. After each iteration a so called “retrospective meeting” or a “lessons learned” meeting will take place, where it will be asked *“what went well in the last sprint and what do we want to do the next time different, better?”* (AP1). Those improvement lessons at the end of each sprint have been indicated as very

important by the APs, because improving after each short iteration results in that the process gets better and better over the project lifecycle.

#### 5.1.4.3 Strengths

*“Even the father of Lean, [...], Toyota are desperately tried to become more Agile” (AP5).* Projects are dynamic in their nature. They are exposed to uncertainty which is driven by the customer or by its external environment and project managers like to take these challenges. If that would be not the case, AP5 argued that this would be *“not a project manager’s job. That is a manufacturing manager’s job”*. AP3 argued further that *“90% of all the problems come from the other direction. A large proportion of it, is indeed the management, which does not determine clearly enough the requirements, which gives feedback too late, which is misunderstood etc.” (AP3)*. Hence Agile PM methods in IT environments provide management techniques which keep the project character and improve performance.

As mentioned in section 5.1.4.1 Agile is perceived as a model and not as a philosophy. The short term focus which is created through the iterations is in line with the project character. These two factors result also in that it is easy to implement Agile in a project. The APs stated that they just “did it” in most of the cases, even without letting the project participants know that Agile methods will be or are used for the project. This has been described by AP2 as follows: *“We just did it. Of course, I did not tell them, we are doing here a different model. No. What they got was that they got every fourteen days a new release, where they could have a look at it, the department. The management got every fourteen days a project status report with a traffic light system and they said: Are we doing well and is our performance lower or is the performance better? Then they were already happy. We did this several times and everyone liked it. At the end we said: well, we used Agile, we used time boxing. That did not play any role at the end. They also just felt good when doing it”*. Agile methods are easy to implement because of their project focus (short term focus), this is in line with the short term

focus of the construction project environment, which has been identified as an advantage of Agile methods.

Breaking the whole project down into smaller, independent and manageable elements, results in complexity reduction, as described by AP2 as follows: *“I just have to deal in detail with the actual and maybe with the next iteration [...] with that I am keeping also the complexity away from my team”*; or explained by AP1: *“That is the big advantage, in my view, to have such short cycles, where one is delivering something and not as if I would deliver something every half year”*. AP2 explained further: *“One sees more or one has more reality in his hands rather than only specifications. I hate these 10,000 pages specifications. This is so stupid. That is effort, which one puts in and it is stupid, because no one can really think in that level of detail in advance. What could happen there on page 387 with the function 327 on the bottom left? That is stupid”*.

Hence Agile models do not provide a detailed planning in advance as current PM techniques do or as Lean construction does. This has been described by AP1 as follows *“with all love for engineering, wanting to plan all detailed, meticulously, the human factor and the environmental factor [...] or whatever comes on top”*. Therefore scheduling seems a straight forward task within Agile PM models, as stated by AP2: *“What I like to do is, [...] there is a big bar and it is called “software development”. Finish!”*. As a result, the master schedule is used to determine the start and end date of the task, to provide a framework. This makes sense if the project faces a lot of parallelisation within the program (AP1). Hence Agile PM models do not claim to be applicable for each project environment.

It is beneficial to use Agile for dynamic projects. Dynamism in this context means that the unknown factors are more than the known factors within the project environment. This has been confirmed for instance by AP3: *“the more requirements are uncertain and the more challenges occur the stronger you should work with Agile and iterative”*, by AP4: *“my environment is dynamic or if it gets more and more dynamic, then it could be that Agile gets more and more important, but where my environment is static, there it could cause more*

damage”, or by AP5: *“The strength is the ability to deal with the unexpected, because you have the right mental attitude to accept that the unexpected will happen”*. These uncertainties, which can be initiated by the customer or by the environment, cause changes and these changes cause a dynamic environment, where Agile seems worth implementing.

Changes are something which are not avoidable in construction projects. This has been said for instance by PMP1 *“we have to react to changes”*, by PMP3 *“changes are one of the main problems or also the symptoms in construction projects”*, by PMP4 *“I think change is one of the most, if not the biggest challenge for construction projects”*, or by PMP5: *“I must allow the change opportunities of a property. Project management without flexibility will never work. There every project will result in failure”*.

However Agile is able to react to these changes through iterations. Hence the strength lies here that Agile copes with a dynamic project environment through using a dynamic PM model. Therefore the environment needs to be highly dynamic to allow work Agile appropriately.

The highest dynamics within the life cycle of a construction project have been identified at early project stages, for that reason the PMPs interviewed see Agile more applicable for these early phases. PMP5 stated for example: *“I go to the customer, I listen to him and I try to listen to him and understand what he wants. Many customers are not able to articulate themselves, to explain what they want. For that reason I say that it is an iterative process for the specialisation of project development. Project development starts once I start talking with the customer, understanding what he wants. Then I start to design, but then I always have to consider him – what are we planning at the moment, does it fulfil his aims?”*. This has been also confirmed by PMP7 *“Agile is especially very exciting for the planning process”*, or by PMP8 *“I think also it is more appropriate for preconstruction”*. PMP9 related the high potential of Agile PM models for the early project stages as follows: *“Because the problem what we have at present is that there are too many systems that are too rigid and not really suitable for*

*initial stages of the project*". Another perspective why Agile shows high potential for the preconstruction phases has been articulated by AP1 as follows: *"finishing the concept has a lot to do with knowledge, with creativity"* and *"[...] Agile is more related to companies where knowledge is produced or with processes where knowledge is produced"*.

Through this iterative and flexible character and through the focus on value, Agile models create highly satisfied customers, *"because they see how it grows, they see where it grows and they can influence it"*. Different individuals perceive quality differently, consequently bearing in mind that APs stated that Agile is highly customer focused, the result is that *"the quality will be massively improved"* (AP3). AP5 related the high customer satisfaction to the following: *"The biggest difficulty was that you would have quite intelligent people interpreting what they believed, what the end customer would want in total isolation from the end customer, so linking those together, so that you could go through an iterative incremental process was key to IT projects [...], short sprints where the customer could check, what you were doing was on the right track and even be sometimes be shocked, that you could even achieve something that wasn't considered possible [...]"*. PMP5 liked this approach of focusing only on that what the customer expects, where PMP5 stated the following: *"Thanks to that, that I am leaving all the things which are not needed, I might get more competitive in comparison with someone who does not understand this, to deal in such a different way with the tasks and customer needs"*.

In addition to the customer satisfaction, it has been also identified that the project team gets highly satisfied and motivated, which has been stated for instance by AP3: *"the positive experience was that the team was extremely enthusiastic"*. AP2 related the team satisfaction to the iterations, because the tasks which are performed during the iterations are not exposed to changes. The result is that the project participants think *"finally I can work"* (AP2) with no interruptions. AP3 argued that the team satisfaction can be related to the following: *"one is only doing as much management as is required, and people are then able to see why those things are required"*. Hence the self-organised teams seem like a big

strength of Agile models, because it makes the whole project more social. *“Only a pure factual level has never worked and will never work. The human factor will be always a part of it”* (PMP1).

#### **5.1.4.4 Weaknesses**

As mentioned in the section before Agile PM models are *“not applicable to each type of project”* (AP1). *“It depends on the project, but also on the team and also on the structure that is around it”* (AP3), if these models should be applied or not.

Agile is limited for static environments, as for instance stated by AP3 *“If one has very stable requirements and less challenges, then agile makes no sense. If one knows exactly what they want at the end and if one can foresee what will happen – so there are no surprises – then it is better to run the project without Agile, because one has then more control”*; or as stated by AP4 *“if I am moving in a static environment, it can be that Agile is contra-productive”*.

Even if it is easy to implement Agile, as it is just seen as a management model, its applications get limited when it has to work within existing structures. This has been stated for instance by AP3: *“we have a hard nut to crack with relatively established structures”*, by AP4: *“in this respect, is Agile and the use of Agile related to what type of project I got. Do I have a bureaucratic project, then it might be not the right solution”*. Especially existing autocratic structures which do not allow the creation of self-organised teams and which do not embrace change have been indicated as a major limitation by the APs. AP3 explained a personal example where they did found out by accident that the controlling management system, of the organisation where they had to implement an Agile method, hindered the team members to take responsibility, resulting consequently that this *“law and order”* PM system hindered the team in becoming self-organised. Hence existing, bureaucratic and hierarchic structures limit Agile PM methods.

Another difficulty for Agile is to convince the client. As it is difficult to explain to the customer *“we have no plans, we just do it”* (AP2). Therefore it is important that there is an *“agreement with the client, the customer that they are happy to*

*operate an Agile process*” (AP6). This requires according to AP4 a client who is more following the approach *“I would like to develop this project together with you and we learn during the project how the project can be improved”*. Existing contractual structures which embrace *“predicted project management [...] or deterministic project management instead of Agile project management”* (AP5) cause difficulties for implementation. An example for this has been provided by AP2, who explained that they did finish a task and the customer was satisfied, but the quality manager came afterwards and said: *“The customer is satisfied, but now I want to look again through it with my quality glasses and I compare it now with the contract”*. This creates a dilemma, because on the one hand a lot of tasks have been performed, which have been not in the contract to satisfy the customer, on the other hand a lot of tasks have been also neglected, which did satisfy the PM company. If the PM company has to provide, on the one hand all tasks from the contract, and on the other has to perform also additional things, the win-win situation will get lost. Hence the *“weakness tend to be that it takes a particular mind-set of senior manager to accept that what is going to be delivered”* (AP5).

This creates a limitation for the “plan as you go” principle of Agile. The issue here is that after some level *“one has to live with the results of the sprints before”* (AP1), because the constant changes produce also additional costs, as for instance stated by AP3 *“Yes, working iterative is important, especially in the software environment, but it is related to some costs, because one has to change things from time to time”*. To overcome this issue, AP3 started using change requests, which is against the Agile value *“customer collaboration instead of contract negotiation”*. Another concern about the claimed agility and flexibility has been identified by PMP4, who stated *“I’m a bit concerned about that you welcome change. I mean if you always change then you never get the task done well”*.

In fact, this indication from someone who never heard about Agile before was also confirmed by AP3. AP3 experienced in one project *“that the architecture run away”* from them, because the team was too busy in self-realisation. Hence the fact that changes are embraced can only work, when the PM has achieved the creation of a self-organised team, who acting a disciplined way. Otherwise it will

result in a chaotic environment, which will not be perceived as successful. Hence there is always a need for some linearity within a project, which cannot be provided through using purely Agile models.

However embracing change reaches its physical limits within the project life cycle of a construction project after some time. This has been recognised by all APs and PMPs. AP1 stated that the problem is caused because of *“the relationship to the execution, because I can manage quite well the shell construction, but if the room concept is suddenly changing, then is the one or other column wrong”*. AP3 explained further that embracing change *“is not so excellent”*, because *“if one starts to build a foundation and afterwards one finds out the building will be three times higher than expected [...], for that the foundation needs to look different”*. Therefore one has of course to *“consider here that Agile methods are developed in an environment where it was about component development”* (AP4).

Even if the environment from IT projects and the environment of construction projects are similar, i.e. dynamic, the major difference between those two project types lies therein that it is not easy to divide a construction project into single individual components, which can then be put together afterwards. Agile methods have also *“things like involving architecture or involving design”* which *“does not really fit for construction”* (AP3). These things do not work for construction, because of the high separation between design and execution, and it is not possible to parallelise or synchronise these phases with each other. The reason for this has been explained for instance by PMP3 as follows:

*“What is interesting for construction projects, because that has really impressed me, this claim of Agile to say: “changes are welcome”. Actually changes are not welcomed in construction, because it is mostly very difficult to make customers - so owners - clear that he has to make decisions today, which will have an impact in a ¾ year. For example, the structural design is calculated from top to bottom [...] but I am building from bottom to top; and actually the customer or user has to determine today in detail which loads he approaches, but the construction of this whole issue takes place after a year”*.

Quite similar examples have been provided by all PMPs. What stands out here is that a construction project cannot escape from the traditional waterfall model, which limits the implementation of iterative or incremental PM models holistically.

In addition, the PMPs have stated that their desire is to create a static environment for the execution (PMP3, PMP5, PMP6, PMP7 and PMP8). The aim is to have as few changes as possible during the execution of the project. The reasons for this have been articulated for instance by PMP4: *“there is a point in time where you can’t or you shouldn’t make any more changes as any change would then affect budget and schedule”*, by PMP5 *“after some degree I say, I have to discipline my customer, because it was also on your slides, changes are welcome”* or by PMP6: *“At the preliminary design anyone can change as he wants and when it is finished, closed, then in the execution design, in the installation design, there will be no changes anymore, because one can afford it and it makes also no sense”*.

Hence changes are welcomed, but only at early project stages. The later the project moves, the higher will be the impact of modifications and changes. The result is that there is very low potential in transferring Agile PM methods from IT to construction, so that a project could be managed holistically. Even if the execution of the project is not static, Agile PM methods will find very low acceptance, because their dynamism is not in line with the desire to create a static environment during the execution.

Other limitations of Agile PM models have been related to the team. According to AP3 one of the reasons why Agile fails is, *“the so called adrenalin junkies”* who think that Agile means to react to everything rather than the planning of anything. This results in a chaotic sequence of activities and chaotic project termination. In addition AP3 explained also that it makes no sense to implement Agile for small teams, which consist of less than eight project participants. *“There one does not need any methodologies. There one works autocratically and it works well”* (AP3).

Another perspective on the team size has been provided by AP2 who stated that *“the problem is, if the task gets too big. [...] I cannot work with Agile with a project team of 30 people”*. In addition AP1 explained also that Agile methods are limited for intercultural projects where the project participants are from different countries, because *“one has different values, backgrounds”*. In such a case it is already difficult enough to create a team, consequently building a team which is self-organised seems almost impossible. Considering that projects are constructed with a lot of parties involved and eventually with participants from different countries (as explained in section 5.1.3.4), the result is that the existing conditions of construction projects are not supportive for Agile models.

The other aspect is that *“one needs the people who want to go with you: the people who are Agile during the project”* (AP2). Considering the conservative character of the construction industry and consequently the resistance to change, results actually in the same weaknesses for implementing Agile as Lean construction is facing currently, which have been discussed in section 5.1.3.4.

A further challenge of Agile has been related to the management. When Agile is implemented, the management needs to accept that the team is working on its own and is self-organised. This takes some time and consequently *“at the beginning everything will be slower”*(AP3). The APs said that especially in autocratic project organisations it will be difficult to get the patience of the management, which results in that the management interfere into the project processes and does not allow the self-organisation of the team.

Further difficulties to establish an integrated and self-organised team for Agile methods are the same ones which have been widely discussed in section 5.1.3.4 for Lean construction.

### **5.1.5 Summary of interview findings**

Through the interview findings, objective two, which was to identify the strengths and weaknesses of traditional, PM, Lean and Agile in relation to the management of complex construction projects, could be answered. In addition, an instrument will be developed out of all interview findings, to achieve objective three, which wants to explore the perceptions of traditional PM, Lean and Agile among industry practitioners. This third objective will also validate the transferability of the interview findings.

The findings indicated a wide variety of different concepts, principles, strengths and weaknesses for each paradigm. The next section will prove the transferability and the universality of the interview findings.

## 5.2 Survey findings

First, the results of the central tendency tests for the independent variables will be shown. Then the internal consistency analysis will be performed. After this the central tendency test for dependent variables will be presented. Finally, the results of the MANOVA statistics will be shown.

### 5.2.1 Central tendency test for the independent variables

The following sections will show the results of the central tendencies for the independent variables.

#### 5.2.1.1 *Years of Experience*

The following table gives an overview about the level of experience which the participants had when responding to the survey.

Table 5-1 experience of survey participants

How long is your work experience	Count
I have no work experience	8
up to 6 years	63
between 6 to 10 years	34
11 years or more	116

The persons who have no work experience in Table 5-1 will be not considered for further statistical analysis as mentioned in section 4.2.6. Hence the new number of survey participants is as follows (Figure 5-5):

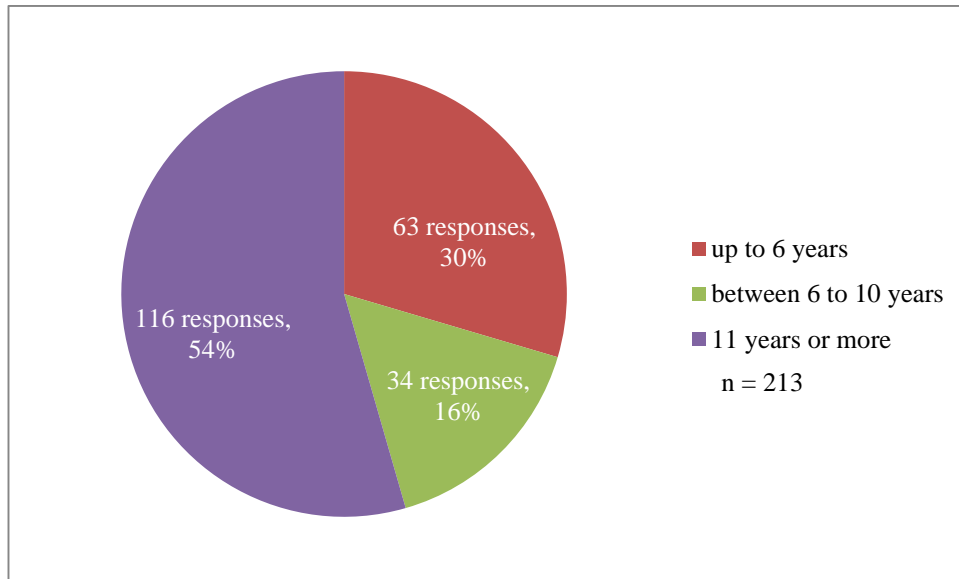


Figure 5-5 survey: work experience

### 5.2.1.2 Project experience

The following table gives an overview about the respondent's project experience.

Table 5-2 survey: Project experience

Project type	Level of experience					MEAN
	1	2	3	4	5	
7. a. Housing, Hostels, Hotels...	25	41	77	42	28	3.033
7. b. Office, Professional Buildings, Laboratories...	21	52	58	45	37	3.117
7. c. Retail, Shopping, Hospital, Energy Providers...	50	54	46	36	27	2.700
7. d. City Halls, University, Museum, Theatre...	77	38	50	32	16	2.399
7. e. Sport Facilities, Parks, Resorts...	109	49	29	20	6	1.897
7. f. Streets, Roads, Bridges, Rail routes...	99	49	27	17	21	2.117
7. g. Community, Church, Courthouse...	123	48	32	7	3	1.681

Key for frequencies: 1 = no experience; 2 = A little experience; 3 = Reasonable experience; 4 = High experience; 5 = A great deal of experience

Table 5-2 shows that the highest level of project experience is for project types, which are related to living (e.g. housing, hotels), work (e.g. office, professional buildings) and service (e.g. retail, shopping, hospitals).

### 5.2.1.3 Project context

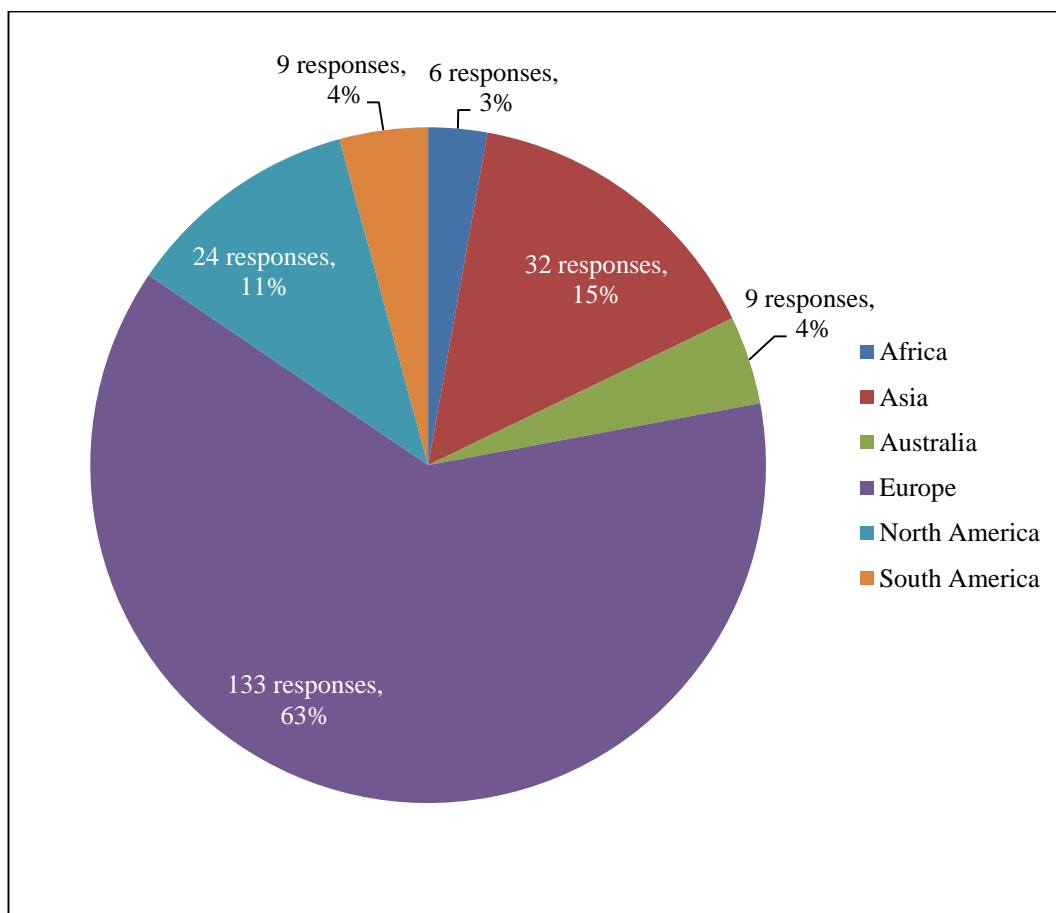


Figure 5-6 survey: project context

Figure 5-6 shows that the highest responses have been from Europe (65%). However, what stands out here is that the sample shows different populations for different continents.

#### 5.2.1.4 Parties involved in construction

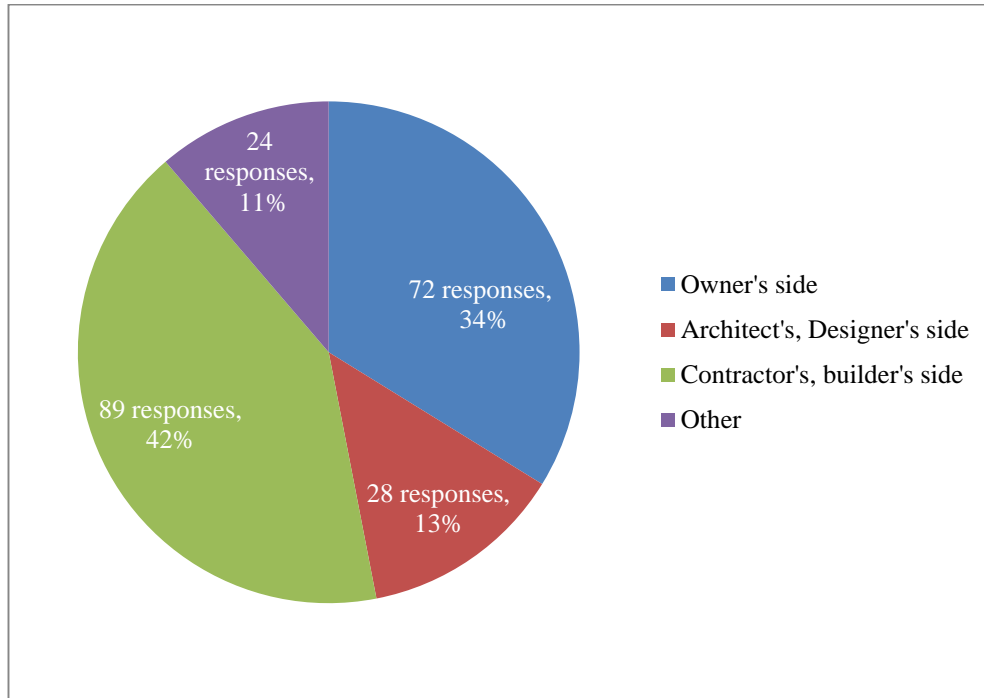


Figure 5-7 survey: occupational culture

Figure 5-7 shows that most of the respondents have been from the contractor's side and owner's side. 28 respondents indicated that they are from the architect's or designer's side. 24 respondents did not locate themselves to an involved party in construction and have stated "other". Those "other" participants are academics (8) and consultants (16).

### 5.2.2 Internal consistency analysis

First the Cronbach's  $\alpha$  for all dependent variables will be done. Then, it will be performed for each group of dependent variables (construction environment, PM, Lean and Agile) separately. Finally, the findings will be summarised.

#### 5.2.2.1 Cronbach's $\alpha$ for all dependent variables together

The case processing summary indicated that eleven responses have been excluded for the analysis of the Cronbach's  $\alpha$  for all (73) dependent variables together. These excluded cases belong to those respondents who have chosen in question

4.a (I have heard about Lean Construction) “disagree” or “strongly disagree”, because if those respondents have never heard about Lean construction they might be not able to answer the questions 4.d (Lean production techniques can be directly transferred to the construction context) and 4.q. (Lean construction is more useful for builders).

When analysing the Cronbach’s  $\alpha$  value for all dependent variables together, it appeared to have good internal consistency  $\alpha_1 = 0.880 > 0.700$ .

However, in further statistics, the four groups of questions will be viewed separately. For that reason the Cronbach’s  $\alpha$  has to be analysed separately, too.

### 5.2.2.2 Cronbach’s $\alpha$ for construction environment

No responses had to be neglected for calculating the Cronbach’s  $\alpha$ . When analysing the Cronbach’s  $\alpha$  value for the dependent variables which are related to the construction environment (11 dependent variables), it appeared to have poor internal consistency  $\alpha_{CE1} = 0.690 < 0.700$ .

Therefore the item total statistics had to be considered, to identify if there are potential questions which could be deleted to increase the  $\alpha$ -value. The item total statistics table is shown below:

**Table 5-3 Cronbach's  $\alpha$  construction environment - Item Total Statistics**

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
2. a. Construction is a highly competitive industry.	19.80	21.914	.034	.070	.710
2. k. Each construction project is unique.	19.45	20.607	.119	.211	.709

Table 5-3 shows an extract of the whole item-total statistics table given from SPSS. The focus of this table was only on the rows which would have a positive impact on the  $\alpha$ -value. Hence item 2.a or 2.k can be deleted to improve the internal consistency. It has been decided to not consider 2.k for further statistical

calculations, as this statement is widely common in practice and can be widely found in literature.

Hence, when reducing the number of dependent variables down from 11 to ten (deleting item 2.k), it appeared to have sufficient internal consistency  $\alpha_{CE2} = 0.709 > 0.700$ .

#### **5.2.2.3 Cronbach's $\alpha$ for PM**

No responses had to be excluded. When analysing the Cronbach's  $\alpha$  value for the dependent variables, which are related to PM (23 dependent variables), it appeared to have good internal consistency  $\alpha_{PM} = 0.757 > 0.700$ . No further actions are required.

#### **5.2.2.4 Cronbach's $\alpha$ for Lean construction**

Eleven responses had to be excluded, because of the reasons mentioned in section 5.2.2.1. When analysing the Cronbach's  $\alpha$  value for the dependent variables, which are related to Lean Construction (23 dependent variables), it appeared to have sufficient internal consistency  $\alpha_{LC1} = 0.710 > 0.700$ . No further actions are required.

#### **5.2.2.5 Cronbach's $\alpha$ for Agile PM**

No responses had to be excluded. The Cronbach's  $\alpha$  analysis for the dependent variables which are related to Agile PM (16 dependent variables) appeared to have poor internal consistency  $\alpha_{APM1} = 0.670 < 0.700$ .

The total item statistics have to be considered, to see if it is possible to improve the Cronbach's  $\alpha$  through reducing the number of items. The results can be seen in Appendix 4.

The total-item statistics do not indicate any possibility for increasing the  $\alpha$ -value. However, one can still use an iterative process to check any possibilities for increasing the internal consistency. This can be achieved through deleting more

than one question at the same time and see what the outcomes are. Because of the questions 4.a and 4.b the questions 5.a (I have heard about Agile PM) and 5.b. (I know what Agile PM is) have been included. Including these questions was more related to structural issues, but the questions about Agile PM do not require any knowledge about Agile PM methods, as they have been asked in a more generic way and construction context. Due to this background, there is a possibility that those questions are the reason for poor internal consistency. Therefore the Cronbach's  $\alpha$  has been calculated without these two dependent variables (5.a and 5.b). Hence when deleting the dependent variables 5.a and 5.b and reducing the number of the dependent variables down from 16 to 14, it appeared to have better internal consistency, as:  $\alpha_{APM2} = 0.696 > 0.670 = \alpha_{APM1}$

However,  $\alpha_2 = 0.696$  is still below 0.700. Therefore the item – total statistics have to be considered, again. The result is as follows.

**Table 5-4 Cronbach's  $\alpha$  Agile PM - Item Total Statistics**

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
5. n. It is not possible to have the design and the building phase in parallel.	27.20	28.388	.190	.202	.702

There is only one dependent variable (see Table 5-4), which will have a positive effect on the  $\alpha$ -value. The above table indicates that the internal consistency can be improved through deleting item 5.n. This action has been undertaken. As a result, when reducing the number of dependent variables down from 16 to 13, through deleting item 5.a, 5.b and 5.n, it appeared to have sufficient internal consistency  $\alpha_{APM3}=0.702 > 0.700$ .

#### **5.2.2.6 Summary Cronbach's $\alpha$**

When deleting the questions 5.a and 5.b from the set of Agile PM questions, the questions 4.a and 4.b can be also taken out from the set of Lean construction questions, because now they do not fit any more into the overall structure of the

initial survey. For doing this, again 11 responses will be not considered, because of the issues explained in section 5.2.2.1. Hence, now question 4.a and 4.b have to be seen as preliminary questions, which have been used to refine the survey results.

When reducing the dependent variables down from 23 to 21, through deleting the dependent variables 4.a and 4.b, it appeared that the internal consistency has slightly decreased for the questions about Lean construction, as  $\alpha_{LC1} = 0.710 > \alpha_{LC2} = 0.707$ . However  $\alpha_{LC2} = 0.707 > 0.700$  and therefore it is still sufficient.

After having so many changes, the internal consistency for all dependent variables should be calculated again, to see if there has been any further improvement or not.

When reducing the items down from 73 to 67 it appeared to have improved internal consistency, because  $\alpha_1 = 0.880 < \alpha_2 = 0.886 > 0.700$ .

The following table gives an overview about all items which have been deleted.

**Table 5-5 Cronbach's  $\alpha$  summary of actions**

Item No	Item Name
2.k	Each construction project is unique.
4.a	I have heard about Lean Construction
4.b	I know what Lean Construction is.
5.a	I have heard about Agile PM.
5.b	I know what Agile PM is.
5.n	It is not possible to have the design and the building phase in parallel.

Hence, the dependent variables shown in Table 5-5 will not be considered for further statistical calculations, because they have a negative impact on the internal consistency of the survey.

### 5.2.3 Central tendency test for the dependent variables

The following sections will show the results of the central tendency test for the dependent variables. The first four sections will show the central tendencies of the four groups of dependent variables (construction environment, PM, Lean, and Agile). Finally, a summary of the findings will be presented.

#### 5.2.3.1 Construction environment

The comparison between the interview findings and the results of the survey for the dependent variables which are related to the construction environment are shown in Table 5-6.

**Table 5-6 central tendency tests - construction environment**

	Count					Valid	Missing	Central Tendency Tests				Interview findings
	1	2	3	4	5			Mean	Median	Mode	Std. Deviation	
2.a. Construction is a highly competitive industry.	128	70	8	6	1	213	0	1.507	1	1	0.744	< 3
2.b. The construction environment is focused on the "lowest price wins" attitude.	65	115	22	9	2	213	0	1.911	2	2	0.811	< 3
2.c. Construction has a claim management culture, where one first provides an offer with a low price and then seeks to make the profit with claims.	57	107	35	12	2	213	0	2.038	2	2	0.862	< 3
2.d. The construction environment is very focused on the short term.	57	74	44	36	2	213	0	2.305	2	2	1.071	< 3
2.e. The character of construction means there are often changes in the parties involved in projects.	59	102	36	14	2	213	0	2.052	2	2	0.891	< 3
2.f. Construction is like a fight from the beginning, which makes it much more difficult to manage in comparison with other industries, where partnerships are used more readily.	38	90	54	27	4	213	0	2.385	2	2	0.982	< 3
2.g. Construction is very conventional in its character.	36	101	50	25	1	213	0	2.315	2	2	0.906	< 3
2.h. Today's construction projects show increasing levels of complexity.	113	84	14	1	1	213	0	1.559	1	1	0.682	< 3
2.i. The separation between design and execution creates difficulties in construction which are not present in other industries.	76	85	31	17	4	213	0	2.005	2	2	0.998	< 3
2.j. Many parties are involved in a construction project.	141	66	5	1	0	213	0	1.371	1	1	0.557	< 3
<b>Key: Strongly agree = 1; Agree = 2; Neutral = 3; Disagree = 4; Strongly disagree = 5</b>												

Hence all interview statements have been in line with the findings from the survey. No further interpretations are required.

### 5.2.3.2 Project Management

The central tendencies for the dependent variables which are related to PM are shown in Table 5-7.

**Table 5-7 central tendency tests – PM**

	Count					Valid	Missing	Central Tendency Tests				Interview findings
	1	2	3	4	5			Mean	Median	Mode	Std. Deviation	
3.a. PM is something universal, i.e. it does not depend in which industry the project is undertaken (project is a project is a project).	25	71	29	70	18	213	0	2.930	3	2	1.213	3
3.b. PM provides the required knowledge about construction to the clients.	26	90	46	43	8	213	0	2.610	2	2	1.057	<3
3.c. A holistic view of the project is required for the client, which starts at the first project idea through to handover to operations.	92	93	23	4	1	213	0	1.728	2	2	0.765	<3
3.d. PM creates a link between the client's organisation and the project.	62	132	15	4	0	213	0	1.817	2	2	0.636	<3
3.e. PM helps the client to articulate her/his vision.	48	109	40	14	2	213	0	2.122	2	2	0.866	<3
3.f. PM communicates the client's expectations to the other project participants.	60	116	30	6	1	213	0	1.930	2	2	0.758	<3
3.g. PM is independent of design and execution perspectives, which enriches the project with a different perspective.	15	66	56	65	11	213	0	2.958	3	2	1.052	<3
3.h. PM provides the right information to the right people with the relevant level of detail.	52	98	40	21	2	213	0	2.169	2	2	0.941	<3
3.i. The aim of PM is to ensure actions are undertaken to meet a developed plan.	81	113	12	6	1	213	0	1.746	2	2	0.728	<3
3.j. The expectations on the project will change over the project life cycle.	57	93	37	22	4	213	0	2.169	2	2	1.000	<3
3.k. Construction projects are characterised with uncertainties, which create difficulties to go through a developed plan until the end.	84	93	18	16	2	213	0	1.869	2	2	0.922	<3
3.l. It will be good to avoid any changes during the execution phase of a project.	76	75	29	28	5	213	0	2.113	2	1	1.106	<3
3.m. Planning everything in detail in advance is inappropriate for construction projects, as they have to cope with high levels of change.	31	58	29	61	34	213	0	3.042	3	4	1.336	<3
3.n. Many uncertainties are caused by the external environment.	34	100	47	26	6	213	0	2.390	2	2	0.987	<3
3.o. Uncertainties influence the PM system.	46	111	34	17	5	213	0	2.174	2	2	0.938	<3
3.p. One of the biggest challenges in construction projects is to manage change.	96	100	11	6	0	213	0	1.657	2	2	0.707	<3
3.q. Uncertainties can be caused by the client.	73	114	19	5	2	213	0	1.822	2	2	0.762	<3
3.r. Uncertainties can cause change(s).	81	118	13	0	1	213	0	1.695	2	2	0.626	<3
3.s. On large scale, complex projects, the schedule quickly loses transparency.	44	80	48	37	4	213	0	2.423	2	2	1.059	<3
3.t. The focus on the lowest price results in the best possible party not always being contracted.	102	79	22	10	0	213	0	1.718	2	1	0.833	<3
3.u. The project participants mainly follow their own economic interests.	81	107	18	7	0	213	0	1.770	2	2	0.739	<3
3.v. PM is good at mitigating the interfaces between different project phases.	35	101	56	17	4	213	0	2.315	2	2	0.906	<3
3.w. PM faces difficulties in managing the interfaces between the trades.	22	112	42	32	5	213	0	2.465	2	2	0.949	<3

**Key: Strongly agree = 1; Agree = 2; Neutral = 3; Disagree = 4; Strongly disagree = 5**

The variable 3.g (mean = 2.958) is still in line with the interview findings, but considering that the value is so close to three, it might need further interpretation. The reason why 3.g is so close to be classed as “neutral” can be related to the respondent’s background in regard to the parties involved in construction. It might be that the PMPs see themselves differently from how their environment

perceives them. However, this issue will be further explored when undertaking the MANOVA. At this stage it can be concluded that the tendency is direction agreement.

The variable 3.m (mean = 3.042) is not in line with the interview findings. Also here, is the value almost at the midpoint and could be seen as neutral. The current practice of PM is in contrast to this statement. Hence people who are PM enthusiasts might not agree with it. Another reason why this statement is not in full agreement might be related to the desire of the parties involved to plan everything in detail and stick to that plan. However, the respondents agreed on question 3.q and 3.r which shows that they know that uncertainties will create changes and uncertainties cannot be controlled. This gives an indication that the parties involved in construction expect detailed planning, but they expect also flexibility and forecasting measures within their plan, which will allow coping with change in an appropriate way.

### 5.2.3.3 Lean construction

The central tendencies for the dependent variables which are related to Lean construction are shown in Table 5-8.

**Table 5-8 central tendency tests - Lean construction**

	Count					Valid	Missing	Central Tendency Tests				Interview findings
	1	2	3	4	5			Mean	Median	Mode	Std. Deviation	
4.c. Production (e.g. manufacturing a car) and construction (e.g. managing a complex construction project) is comparable.	24	74	36	61	18	213	0	2.883	3	2	1.190	3
4.d. Lean production techniques can be directly transferred to the construction context.	18	80	37	53	14	202	11	2.827	3	2	1.126	3
4.e. Construction projects can be seen as temporary production systems, where the focus is on the building as a product.	47	121	20	21	4	213	0	2.127	2	2	0.931	<3
4.f. There is a huge amount of waste in construction.	100	86	20	6	1	213	0	1.695	2	1	0.793	<3
4.g. Having a good team is essential for success.	159	47	7	0	0	213	0	1.286	1	1	0.521	<3
4.h. The interfaces between the trades do not work well together.	34	72	75	27	5	213	0	2.516	3	3	0.984	<3
4.i. Dividing the work into smaller elements reduces complexity.	49	90	43	24	7	213	0	2.296	2	2	1.047	<3
4.j. During the execution phase changes should be kept to a minimum.	77	101	27	7	1	213	0	1.845	2	2	0.801	<3
4.k. The current most used types of contracts are not supportive for cooperation.	60	96	43	12	2	213	0	2.061	2	2	0.891	<3
4.l. The number of projects using contracts where the profit and the risks are shared is very low in the industry.	64	99	41	7	2	213	0	1.986	2	2	0.844	<3
4.m. The construction environment is characterised by high levels of distrust.	57	102	45	9	0	213	0	2.028	2	2	0.806	<3
4.n. Working with the same partners from project to project is the ideal scenario.	37	106	43	24	3	213	0	2.296	2	2	0.933	<3
4.o. ...But it cannot be achieved.	29	66	66	43	9	213	0	2.704	3	2a	1.069	<3
4.p. Not reacting to customer wishes, which cause changes, is not an option in construction, because the relationship between client and other project participants is far more personal than in other sectors.	27	86	61	33	6	213	0	2.554	2	2	0.992	<3
4.q. Lean construction is more useful for builders.	17	64	77	34	10	202	11	2.782	3	3	0.989	<3
4.r. The construction environment is characterised by high levels of conflicts.	40	123	36	14	0	213	0	2.113	2	2	0.781	<3
4.s. Only a few things can be prefabricated in construction projects.	13	42	34	95	29	213	0	3.399	4	4	1.131	<3
4.t. Construction is only dealing with prototypes.	10	37	53	91	22	213	0	3.366	4	4	1.036	<3
4.u. Even if the constructed product is static, the environment of construction is highly dynamic.	62	117	27	7	0	213	0	1.901	2	2	0.736	<3
4.v. Construction means to build things in an ill-defined environment somewhere in the world under unsure circumstances.	16	71	67	47	12	213	0	2.850	3	2	1.031	<3
4.w. Managing a construction project requires flexibility in some project stages.	87	115	8	2	1	213	0	1.662	2	2	0.643	<3

Key: Strongly agree = 1; Agree = 2; Neutral = 3; Disagree = 4; Strongly disagree = 5; a. Multiple modes exist. The smallest value is shown

The Lean construction dependent variables show that most of the interview findings are in agreement with the survey respondents, except two.

The reason for 4.s might be related to the wording of the survey, i.e. what is “few things”, especially for whom? Hence LP4 explained this issue in regard to the so

called “*trade borders, who is doing what*”. Out of the interview findings it was concluded that the high separation between the phases and the high number of involved planners limits the usage of prefabricated elements. However, to conclude here, practice perceives this issue in the opposite way. It is limited yes, but only for a few things, instead of only a few things can be prefabricated.

Variable 4.t indicates also that this interview finding is not in line with the survey respondents. The issue here is that construction is dealing with unique projects but not with prototypes. The difference is that a prototype will be constantly improved and tested until the product can be finalised and send to mass production. One has several chances to improve a prototype. In construction, one has only one chance. Hence, this interview finding will be also excluded when developing the AgiLean PM framework.

#### 5.2.3.4 Agile PM

The central tendencies of the last group of dependent variables is shown in Table 5-9.

**Table 5-9 central tendency tests - Agile PM**

	Count					Valid	Missing	Central Tendency Tests				Interview findings
	1	2	3	4	5			Mean	Median	Mode	Std. Deviation	
5.c. Construction projects are dynamic endeavours.	70	116	25	2	0	213	0	1.808	2	2	0.670	<3
5.d. A lot of changes can be related to the client.	59	122	24	8	0	213	0	1.911	2	2	0.731	<3
5.e. A lot of changes can be also related to external influences, i.e. uncertainties/risks.	53	140	14	6	0	213	0	1.873	2	2	0.643	<3
5.f. Projects require not only planning but also situation-related acting.	85	120	8	0	0	213	0	1.638	2	2	0.554	<3
5.g. Breaking the work down into smaller elements or activities helps in reducing complexity.	56	101	29	21	6	213	0	2.155	2	2	1.014	<3
5.h. Changes are something which are unavoidable in construction projects.	55	103	29	22	4	213	0	2.141	2	2	0.980	<3
5.i. The level of uncertainty goes down the closer the project comes to the end.	69	94	25	23	2	213	0	2.038	2	2	0.980	<3
5.j. At present there are too many PM systems that are too rigid and therefore not really suitable for the initial stages of the project.	33	77	85	17	1	213	0	2.418	2	3	0.863	<3
5.k. The project team is more motivated if they can work with low levels of disruptions.	60	109	38	5	1	213	0	1.958	2	2	0.773	<3
5.l. Existing organisational hierarchies limit the ability to create self-organised teams.	41	91	54	23	4	213	0	2.333	2	2	0.970	<3
5.m. If you always change things then you never get the task done well.	33	99	47	32	2	213	0	2.394	2	2	0.953	<3
5.o. Changes are welcomed, but only at early stages of the project.	30	73	59	45	6	213	0	2.643	3	2	1.053	<3
5.p. The further into the project life cycle, the higher will be the impact of changes.	94	73	26	15	5	213	0	1.892	2	1	1.025	<3

**Key: Strongly agree = 1; Agree = 2; Neutral = 3; Disagree = 4; Strongly disagree = 5**

All interview findings have been in agreement with the survey respondents.

#### 5.2.3.5 Summary of the central tendency tests

The following table shows the dependent variables, which have not been in line with the interview findings.

**Table 5-10 central tendency tests – summary**

Variable	Mean	Mean
	Survey	Interview
3. m. Planning everything in detail in advance is inappropriate for construction projects, as they have to cope with high levels of change.	3.042	< 3
4. s. Only a few things can be prefabricated in construction projects.	3.399	< 3
4. t. Construction is only dealing with prototypes.	3.366	< 3

The above shown variables could not be validated and will not be considered in the initial way for the derivation of the AgiLean PM framework.

The findings of this section allowed to achieve objective three. Hence, this section explored the perceptions of traditional PM, Lean and Agile among industry practitioners. The findings are based on the interview data. Hence transferability has been validated for the interview findings, except for the variables shown in the above table.

#### **5.2.4 MANOVA**

The following sections will show the results of the MANOVA, which has been performed for the hypotheses shown in section 4.2.6.

##### ***5.2.4.1 H1: There is no relationship between a respondent's attitudes towards the construction environment and the project context in which they work.***

The MANOVA analyses showed no statistically significant difference at the  $p < 0.05$  level for the variables which are related to the construction environment:  $H1_{Wilks' \text{ Lambda}} = .741$ ,  $F(50, 906.383) = 1.233$ ,  $p = .133$ . Thus H1 was confirmed.

##### ***5.2.4.2 H2: There is no relationship between a respondent's attitudes towards PM and the project context in which they work.***

The MANOVA revealed no significant multivariate main effect for the variables which are related to PM:  $H2_{Wilks' \text{ Lambda}} = .513$ ,  $F(115, 912.699) = 1.157$ ,  $p = .137$ . H2 has been confirmed.

##### ***5.2.4.3 H3: There is no relationship between a respondent's attitudes towards Lean construction and the project context in which they work.***

The MANOVA statistic showed that there was a statistically significant difference between the respondent's attitudes towards Lean construction and the project

context in which they work:  $H3_{Wilks'} \text{ Lambda} = .445$ ,  $F(105, 865.272) = 1.483$ ,  $p = 0.002 > 0.05$ . Thus  $H3$  has been rejected.

To be able to identify the reason for rejection, the Post Hoc test, Hochberg's GT2 has been undertaken. The results of the Post-hoc test are provided in Table 5-11.

**Table 5-11 MANOVA - Post Hoc test for H3**

					95% Confidence Interval		
Dependent Variable		Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound	
4. c. Production (e.g. manufacturing a car) and construction (e.g. managing a complex construction project) is comparable.	Europe	Africa	.27	.484	1.000	-1.17	1.70
		Asia	-.26	.236	.989	-.96	.43
		Australia	.05	.400	1.000	-1.14	1.23
		North America	.89*	.258	.010	.13	1.66
		South America	.16	.400	1.000	-1.03	1.34
4. d. Lean production techniques can be directly transferred to the construction context.	Europe	Africa	.57	.450	.966	-.76	1.90
		Asia	-.36	.219	.781	-1.01	.28
		Australia	.01	.371	1.000	-1.09	1.11
		North America	.99*	.240	.001	.28	1.70
		South America	-.10	.371	1.000	-1.20	1.00
4. i. The number of projects using contracts where the profit and the risks are shared is very low in the industry.	Europe	Africa	-.33	.343	.997	-1.35	.68
		Asia	-.17	.167	.996	-.66	.33
		Australia	.00	.283	1.000	-.84	.84
		North America	.62*	.183	.012	.08	1.17
		South America	.11	.283	1.000	-.73	.95
Based on observed means.							

Table 5-11 shows that three out of twenty items of the instrument show statistical significance. All of the items show that there is a statistical significance between Europe and North America, i.e. the perceptions about Lean construction depend if the respondent has been from Europe or from North America. It will be helpful to plot those items where statistical significance has been identified, to be able to better interpret these findings. The first two items are shown in the following figure.

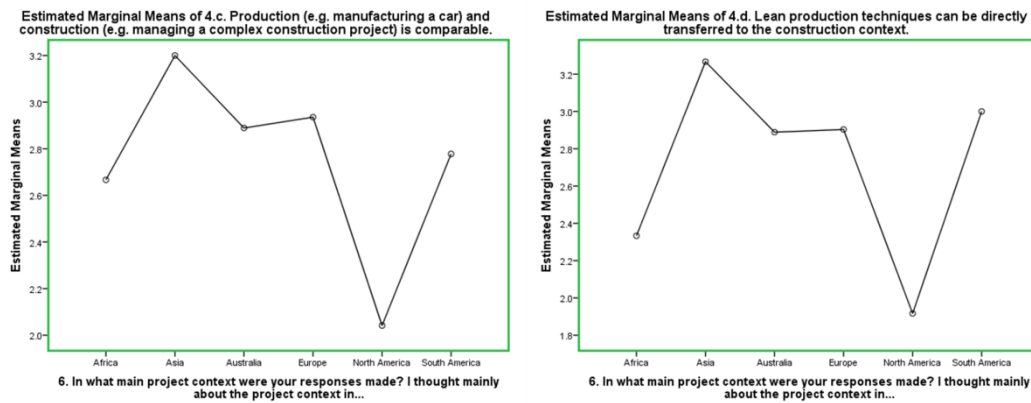


Figure 5-8 MANOVA – Post Hoc - H3 - 1

The plots 4.c and 4.d in Figure 5-8 show outstanding differences between Europe and North America. This could be related to the degree of Lean construction development, because it is different within those continents. If one considers the Lean construction history, most of the key developments took place in North America. Hence, the degree of awareness and knowledge might cause different perceptions between the industries. However, the interview findings reflect also that there are two different types of Lean construction advocates. The survey strengthens that the advocates who believe that Lean production can be directly transferred to the construction context are more common in North America, rather than in other continents.

The last item is shown in the following figure.

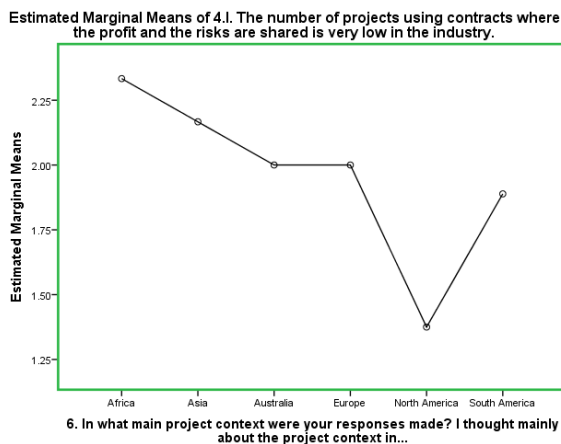


Figure 5-9 MANOVA – Post Hoc - H3 - 2

Figure 5-9 shows statistical significance between Europe and North America. The plot indicates clearly that the questionnaire respondents are in agreement with the interview finding, only the level of agreement depends on the continent context.

To conclude so far, H3 has been partly rejected in the case of North America. However, the responses made by North America are still in line with the interview findings. The findings indicate that the perceptions about Lean construction concepts and principles are in general everywhere the same, but differ for the Lean philosophy. Because people from North America tend to believe that Lean production can be directly transferred to the construction context and people from the rest of the world do not. Considering that this study does not want to challenge the philosophy of Lean, but rather wants to focus on concepts and principles, the result is that the interview findings can be used as they are (without those stated in section 5.2.3.5). This in turn results in that the assumptions made about Lean construction, which will be used for the derivation of the AgiLean PM framework, are in general universally applicable, but seem to find lesser agreement in North America. This might result in that the level of acceptance for the AgiLean PM framework could be lesser in North America than in other continents.

***5.2.4.4 H4: There is no relationship between a respondent's attitudes towards Agile PM and the project context in which they work.***

The MANOVA test indicates that there is no statistical significance at the 5% level between the perceptions about Agile PM and the continent of the project context:  $H1_{Wilks' \Lambda} = .672$ ,  $F(65, 925.478) = 1.248$ ,  $p = .095$ . Thus H4 has been confirmed.

***5.2.4.5 H5: There is no relationship between a respondent's attitude towards the construction environment and their involvement in construction.***

The MANOVA statistic showed that there was no statistically significant difference between the respondent's attitudes towards the construction environment and their location within the parties involved in construction:  $H5_{Wilks' \Lambda} = .856$ ,  $F(30, 587.715) = 1.064$ ,  $p = 0.375$ . Thus H5 has been confirmed.

**5.2.4.6 H6: There is no relationship between a respondent's attitude towards PM and their involvement in construction.**

The MANOVA test indicates that there is statistical significance at the 5% level between the perceptions about PM and the respondent's involvement in construction:  $H6_{Wilks' \text{ Lambda}} = .589$ ,  $F(69, 559.512) = 1.574$ ,  $p = .003 < .05$ . Thus H6 has been rejected.

The Post Hoc test identified significance between the owner representatives and contractors/builders and the respondents who have classed themselves as "Other". The results of the Post-hoc test for the contractors/builders are provided in Table 5-12. The results of the Post Hoc test for the "Others" are in Table 5-12.

**Table 5-12 MANOVA - Post Hoc - H6 (1)**

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
3. h. PM provides the right information to the right people with the relevant level of detail.	Owner's side	Architect's, Designer's side	-.07	.206	1.000	-.62	.48
		Contractor's, builder's side	-.42*	.147	.028	-.81	-.03
		Other	-.49	.218	.150	-1.06	.09
3. r. Uncertainties can cause change(s).	Owner's side	Architect's, Designer's side	-.07	.137	.995	-.44	.29
		Contractor's, builder's side	.28*	.097	.026	.02	.54
		Other	.15	.145	.872	-.23	.54

Based on observed means.  
The error term is Mean Square (Error) = .880.  
\*. The mean difference is significant at the .05 level.

Two out of 24 items showed statistical significance at the  $p < 5\%$  level. The plots of these statistically significant items are shown in the figure below.

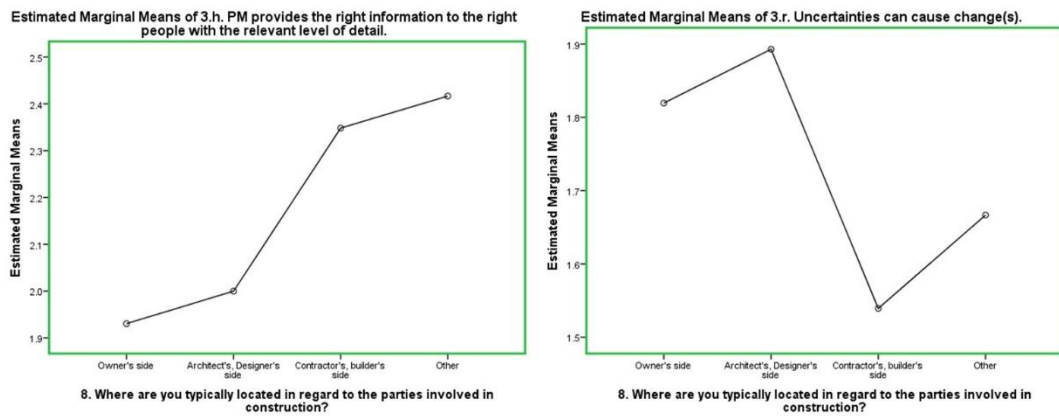


Figure 5-10 MANOVA – Post Hoc – H6 (1)

Plot 3.h (left side in Figure 5-10) shows that the contractor's feel that the PM does not provide the right amount of information to the right people with the relevant level of detail. The reason why the "Other" respondents appear to have no statistical significance is related to the difference in the sample between the groups. Plot 3.r shows that all respondents agreed with this dependent variable, but only the level of agreement is different. Hence the respondents who are mainly involved in the execution are slightly more in favour for this assumption than the rest. Therefore it can be concluded that both assumptions can be used for deriving the AgiLean PM framework.

The following table shows the results of the Post Hoc test for those respondents who have classed them as "Other".

Table 5-13 MANOVA - Post Hoc - H6 (2)

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
3. m. Planning everything in detail in advance is inappropriate for construction projects, as they have to cope with high levels of change.	Owner's side	Architect's, Designer's side	.62	.292	.196	-.16	1.39
		Contractor's, builder's side	.43	.208	.227	-.13	.98
		Other	.90*	.309	.023	.08	1.72
3. v. PM is good at mitigating the interfaces between different project phases.	Owner's side	Architect's, Designer's side	-.36	.199	.352	-.89	.17
		Contractor's, builder's side	-.14	.141	.896	-.52	.23
		Other	-.61*	.210	.024	-1.17	-.05

Based on observed means.

The error term is Mean Square (Error) = .880.

\*. The mean difference is significant at the .05 level.

Again two out of 24 items show statistical significance between the “Owner’s side” and “Other”. The plots of these two items are provided in the following figure below.

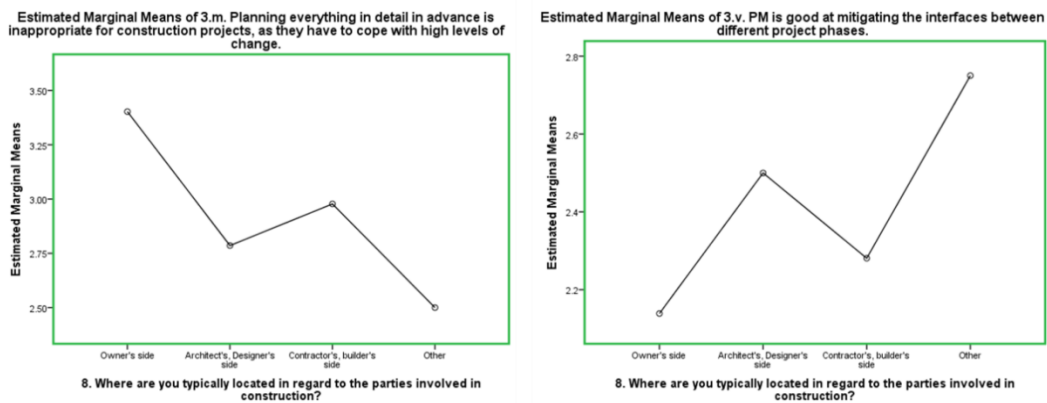


Figure 5-11 MANOVA – Post Hoc – H6 (2)

Figure 5-11 indicates that the respondents who have a more primary role within the project life cycle prefer the plan all in advance approach. However, the

respondents who indicated themselves as “Other”, who might have a more objective and theoretical view on the project life cycle were more in favour for this statement. Out of this, it can be concluded that the concept and principles of AgiLean PM framework should have the characteristic to be able to provide a detailed plan in advance, as otherwise it might not get accepted. But it should also be able to react to uncertainties and changes in an iterative way.

Plot 3.v in Figure 5-11 shows that there is no statistical significance between those parties who have a primary role within the project life cycle. Hence in theory, the PM should be able to mitigate the interfaces between the trades. However, considering that most of the respondents who have categorised themselves as “Other” are consultants, gives an indication that the PM practice did not match the expectations for those projects where these consultants have been involved. So to conclude, the AgiLean PM framework should focus more on ways for mitigating the interfaces between the different project phases.

**5.2.4.7 H7: *There is no relationship between a respondent’s attitude towards Lean construction and their involvement in construction.***

A statistically significant MANOVA effect was obtained for this hypothesis too:  $H7_{Wilks' \text{ Lambda}} = .575$ ,  $F(63, 532.169) = 1.720$ ,  $p = .001 < .05$ . Thus H7 has been rejected. The Post Hoc statistic indicated that only two items out of twenty showed statistical significance. Those two items are shown in the following table.

Table 5-14 MANOVA - Post Hoc – H7

			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable						Lower Bound	Upper Bound
4. e. Construction projects can be seen as temporary production systems, where the focus is on the building as a product.	Owner's side	Architect's, Designer's side	-.03	.209	1.000	-.58	.53
		Contractor's, builder's side	.38*	.143	.047	.00	.76
		Other	.81*	.209	.001	.25	1.36
4. h. The interfaces between the trades do not work well together.	Owner's side	Architect's, Designer's side	.29	.229	.737	-.31	.90
		Contractor's, builder's side	.27	.157	.394	-.14	.69
		Other	.63*	.229	.040	.02	1.23

Based on observed means.

The error term is Mean Square (Error) = .420.

\*. The mean difference is significant at the .05 level.

The plot of these two items is illustrated through the following figure.

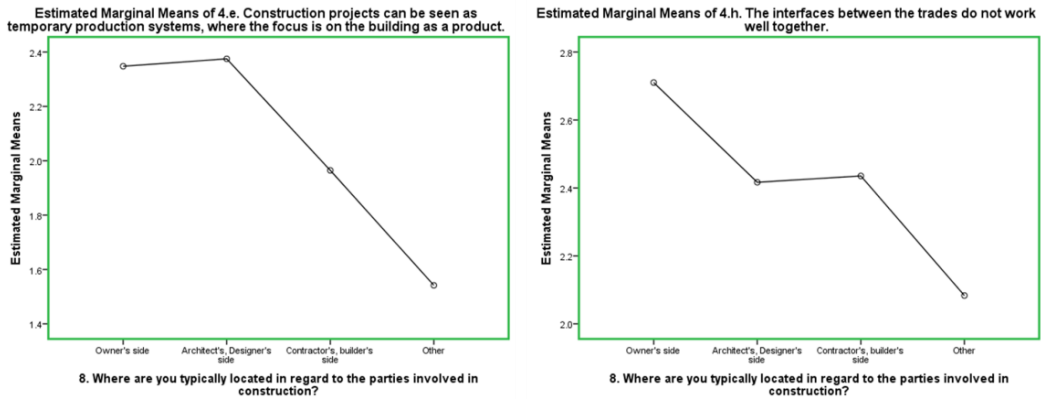


Figure 5-12 MANOVA – Post Hoc – H7

Plot 4.e (in Figure 5-12) shows that there is a statistical significance, when the respondents did indicate that they are involved in construction as “Contractors/builders” or as “Other”. The level of agreement was lower for those who are involved in a project at early stages. Plot 4.h highlights that those who are involved in the design and the execution, faced the problem that the interfaces

between the trades do not work well together, whereas those on the owner's side believe that there are not so many problems in managing the interfaces between the trades. However, even though there is statistical significance for these two items, both of them are in agreement with the interview findings.

**5.2.4.8 H8: There is no relationship between a respondent's attitude towards Agile PM and their involvement in construction.**

The MANOVA analyses showed statistically significant difference at the  $p < 0.05$  level for the variables which are related to the Agile PM: H8 Wilks'  $\Lambda = .753$ ,  $F(39, 584.107) = 1.505$ ,  $p = .027$ . Thus hypothesis 8 was rejected.

The result of the Hochberg's GT2 Post Hoc test, are shown in the following table.

**Table 5-15 MANOVA - Post Hoc – H7**

Dependent Variable		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
5. j. At present there are too many PM systems that are too rigid and therefore not really suitable for the initial stages of the project.	Owner's side Architect's, Designer's side	.06	.188	1.000	-.44	.56
	Contractor's, builder's side	.07	.134	.997	-.29	.42
	Other	.65*	.199	.007	.12	1.18

Based on observed means.  
The error term is Mean Square (Error) = 1.044.  
\*. The mean difference is significant at the .05 level.

The findings of the Post Hoc test can be illustrated with the following figure.

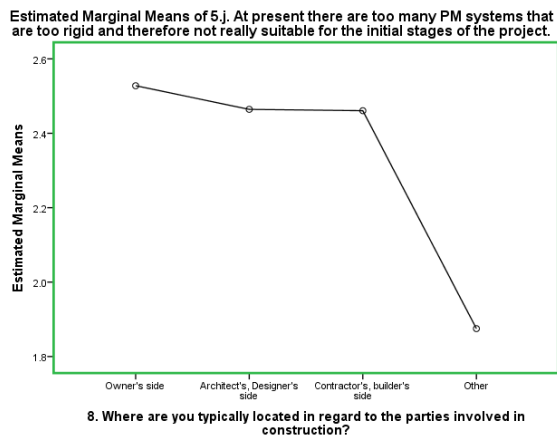


Figure 5-13 MANOVA – Post Hoc – H7

In general all the parties involved in construction agreed with the interview finding. Again, only the level of agreement was different. While those who are actively involved in construction had a quite similar opinion, those who have a more external function were more in favour for this statement.

#### 5.2.4.9 Summary of the MANOVA findings

Table 5-16 gives a summary about the MANOVA findings.

Table 5-16 summary MANOVA findings

Hypothesis	Result
H1: There is no relationship between a respondent's attitudes towards the construction environment and the project context in which they work.	Confirmed
H2: There is no relationship between a respondent's attitudes towards PM and the project context in which they work.	Confirmed
H3: There is no relationship between a respondent's attitudes towards Lean construction and the project context in which they work.	Rejected (three items)
H4: There is no relationship between a respondent's attitudes towards Agile PM and the project context in which they work.	Confirmed
H5: There is no relationship between a respondent's attitude towards the construction environment and their involvement in construction.	Confirmed
H6: There is no relationship between a respondent's attitude towards PM and their involvement in construction.	Rejected (four items)
H7: There is no relationship between a respondent's attitude towards Lean construction and their involvement in construction.	Rejected (two items)
H8: There is no relationship between a respondent's attitude towards Agile PM and their involvement in construction.	Rejected (one item)

H1, H2, H4 and H5 have been confirmed, while H3, H6, H7 and H8 have been rejected. However, those hypotheses which have been rejected had only a few items where statistical significance has been obtained. In addition, the majority of the items from the rejected hypothesis, have been still in line with the interview findings.

This section enabled the achievement of objective four. Analysing the influence of moderating variables, such as country context and party involved on the perceptions of traditional PM, Lean and Agile revealed that on the one hand the findings obtained from the interviews are universal, i.e. not related to a project context; but on the other hand the interview findings are not in line with the views of each party involved in construction.

# 6 Discussion and framework development

This chapter will develop the AgiLean PM framework. It will follow the approach for synthesising PM, Lean and Agile, which is described in section 4.3. First, the paradigm atoms for PM, Lean and Agile will be derived. Then, separation will be applied. After this, merger will be applied. Followed by this, the derived approach of re-merger will be used to develop the AgiLean PM framework. In the last section, the AgiLean PM framework will be verified, through assessing its ontology, examining the practicality, and identifying the transferability.

## 6.1 The concepts and principles of PM, Lean and Agile

The following sections will discuss the concepts and principles of construction PM, Lean construction and Agile PM with the findings of the literature and the primary data collected.

### 6.1.1 Construction PM

The literature and the interview findings allowed the derivation of the following concepts for construction PM (in Figure 6-1 referred as PM).

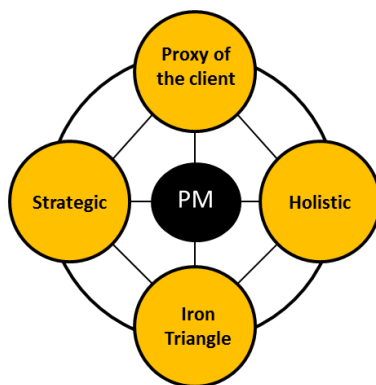


Figure 6-1 concepts of construction PM

The concepts of construction PM (as illustrated in Figure 6-1), are based on the finding that PM has an integrative character (Low, 1998), where the PM is acting

as the proxy of the client (Reve and Lewitt, 1984; Low, 1998; Sommer, 2009). To facilitate this, the PM approaches a construction project in a holistic way. Therefore PM is something which is more focused on strategic issues rather than operative. Another key concept of PM is to identify the project aims and objectives and then to develop a plan for how those can be achieved (Sommer, 2009). Even though a formal distinction between project and PM success was made in the literature (deWit, 1988); the focus of the interviewed project managers was more on the Iron-Triangle of PM (Atkinson, 1999) and hence on PM success. The reason for this is that PM success is an universal approach, in which the concept of project success is more specific.

Though there are many different principles suggested by the APM (2006) and PMI (2008), those are also more universal and claim applicability for any type of project. The more specific literature about construction PM (e.g. Low, 1998; Kochendoerfer et al., 2007; Walker, 2007; Sommer, 2009) and the interview findings indicate five clear core principles of construction PM, which are commonly used in construction practice and can be related back to the above concepts shown in Figure 6-1. Those are as follows:

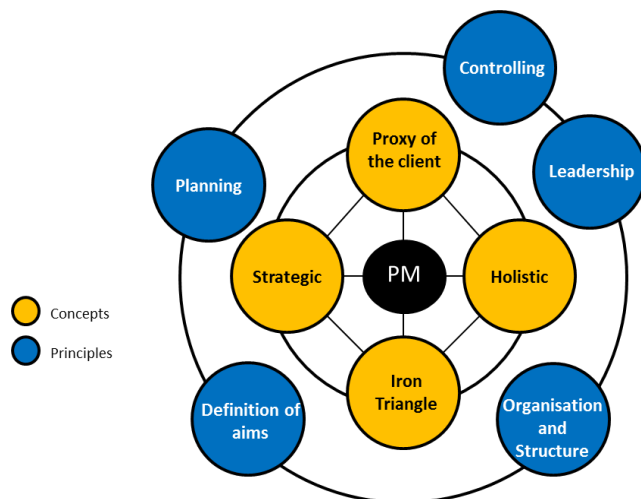


Figure 6-2 principles and concepts of construction PM

The crucial task of PM is to meet the project requirements (Edum-Fotwe and McCaffer, 2000; APM, 2006; PMI, 2008). To facilitate this the project aims and objectives have to be defined (Reve and Levitt, 1984; Low, 1998; Sommer, 2009).

In addition to this, the interviewees emphasised that the definition of the aims and objectives is a cyclic process and should be done through rhythmic meetings over the project life cycle. The defined aims and objectives relate then to the cost, schedule and quality planning (Ayas, 1996; Low, 1998; Kochendoerfer et al., 2007; Sommer, 2009). The organisation and structuring of the project support following the plan (ibid.). Once the planning and the organisation are in place, then the PM will monitor the project through appropriate controlling measures (Shenhar and Dvir, 1996; Sommer, 2009), even if the literature states that current controlling tools for construction PM are reactive and lack in proactive management (Koskela and Howell, 2002b). The interview findings highlighted also that the controlling tools of the PMPs have forecasting options, which builds in this proactivity. The interviewees and the literature (Hersey and Blanchard, 1982; Ancona and Caldwell, 1992; Globerson, 1994; Lewis et al., 2002; Papadimitriou and Pellegrin, 2007) focused also on good leadership or management styles. Hence greater emphasis is on the appropriate management style of the project manager, and not on team development.

### 6.1.2 Lean construction

The literature and the interview findings allowed the derivation of the following concepts for Lean construction (in Figure 6-3 referred as Lean).

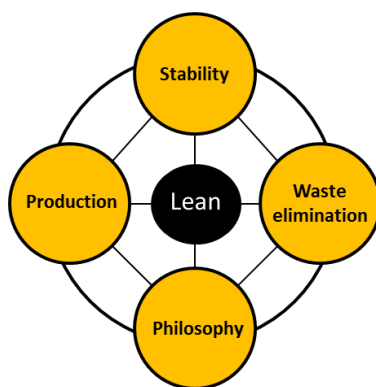
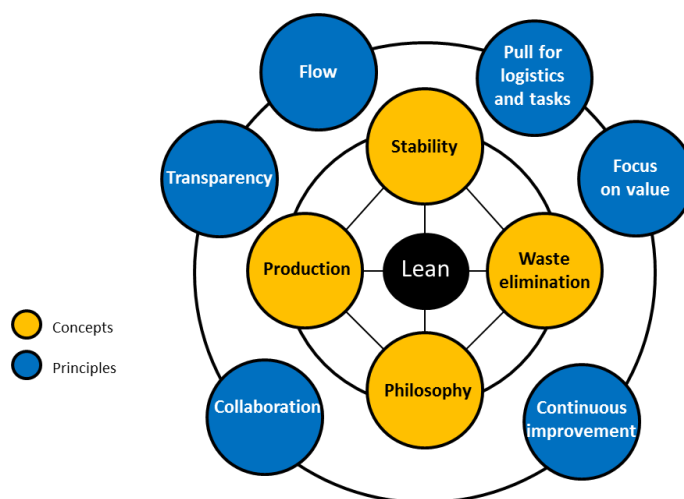


Figure 6-3 concepts of Lean construction

The interview findings indicated that Lean construction is in its most true form a philosophy, i.e. as a theory or attitude which acts to guide behaviour. The Lean

philosophy aims to maximise value adding activities, minimise non-value adding activities and eliminate waste activities (Koskela, 1992). Further distinctions could be made for the philosophy through the literature and interview findings, where on the one hand some practitioners believe that Lean production can be directly implemented to the construction environment; on the other hand there are others who think that Lean production needs to be adjusted to the circumstances within the construction environment (Green and May, 2005; Jorgensen and Emmitt, 2008). This distinction has significant impacts on the way how the Lean construction philosophy is “lived” by the LPs. However, the literature (e.g. Ballard and Howell, 2003a) as well as the interview findings indicated that both views come together through exploring construction projects as temporary production systems. If this view can be established on construction projects, then stability can be pursued. The reason for this is that the top-down management approach of construction projects will be changed to bottom-up, to a planning on the micro level, which will provide innovative solutions (Koskela and Vrijhoef, 2001). The identified Lean construction principles are shown in the following figure.



**Figure 6-4 principles and concepts of Lean construction**

In general the identified Lean production principles (see Womack and Jones, 2003) found agreement within the LPs. Nevertheless a few other principles came to the fore when analysing the collected data (as shown in Figure 6-4). Collaboration has been indicated as one of the most crucial principles for Lean

construction. Though this has been also found within the literature (Egan, 1998; Ballard and Zabelle, 2000; Ballard, 2000a), emphasis placed on this was very strong and in agreement with all LPs. The reason for this can be related to the different environmental typologies between construction and production (where Lean is originated from). This issue causes a dilemma between Lean and construction. Lean construction is based on a philosophy for a static environment but a dynamic product. Construction in contrast, has a dynamic environment and a static product. The dynamic environment is caused because of uncertainties (Winch, 2006). This has been realised by the Lean advocates (e.g. Egan, 1998; Ballard and Howell, 1998; Ballard and Howell, 2004). Therefore the aim of the Lean advocates is to create stability within the construction project environment (Ballard and Howell, 1998; Choo et al., 1999; Koskela et al., 2002; Howell et al., 2004; Vrihhoef and Koskela, 2005). This stability can be achieved through creating reliability (ibid.). One way of creating reliability is through establishing long term, collaborative relationships with the supply chain (Egan, 1998). This collaboration between the project participants has to create a trustful and reliable environment, consequently resulting in stability. This stabilised construction environment allows the planning of production units, where then transparency over the process can be developed, as an enabler for process optimisation (flow and pull). Even though the elimination of waste has been indicated as a main concept within the literature (e.g. Koskela, 1992; Howell, 1999; Koskela, 2000; Womack and Jones, 2003; Liker, 2004), the LPs identified the focus on value as a facilitating principle for this concept. This seemed quite obvious, because only if value for the customer is identified, non-value can be minimised and waste can be eliminated. The principles of flow, pull and continuous improvement are adopted in the same way as it is suggested by the Lean production literature (Ballard, 2000a; Womack and Jones, 2003; Liker, 2004), with the only difference that pull is also applied for work packages or tasks and not only for site logistics.

### 6.1.3 Agile PM

Though there have been values and principles expressed by the Agile Manifesto (2001), the following concepts and principles within this section seemed more relevant for the purposes of this research, because they were influenced by the data collected from the practitioners. The literature and the interview findings allowed the derivation of the following concepts for Agile PM (in Figure 6-5 referred as Agile).

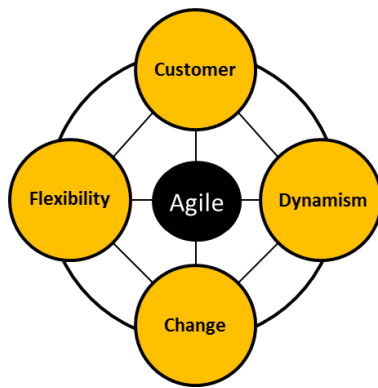
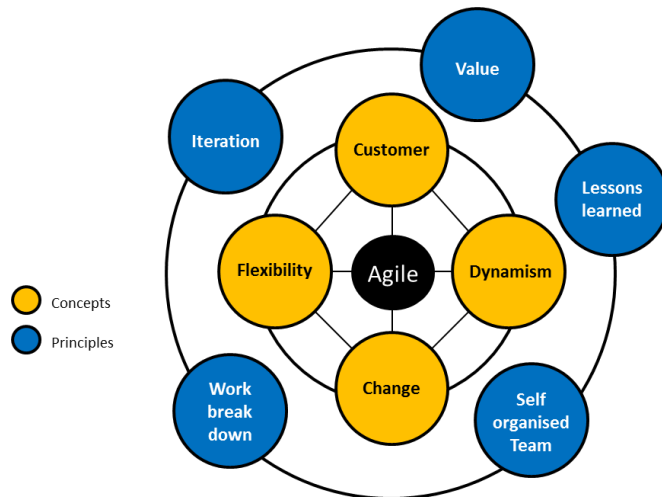


Figure 6-5 concepts Agile PM

The core concept of Agile is to put the dynamic aspect of a project to the fore. Agile PM understood that projects are dynamic undertakings (Chin, 2004; Wysocki, 2006; Moe et al., 2010). Therefore Agile PM tries to cope with this dynamic environment through using a dynamic methodology. This dynamism is caused because of changes, which could be created due to the external environment or the customer (e.g. Collyer and Warren, 2009; Lewander et al., 2011). Hence instead of trying to mitigate the changes, Agile PM methods allow changes, because they believe that those add value (Hass, 2007). The interview findings highlighted also the concept of involving the customer, because through this, customer satisfaction can be achieved, as the customer will also have an influence on the project progress. Out of those concepts, the following principles have been identified through the literature and interview findings.



**Figure 6-6 principles and concepts of Agile PM**

Five principles have been identified, as shown in Figure 6-6. The literature (e.g. Wysocki, 2006; Hass, 2007; Fernandez and Fernandez, 2008; Saleh, 2011) and the interview findings highlight that “iteration” is the core principle of Agile PM. Iterations create dynamisms. This consequently results with the ability to react to uncertainty. The interview findings show that the “work breakdown” is the facilitator for this. The work has to be broken down into single individual parts. Each of these individual parts creates value for the customer in the best case. Hence the customers can decide afterwards, if this piece of the project is perceived as value added (Schwaber, 2004; Wysocki, 2006). In addition the customers can prioritise the tasks which are of more value for them before the iteration starts (ibid.). The literature review has shown that Agile PM methods have self-organised teams as a crucial enabler (e.g. Agile Manifesto, 2001; Hunt, 2006; Moe et al., 2010). However, the APs differentiated between the management and technical level, when talking about the organisation of an Agile project. On the one hand, strategic decisions, such as sequencing the tasks or approving the done work, will be done through the management team. On the other hand, the project team, which is self-organised, will deal with technical issues on the operative level during the iteration. Another aspect, which has been highlighted by the interviewees, is the lessons learned meeting at the end of the iterations, which allows constant improvement of the performed work.

## **6.2 Development of the AgiLean PM framework: Application of separation**

To derive the paradigm atom the strengths and the weaknesses of each paradigm have to be brought in relation with the principles (see Figure 4-12, p. - 150 -). The outcome of this is shown in Figure 6-7 (see p. - 236 -).

The different strengths and weaknesses will be discussed in section 0, when applying merger.

Figure 6-7 (see p. - 236 -) shows that all paradigm atoms seem to have a quite balanced number of strengths and weaknesses.

Figure 6-8 (see p. - 237 -) shows that all the paradigm atoms have been split into their fragments. Each fragment is one principle, which has its own strengths and weaknesses. As discussed in section 4.3.2 this results in an unstructured set of principles which can be seen as a sort of tool box. It is not possible to relate the concepts to the principles, as those are more generic. Hence, the concepts will be neglected for the application of the merger, and re-merger approaches.

The next step will be to make out of these separated principles one unit through applying the merger approach.

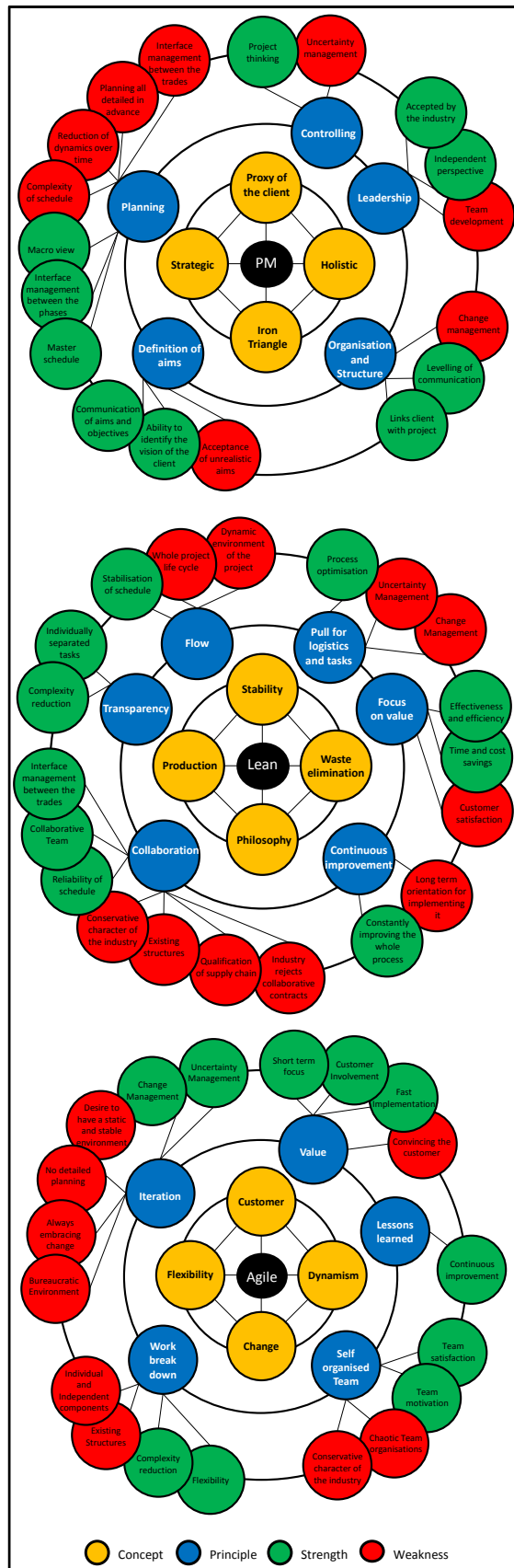


Figure 6-7 PM, Lean and Agile atoms

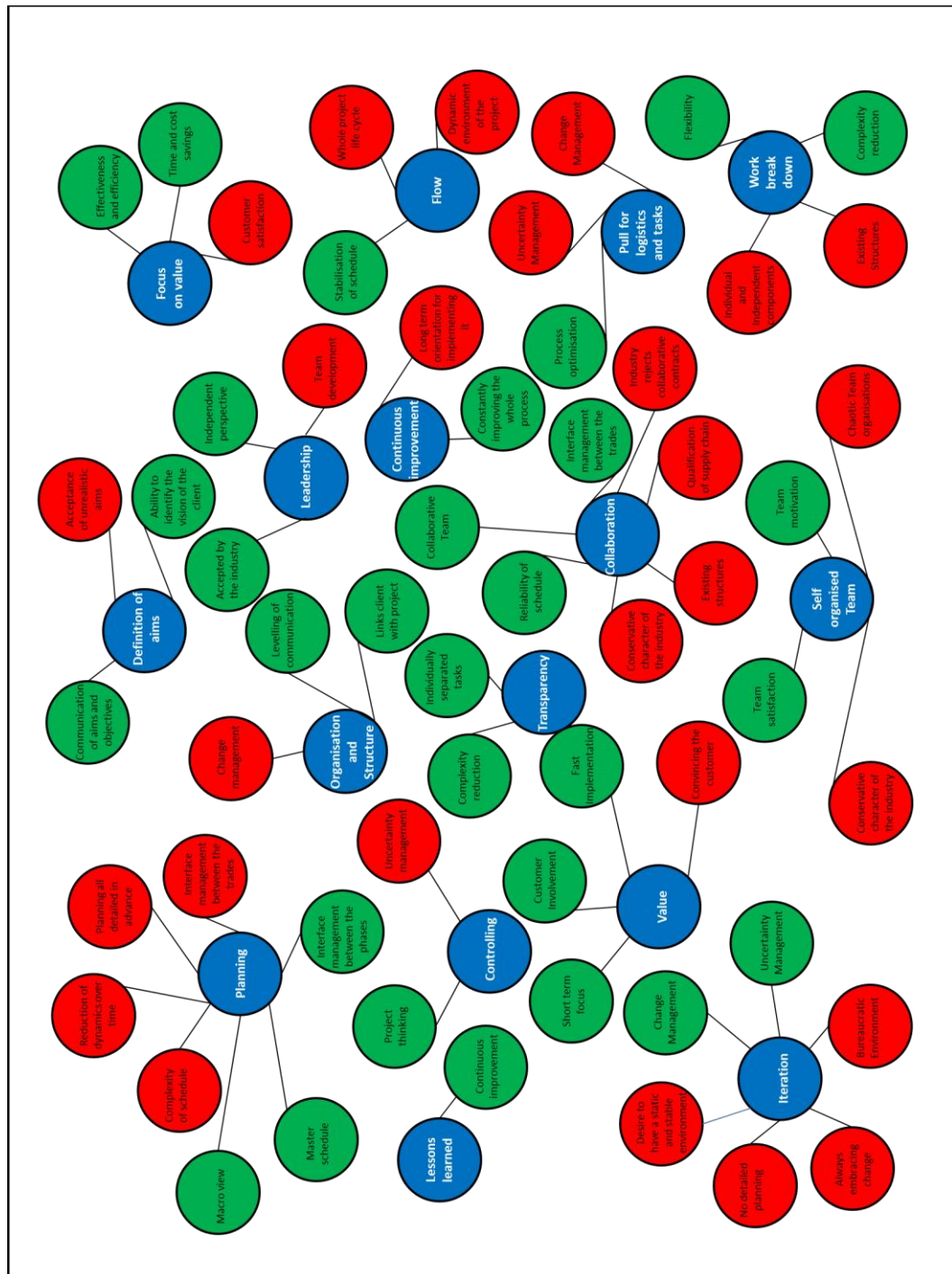


Figure 6-8 application of separation to Lean, Agile and PM atoms

### **6.3 Development of the AgiLean PM framework: Application of merger**

The application of merger to the pool of principles, which are shown in Figure 6-8, results in different reactions between the atom nucleus fragments. The strengths search for weaknesses of another paradigm to eliminate it. Metaphorically, those strength and weakness characteristics create explosive reactions. The following sections will discuss how the weakness of a paradigm's principle has been eliminated by the strength of another paradigm.

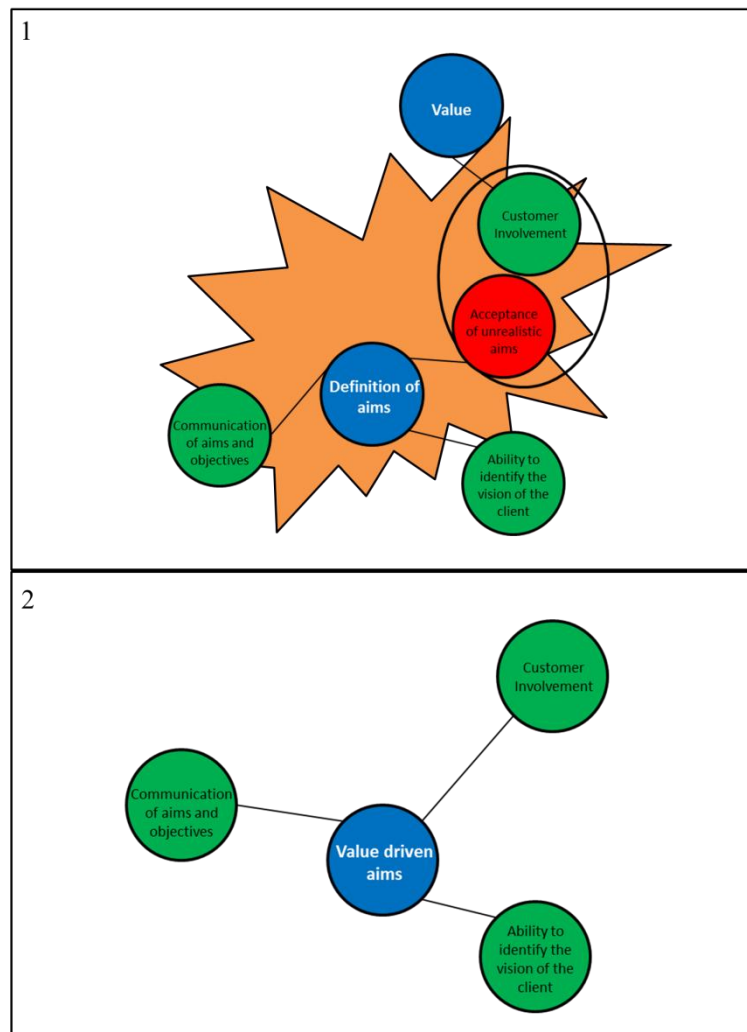
#### **6.3.1 PM merger**

This section will discuss the application of the merger approach to the principles of construction PM (see Figure 6-7, p. - 236 -).

##### **6.3.1.1 Definition of aims and objectives**

For the principle of defining the project aims and objectives three characteristics have been identified (see Figure 6-7 p. - 236 -). A strength, which has been mainly emphasised by the interviewees, is that the PM is able to identify and articulate the vision of the client and put it to a construction context. This is very supportive for the project, because in most cases the clients have not the required skills to undertake the project on their own (Reve and Levitt, 1984; Low, 1998; Sommer, 2009). In addition, the literature (e.g. Edum-Fotwe and McCaffer, 2000; APM, 2006; Kochendoerfer et al., 2007; PMI, 2008) and the interview findings have reflected that communicating the aims and objectives of the project to the project participants is this principle's main strength, because different participants might perceive the aims differently due to their occupational culture (see also Figure 2-6 p. - 25 -). However, this principle has been also criticised by the interviewees due to the acceptance of unrealistic aims, which cause potential threats for the project. The interviewees have further explained that in most of the cases, the only way of not accepting an unrealistic aim is through rejecting the project, as the clients might find someone else who is willing to do the job. Hence, the acceptance of unrealistic aims has been identified as a weakness of this principle. The following

figure illustrates which strengths of another paradigm have eliminated this weakness.



**Figure 6-9 PM merger: Definition of aims**

Figure 6-9 shows that the value principle of Agile provides a characteristic, which is able to eliminate the mentioned weakness of construction PM. The acceptance of unrealistic aims can be eliminated through using the customer involvement characteristic of Agile PM, because if the clients are actively involved in the management process they will see what is feasible and what is not. The interviewees stated also that this will increase the level of customer satisfaction, because the customers will be able to monitor the processes. Hence through merging the definition of aims principle of PM and the value principle of Agile, a new principle has evolved, called “value driven aims”.

### **6.3.1.2 Planning**

The principle of planning consists of seven characteristics, where three out of those have been strengths (see Figure 6-7, p. - 236 -). The literature (e.g. Sidwell, 1990; Jaafari, 2001; Kochendoerfer et al., 2007; Sommer, 2009) and the interview findings indicated that a main strength of this principle is that the planning of the project happens within a macro view. This results in that the PM does not get lost in detail and is able to steer the project in a more holistic way. In addition, the literature (e.g. Kochendoerfer et al., 2007; Sommer, 2009) and the interview findings indicated that the PM sets the framework for the key milestones through providing the master schedule. This framework is also used by modern management paradigms (Ballard, 2000a; Schwaber, 2004; Daneshgari, 2010). Hence the strength here is that the PM gives the required overview about the project's key milestones through providing a master schedule, which is in turn facilitated through the macro view on the project. This results consequently in that the PM is good in managing the interfaces between the phases.

However, the findings of the collected data have shown that construction PM faces difficulties in managing the interfaces between the trades, because they have no overview about the detailed process. Another weakness of the planning principle is the desire to plan all detail in advance. The literature (e.g. Rodrigues and Bowers, 1996; Chapman, 1998; Atkinson, 2006; Hass, 2007) and the collected data emphasised that, because of this, the PM will struggle to react to consequences, which are caused by the dynamic environment. This characteristic results in the pursuit to plan the execution in such a way that changes and therefore dynamics can be avoided. Besides the low possibility for achieving this, due to the aforementioned reasons, the interviewees stated also that this will give a foundation for customer dissatisfaction. The collected data showed that even though the master schedule provides the framework for the project, the PM faces difficulties in articulating this information in an appropriate manner to the project participants, as the project schedule has been perceived as too complex. The identified strengths and weaknesses of this principle and the application of the merger approach are summarised in Figure 6-10.

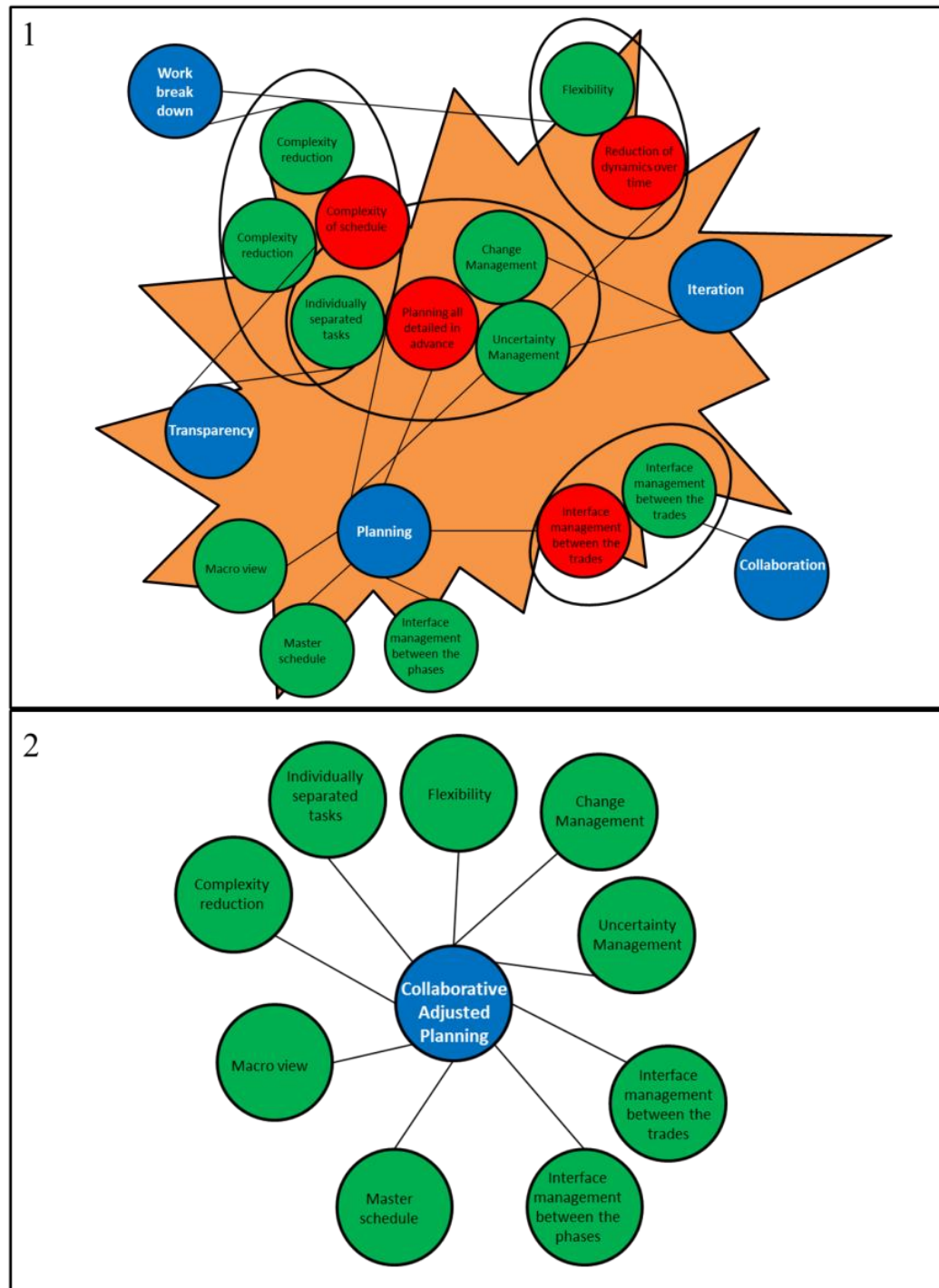


Figure 6-10 PM merger: Planning

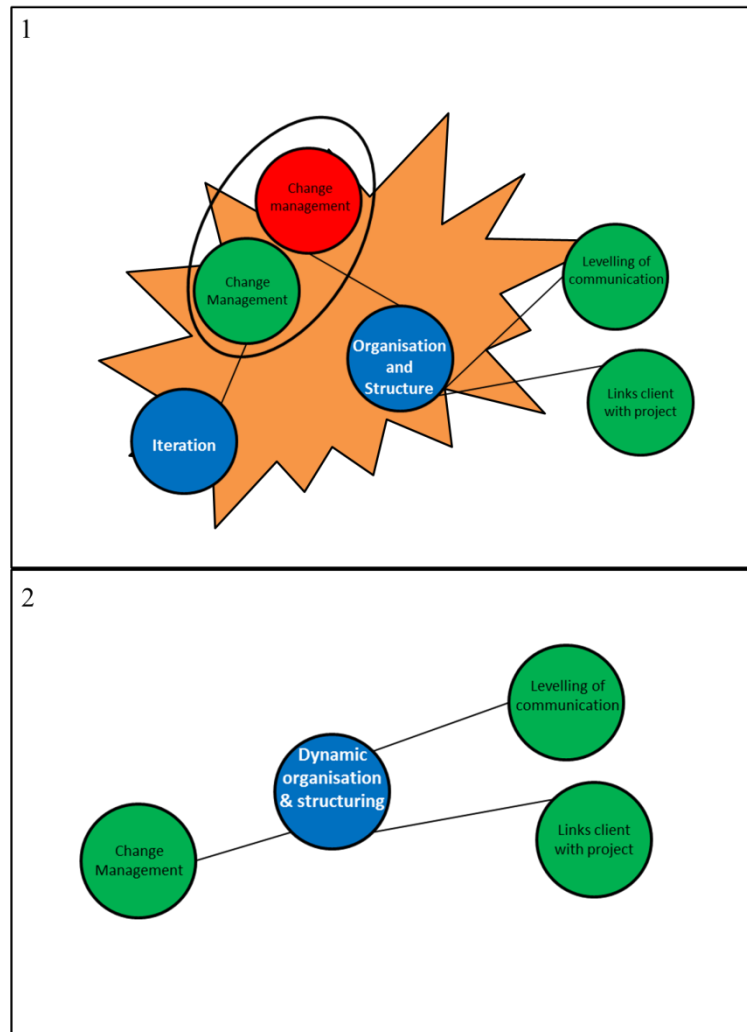
The ability to manage the interfaces between the trades can be improved with the collaboration principle of Lean (as shown in Figure 6-10), because the collaborative team approach of Lean construction results in more communicative interactions between the trades. This will eliminate the interfaces between the

trades. The iteration principle of Agile is used to improve the weakness of having the desire to provide detailed planning in advance. The dynamics are caused, because of uncertainties, which in turn cause changes (Collyer and Warren, 2009). The iterations of the Agile paradigm allow the reaction to uncertainty and change. However, the principle of iteration provides actually only the structured process for doing this. The prerequisite for allowing this flexibility is caused through the principle of work breakdown, because this principle of Agile has the ability to separate the work into independent individual components. This flexibility, which is caused by the work breakdown principle, will create a foundation for a more dynamic planning system. Therefore this principle is utilised to eliminate the weakness of the planning principle, which pursues the reduction of the project dynamics over time. The work break down principle of Agile in combination with the transparency principle of Lean will help in reducing the complexity of the schedule, through dividing it into individual components and tasks, which will create a macro and micro view of different project elements. Hence, through the combination of these principles, a new principle has evolved which is called “collaborative adjusted planning”.

#### ***6.3.1.3 Organisation and structure***

Three characteristics have been identified for the principle of organisation and structure (see Figure 6-7, p. - 236 -). The literature (e.g. D’Arrigo and Smith, 1996; Low, 1998; Lenfle, 2011) as well as the interview findings indicated that PM has an integrative character, which enables the PM to provide the right amount of information to the right project participants. Hence the levelling of communication has been identified as its main strength. In addition, the primary data collected denoted that PM creates a link between the client’s organisation and the project. This principle enables the set-up of an appropriate PM system with low interfaces between the project and the client’s organisation. Hence, all elements, which create the PM system, such as change management, cost controlling, scheduling, decision management, documentation etc. are in line with the requirements of the client’s organisation.

Nevertheless, within these PM system elements, change management has been determined as a weakness by the interviewees. This is also in line with the reviewed literature, where for instance Rodrigues and Bowers (1996), Chapman (1998), Winch (1998) and Atkinson et al. (2006) found out that the management of changes is a difficult task for construction projects. The following figure shows how the strength of another paradigm can eliminate this weakness.



**Figure 6-11 PM merger: Organisation and structure**

Figure 6-11 shows that the weakness of this principle can be eliminated through merging it with the iteration principle of Agile. The reason for this is that the iterations allow reacting to change in a systematic and structured way. The application of merger on these two nucleus fragments, results in a new principle called “dynamic organisation and structuring”.

#### **6.3.1.4 Controlling**

The principle of controlling is facilitating the project thinking of the project managers. Controlling compares the expected with the actual and derives counteractions if required (e.g. APM, 2006; Kochendoerfer et al., 2007; PMI, 2008; Sommer, 2009). The collected data emphasised also that there is a short term focus, which characterises PM in general. This is related to the short duration of a project. The PM has only one chance and this chance has to be performed in a limited time framework. Hence long term orientation seems not really in line with project thinking. Therefore project thinking has been categorised as a positive characteristic. The reason for this is that short term thinking is in line with the project character. Project thinking needs also the ability to identify potential threats or opportunities in advance so that appropriate actions can be made.

Though, this is difficult for uncertainties, because either the probability or the impact of uncertainties is unknown (Pender, 2001). As a result, it has been identified that the principle of controlling is limited in coping with uncertainty, because uncertainties have to be managed more reactively. Figure 6-12 shows how the strength of another paradigm can eliminate this weakness.

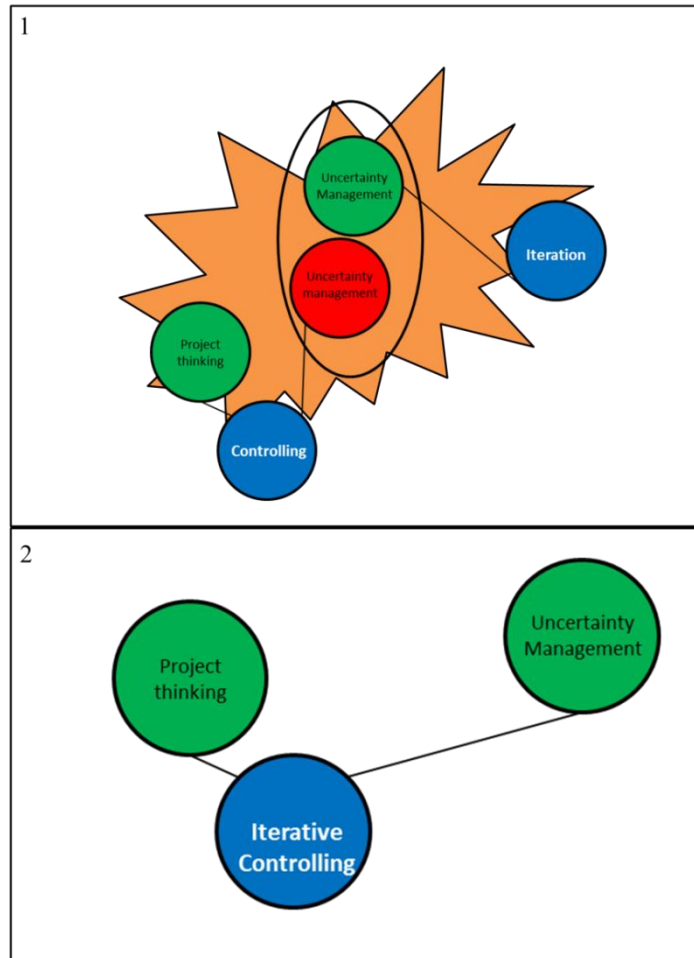


Figure 6-12 PM merger: Controlling

Figure 6-12 illustrates that the iteration principle of Agile is able to eliminate this weakness, because of the same reasons as explained in section 6.3.1.3. The application of merger did result in a new principle called “iterative controlling”.

#### 6.3.1.5 Leadership

The fragmented nature of the construction industry results in a functional and a firm separation, when setting up the project organisation (e.g. Winch, 1989; Walker, 2007). This causes a huge amount of diversity within a construction project, where the parties involved are mainly focused on their own interests (Winch, 1989; Wild, 2002; Bertelsen, 2003). Hence team building has been indicated as a complex task for construction projects (Low, 1998, Okmen and Oztas, 2010). Therefore the focus of the PM literature is on good leadership (e.g.

APM, 2006; PMI, 2008; Sommer, 2009). In addition, the collected data highlighted that these “law and order” organisations are accepted by the industry. This acceptance has been identified as strength, because it is not threatened by the conservative character of the industry. A further strength of this principle is that PM is providing a third neutral perspective on the project, which is independent of design and execution perspectives. This supports the integrative character of PM.

However, the collected data gave also an indication that PM lacks in team development. One reason for this is the nature of construction projects, which is characterised with psychosocial dynamics (Wild, 2002). Another reason for this might be caused by the focus on leadership by key PM literature (e.g. APM, 2006; PMI, 2008; Sommer, 2009). Figure 6-13 shows how the strengths of other paradigms can eliminate this weakness.

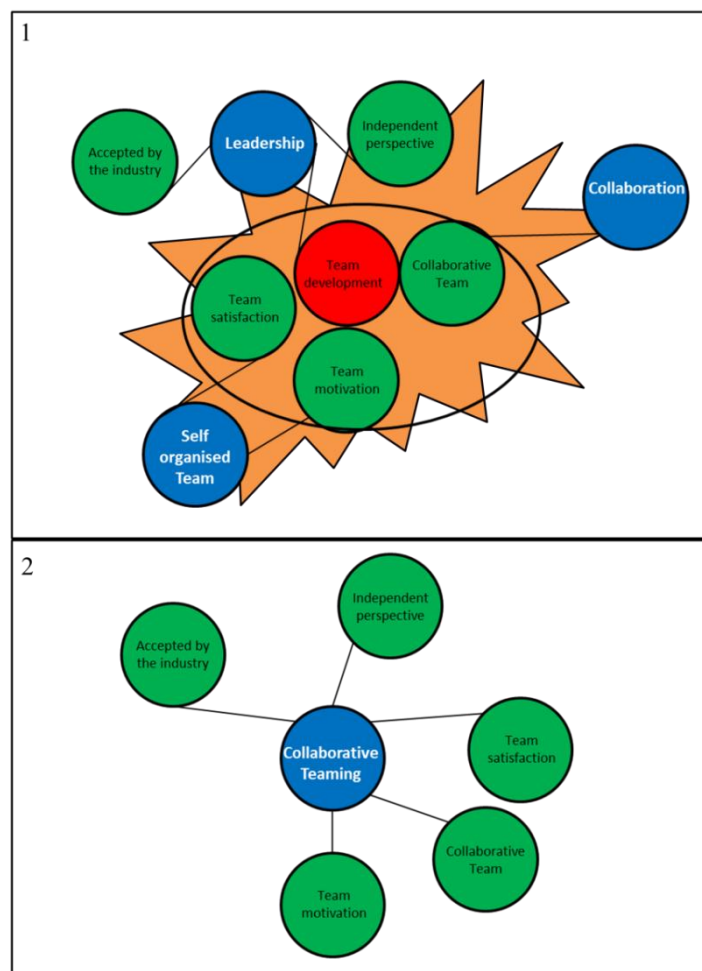


Figure 6-13 PMmerger: Leadership

Figure 6-13 illustrates that the self-organised team principle of Agile and the collaboration principle of Lean are able to eliminate this weakness. The self-organised team principle is focused on dividing the project between management and technical issues. The technical issues will be managed only by the team under their own responsibility. This results in motivation and satisfaction of the team members. The collaboration principle of Lean construction will allow this self-organisation in a structured way. Hence the application of merger did result in a new principle called “Collaborative Teaming”.

### **6.3.2 Lean construction merger**

This section will discuss the application of the merger approach to the principles of Lean construction (see Figure 6-7, p. - 236 -).

#### **6.3.2.1 Collaboration**

The main strength of this principle is that it changes the hierarchic organisational structure of the project, to a flat and dynamic project organisation, which suits best to Lean (Jenner, 1998). This principle aims to create trust and focus on the project as a whole to avoid conflicts (e.g. Orr, 2005; Seppanen et al., 2010). Especially the collected data from the practitioners highlighted the importance of having the collaborative team in place. The practitioners interviewed explained that within the collaborative team, the team members are agreeing together on the program. Consequently means this that the work, which has to be performed, has not been dictated as usual. That makes the program reliable (Ballard and Howell, 1998; Choo et al., 1999; Koskela et al., 2002; Howell et al., 2004; Vrihhoef and Koskela, 2005). This has been identified as a strength of this principle, because the collected data shows that the parties involved have the desire to create more stability. This stability can be achieved through creating reliability. The communication and interactions within the collaboration principle result also in the strength of being able to manage the interfaces between the trades.

The conservative character of the industry is causing a major barrier for Lean construction in general, but also for the collaboration principle in particular. The

collected data indicated clearly that the industry is not open for new approaches. In addition, the examples about unsuccessful Lean construction projects, which have been provided by the LPs, have been mostly related to difficulties in convincing the project participants. Another aspect, is that the supply chain needs to get trained in Lean construction, because Lean is seen more as a philosophy (Womack and Jones, 2003; Liker, 2004; Koskela, 2000) and the interviewees stated that it can take up to three years just to understand this philosophy. This approach is not in relation with construction practice. Hence, the focus on the long term (which is in a general a good thing) is not in line with the short term project character. Besides these more human related aspects, the literature (e.g. Egan, 1998; Green and May, 2005) and the data collected stressed also that Lean cannot work within the existing structures of construction. The reason for this is that these existing structures do not really support collaboration. This has been also realised by the Lean advocates (Egan, 1998) and instead of adopting Lean to the existing structures, the desire was more on changing these existing structures through collaborative contracts. The aim of these contracts is to minimise the fragmentation of the construction industry in the long term. However, the collected data reflected that these contracts find low application in the industry, because the parties involved do not perceive them as beneficial. The conservative character might have also an impact on this perception. The identified strengths and weaknesses of this principle and the application of the merger approach are shown in Figure 6-14.

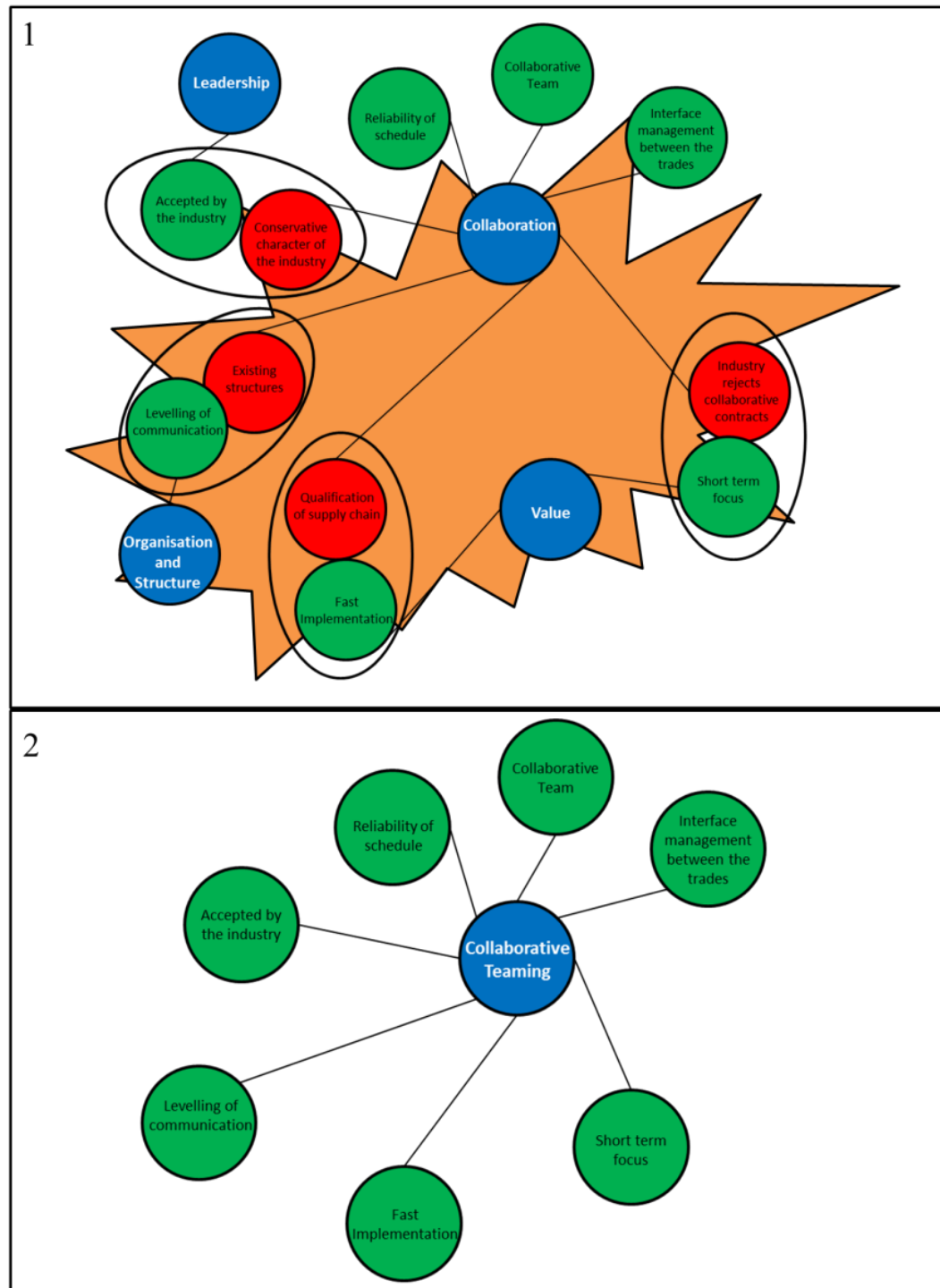


Figure 6-14 Lean merger: Collaboration

It has been identified that the conservative character of the industry causes a main barrier for this principle. However, Figure 6-14 shows that this weakness can be eliminated through using the leadership principle of PM, because this approach is accepted by the industry. Hence the leadership principle can force the project

participants to do what is good for them. The existing structures do not support the collaboration principle of Lean, too. However, instead of changing the existing structures, the collaboration principle can be integrated into those through merging it with the organisation and structure principle of PM. This principle of PM can level the communication and set a framework for the operative level. The weakness of qualifying the supply chain through long term training can be disregarded through the value principle of Agile, because this principle of Agile has understood that a fast implementation strategy is required which has to be in line with the project character. This relates it also to a different strength of Agile's value principle, namely the short term focus. Agile is focused on the short term, as a project has to be also constructed in a short term period. Hence instead of looking at long term relationships and changing the industry, the value principle of Agile will improve the collaboration principle in a way, so that it can be applied and implemented quickly on the project. Hence, through the application of the merger approach and merging the collaboration principle of Lean construction with the leadership principle of PM, organisation and structure principle of PM, and value principle of Agile, a new principle has evolved called "collaborative teaming".

#### **6.3.2.2 Focus on value**

The literature (e.g. Green, 1999a; Naim et al., 1999; Naylor et al., 1999; Mason-Jones et al., 2000; Winch, 2006) and the findings of the primary data emphasised that the application of Lean will result in effectiveness and efficiency, which consequently ends up in time and cost savings. Hence value within Lean construction is highly focused on efficiency.

However, Piercy and Morgan (1997) found out that the focus on efficiency might result in fewer customer choices and is therefore not always perceived as valuable by the customer. The aspiration to create stability so that the processes can be optimised results in a rigid PM system. However, considering also that construction projects usually have powerful clients (Ankrah et al., 2005), the result is that the focus on time and cost savings might not always be in the interest

of the owners. Hence the lack of customer satisfaction has been identified as a weakness of this Lean principle. The following figure shows how the strength of another paradigm can eliminate this weakness.

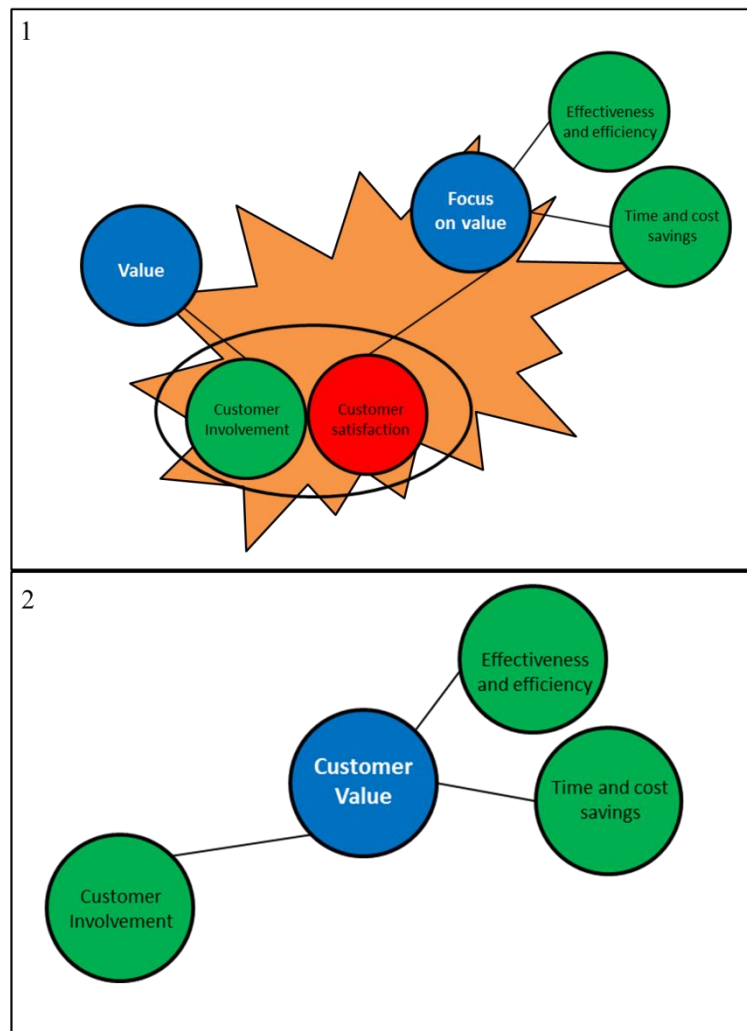


Figure 6-15 Lean merger: Focus on value

Figure 6-15 shows that the identified weakness can be removed through merging this principle with the value principle of Agile. The reason for this is that the value principle of Agile is focused on involving the customer, which allows the customer to actively take part in the management process. Hence through the application of the merger approach to this context, a new principle evolved called “customer value”.

### **6.3.2.3 Transparency**

For this Lean construction principle two characteristics have been identified. Both of them are strengths. The core strengths are that this principle provides transparency over the process so that complexity can be reduced. This is in the sense of Lean construction, as the aim of Lean construction is to reduce the complexity of the construction processes (Ballard and Howell, 1997; Ballard and Howell, 2004). A main facilitator for this has been identified by the interviewees, which is the separation of the tasks in a detailed manner. Hence, Lean construction is moving from the project level down to the process level (e.g. Salem et al., 2005; Friblick et al., 2009; Kalsaas et al., 2009; Porwal et al., 2010) and achieves through this a high transparency about the project work which needs to be performed.

### **6.3.2.4 Flow**

The primary data collected emphasised that the parties involved want to have a linear static program, so that they are certain about the things that have to be done. This principle of Lean construction provides a way for achieving this. After having established the previous three principles, the next step is to create flow on the detailed operative level (Womack and Jones, 2003). This principle creates within the work program stability (ibid.), which is identified as strength.

However, the literature (e.g. Ballard, 2000a; Salem et al., 2005; Ballard et al., 2009; Seppanen et al., 2010) and the primary data collected associated this principle mostly with the execution phase (see Figure 2-8, p. - 28 -) of a construction project. Hence a weakness of this principle is that it cannot be applied in this way to the whole project life cycle. Furthermore, even if the parties involved in construction aim for a linear static process, this cannot be achieved easily for construction projects, because of the project dynamics (Chapman, 1998; Love et al., 2002a; Wysocki, 2006; Collyer and Warren, 2009). Hence a different weakness of this principle is that it is not tailored for a dynamic environment. The following figure shows how the strengths of another paradigm can eliminate these weaknesses.

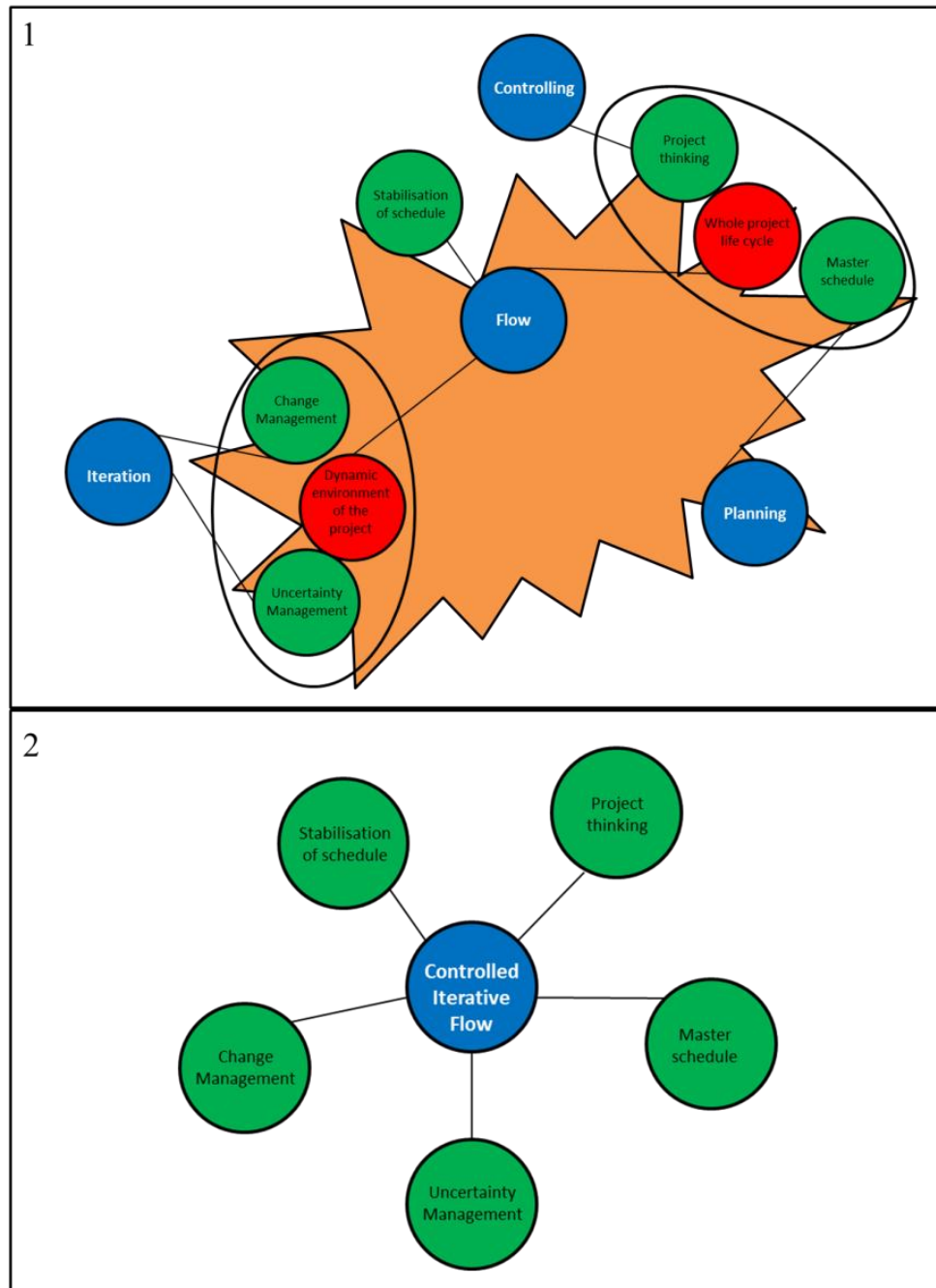


Figure 6-16 Lean merger: Flow

Figure 6-16 shows that the weakness of not being associated with the whole project life cycle can be eliminated through merging it with the controlling and planning principles of PM. The planning principle sets the master schedule as foundation for applying the flow principle. The controlling principle will allow the identification of opportunities and threats in advance. In addition the controlling principle will adjust the flow principle to the project circumstances.

The iteration principle of Agile removes the incapability to cope with a dynamic project environment of this principle. Through merging those principles together, the flow principle will be applied for small iterative steps within the project life cycle. This allows the ability to react to uncertainties and change as far as the physical circumstances of the constructed facility allow it. Hence through the application of the merger approach to this context, a new principle evolved called “controlled iterative flow”.

#### **6.3.2.5 *Pull for logistics and tasks***

The pull principle of Lean production (Womack and Jones, 2003) is on the one hand applied to site logistics, but on the other also to the tasks. The interview findings have shown that, if this principle is applied to site logistics, then the implementation is in a similar fashion to Lean production. On the tasks the pull principle is applied through a revised phase planning, where practitioners have to plan from the back to the front (Ballard, 2000a; Salem et al., 2005; Ballard et al., 2009; Porwal et al., 2010). However, the interview findings have shown that this technique is not applied by all LPs. In general, the strength lies here in process optimisation, as the process will be further improved through this principle.

Nevertheless, the application of this principle results in the requirement of a stable platform. The pull principle does not allow any type of flexibility, as any late (or even maybe any early) delivery will have an impact on the program (Cusumano, 1994; Hines et al., 2004; Andersson et al., 2006). Hence, the weakness of this pull principle is change and uncertainty management. The following figure shows how the strengths of another paradigm can eliminate these weaknesses.

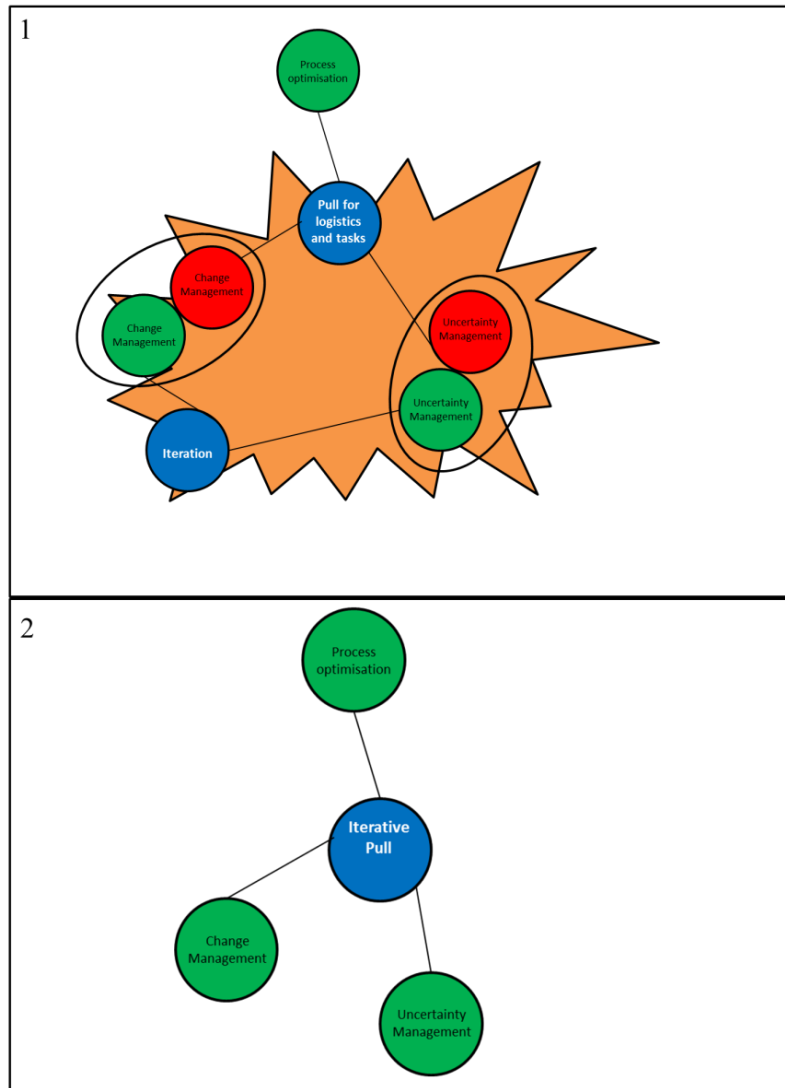


Figure 6-17 Lean merger: Pull

Figure 6-17 illustrates that the pull principle of Lean construction can be improved with the iteration principle of Agile. Pull will be established, but only for the time framework where the iteration takes place. This action enables the pull principle to be more flexible and cope with change and uncertainty. As a result, through merging the pull principle of Lean construction with the iteration principle of Agile, emerges a new principle called “iterative pull”.

#### 6.3.2.6 Continuous improvement

The primary data collected highlighted that the principle of continuous improvement has been directly adapted from the production to the construction

context. Within Lean production literature (Womack and Jones, 2003; Liker, 2004) the principle of continuous improvement is a cyclic process and is characterised with a long term orientation.

However, this long term orientation has been identified as a weakness of this principle, because of the short term focus of a project. This has been also confirmed by the LPs who stated that they have only one chance in construction and that it might be not possible to use further, improvements made in previous projects.

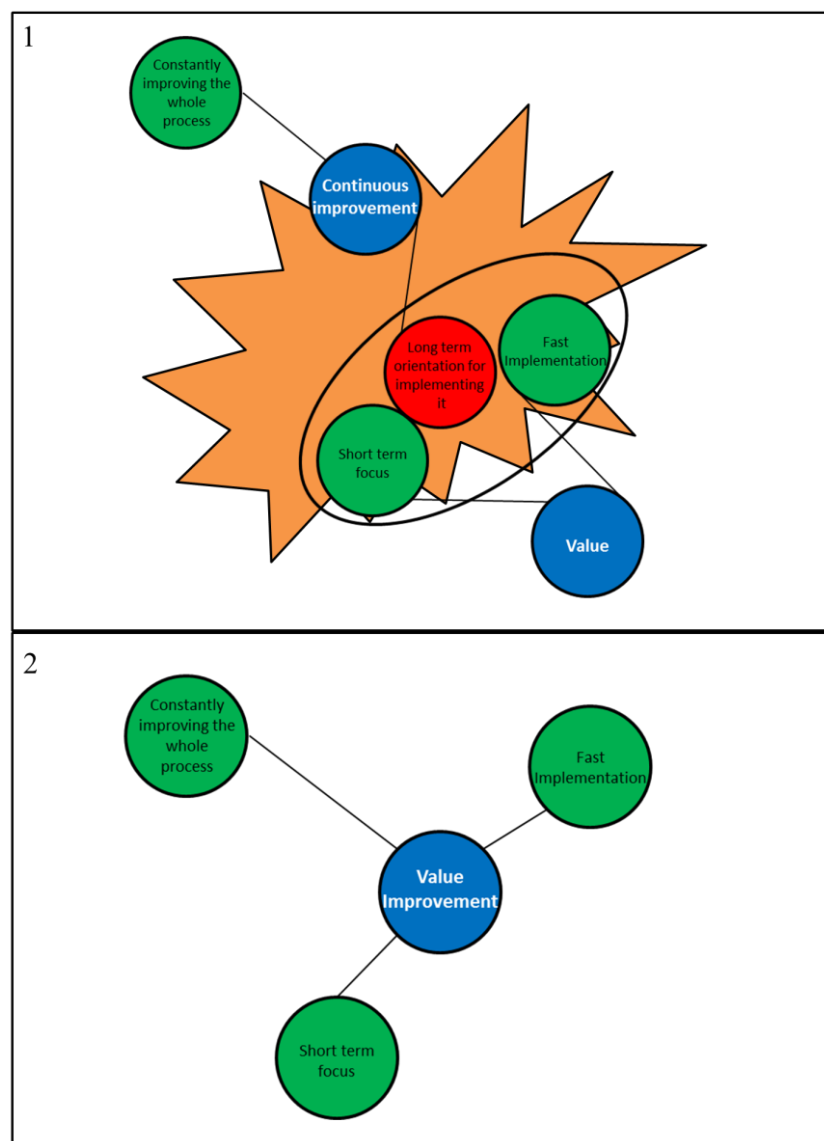


Figure 6-18 Lean merger: Continuous improvement

The weakness of being focused in the long term can be removed by applying the value principle of Agile (see Figure 6-18). The value principle's strength of being short term oriented and the ability to be implemented quickly creates a new principle, which is called "value improvement". Value improvement will focus on the quick wins during the project life cycle. This new principle is focused on assessing the potential improvements in relation with the required effort for those.

### **6.3.3 Agile merger**

This section will discuss the application of the merger approach to the principles of Agile PM (see Figure 6-7, p. - 236 -).

#### **6.3.3.1 Work break down**

A main principle of Agile PM is to break the whole project down into small modular elements (Aoyama, 1998). The primary data collected emphasised that the application of this principle takes the project complexity away. The reason for this is that these small individual and independent components are perceived as more tangible for the customer and the project participants (Highsmith and Cockburn, 2001). The application of this principle makes the whole PM process more flexible, because the project participants can change any project component, except the one which is currently in execution, as the project consists of individual and independent components (Schwaber, 2004; Hunt, 2006; Potter and Sakry, 2009; Flouri and Berger, 2010).

The literature (e.g. Lindstrom and Jeffries, 2004; Hass, 2007; Chan and Thong, 2009; Moe et al., 2010) and the interview findings stressed that existing structures cause a barrier for implementing this principle. Chan and Thong (2009) and Moe et al. (2010) found out that Agile PM requires new management skills and the change of existing work habits, because when implementing Agile the aim shifts from process optimisation to flexibility and responsiveness. The APs gave practical insights, where for instance existing controlling structures, which lead to process optimisation, hinder Agile practices. Hence a weakness of this principle is to deal with existing structures. In addition, the interviewed practitioners

challenged the feasibility of dividing the project into individual and independent components, for the case of construction projects. Agile divides the project down into small project components, where each component goes almost through each phase of the project life cycle (see Figure 2-8) within the iteration. This modular thinking did not find any acceptance by almost all practitioners interviewed. The reason for this is that the design and the execution cannot be separated of each other. A building has to follow a top down approach for the design, but a bottom up approach for the execution. Hence, the separation of individual and independent components has been identified as a weakness of this principle when associating it with construction.

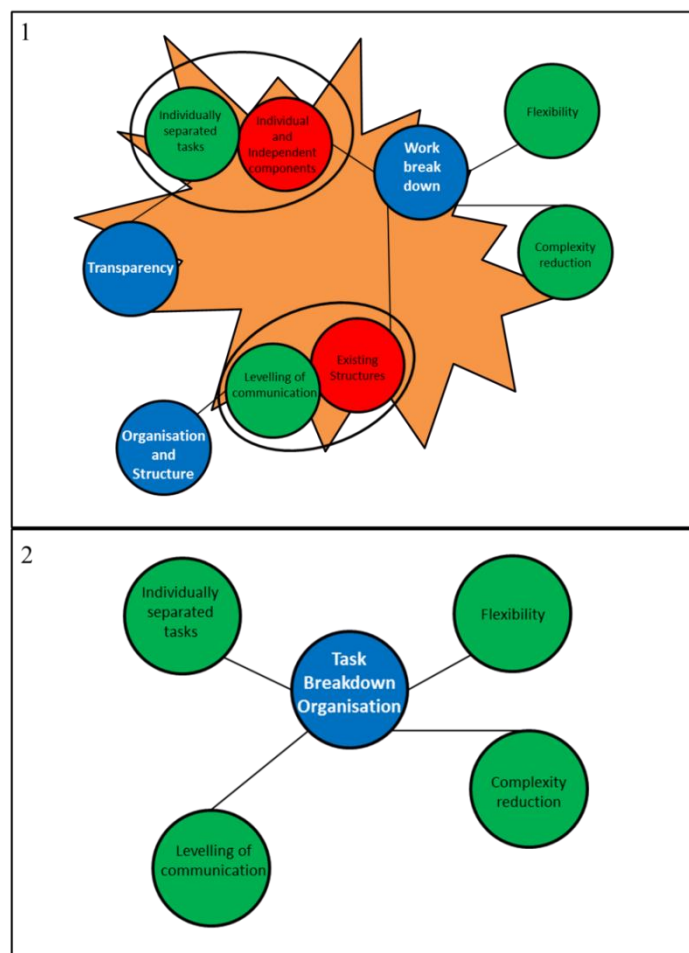


Figure 6-19 Agile merger: Work breakdown

The transparency principle of Lean construction is creating individually separated tasks. This keeps the relationship to other tasks and sees the project as a whole.

Hence, Figure 6-19 shows that the weakness of separating the project into individual and independent components can be removed through the transparency principle of Lean construction. The limited capability to deal with existing structures of this principle can be eliminated through the organisation and structure principle of PM. The organisation and structure principle of PM levels the communication between the project participants. Hence the work break down principle can be integrated into the existing structures and the communication and information can be filtered between the different hierarchies through getting support by the PM paradigm. The application of merger on these three nucleus fragments, results in a new principle called “task breakdown organisation”.

### **6.3.3.2 Iteration**

Agile assumes that the project dynamics cannot be mitigated (Highsmith and Cockburn, 2001; Moe et al., 2010). Therefore the aim of Agile is to cope with these project dynamics through a dynamic PM system (Hass, 2007). This dynamism is facilitated by iterations. The literature (e.g. Highsmith and Cockburn, 2001; Murphy, 2004; Chom, 2009; Moe et al., 2010) and the primary data collected emphasised that the planning of iterations allows the management of change in a systematic and structured way, as the project participants can change anything before and after the iteration. The interview findings indicated also that this flexibility enables the PM to better react to uncertainties. Hence this structured reactive management, results in the strengths of change and uncertainty management for this principle.

However, a barrier for Agile has been identified by the APs with bureaucratic environments. The APs explained that compromises are important when applying Agile. The clients do not have to focus so much on the project scope, because the team is performing different tasks and also re-doing some work. Hence, for the case that the client insists on performing the initial scope, the result is more work, as the PM has to do the whole scope plus additional tasks which were uncertain at the beginning. The APs identified another weakness of this principle, where they indicated that the plan as you go attitude seems quite chaotic and unreliable in

some cases. In addition, the general goal of promoting variability and always embracing change is related to physical limits within construction. Furthermore, the primary data collected stresses that even if it is not feasible, the general desire of the parties involved in construction, is to have a static and stable project environment. Given the conservative character of the industry, the result is that the direct application of the iteration principle, which puts the dynamic aspect to the fore, will not find acceptance by the parties involved in construction. The identified strengths and weaknesses of this principle and the application of the merger approach are shown in Figure 6-20.

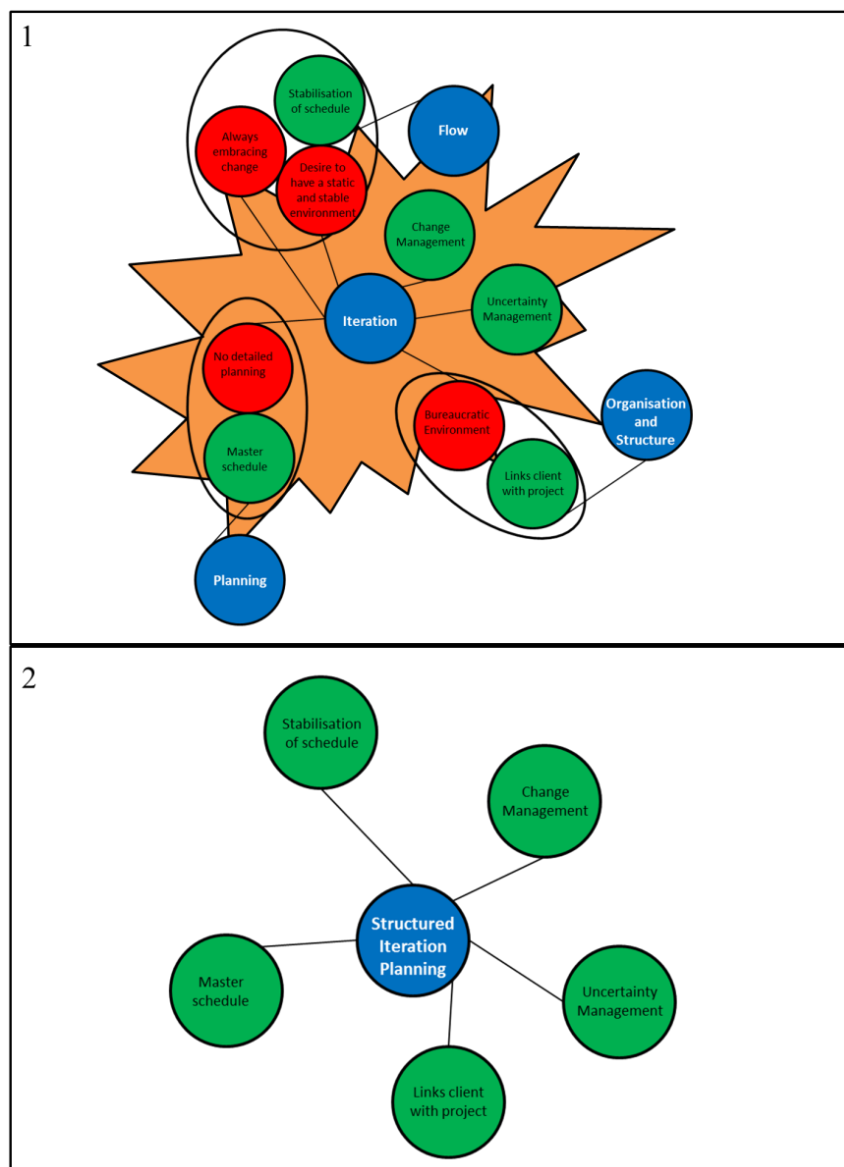


Figure 6-20 Agile merger: Iteration

The limited capability to cope with bureaucratic environments of the iteration principle can be removed through merging it with the organisation and structure principle of PM (see Figure 6-20). The function of the organisation and structure principle is here to eliminate the interfaces between the client's organisation and the project. The weakness of having no detailed planning can be rejected through the PM principle of planning. A master schedule can be used to identify the key milestones on the strategic level. On the operative level, Agile can proceed in its own way. The more construction related weaknesses of always embracing change and the desire to have a static environment by the parties involved can be eliminated with the flow principle of Lean construction. The flow principle creates stabilisation. Hence, stabilisation will be built in through creating reliability during the iterations, which will avoid a chaotic and unreliable project environment. The application of merger did result in a new principle called "structured iteration planning".

#### **6.3.3.3 Value**

The literature (e.g. Agile Alliance, 2001; Karlesky and Voord, 2008) and the primary data collected emphasised that Agile PM methods will deliver the customer working pieces of the project at the end of the iterations, which are perceived as value added by the client. In addition, the literature (e.g. Schwaber, 2004; Potter and Sakry, 2009; Fernandes and Sousa, 2010) as well as the APs interviewed indicated that the clients are very involved in the process, as they can prioritise tasks, give feedback and eventually change things. The high level of customer involvement has been identified as a strength of this principle. This results in that the focus of Agile is more on the short term. This has been identified as a strength, because it is in line with the short term focus of a construction project. In addition, the interview findings have shown that Agile PM has to be perceived more like a model. This results consequently in that the implementation of Agile PM is a fast and straight forward process, which has been identified as strength, too. The interviewees explained that they just did it, in most of the cases without letting the people know that it is Agile.

However, even though Agile shows a lot of things which may be perceived as value added by the customer, the APs who have been interviewed stated that they face difficulties in convincing the customer. The reason for this has been related to the quite unstructured and chaotic nature of Agile, where one has no detailed planning and just sees how the project evolves over time. Therefore convincing the clients or customers has been identified as a weakness.

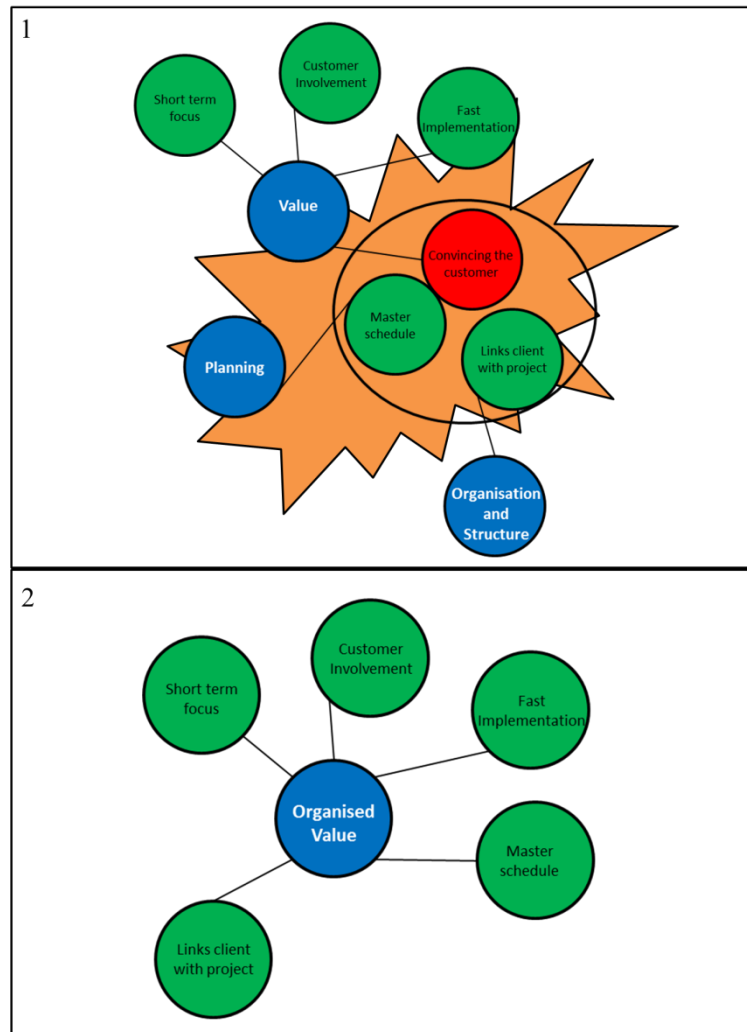


Figure 6-21 Agile merger: Value

Figure 6-21 shows that this weakness can be removed through merging this principle with the planning as well as organisation and structure principle of PM. The planning principle will provide a master schedule, where key milestones will be in place. The organisation and structure principle will eliminate the interfaces between the client's organisation and the project. Hence, the application of merger

on these three nucleus fragments, results in a new principle called “organised value”.

#### **6.3.3.4 *Self-organised team***

A key principle of Agile is to create self-organised teams (Agile Alliance, 2001; Hunt, 2006; Moe et al., 2010). The APs stressed that a distinction between technical and management level takes place within an Agile project. The self-organised team is responsible for the technical level (e.g. Hunt, 2006; Hu et al., 2009; Potter and Sakry, 2009; Fernandes and Sousa, 2010). The interviewees stated that this responsibility results in higher team motivation and team satisfaction, because the project team members have a platform where they can identify themselves with the project work. This cultural shift, which creates team satisfaction and team motivation, is identified as strengths.

However, the APs explained also that this self-organisation can result in self-realisation, i.e. following personal interests instead of team or project interests, which can cause a threat to the achievement of the project aims. Hence, if the team does not show the required amount of self-discipline, then it will end up consequently in a chaotic team organisation, which will not cause any level of motivation or satisfaction. In addition, the collected data emphasised that the conservative character of the industry, which is primarily focused on its own (mainly economic) interests (Winch, 1989; Wild, 2002) might not accept this innovative way of team arrangement for construction projects. The following figure shows how the strengths of other paradigms can eliminate these weaknesses.

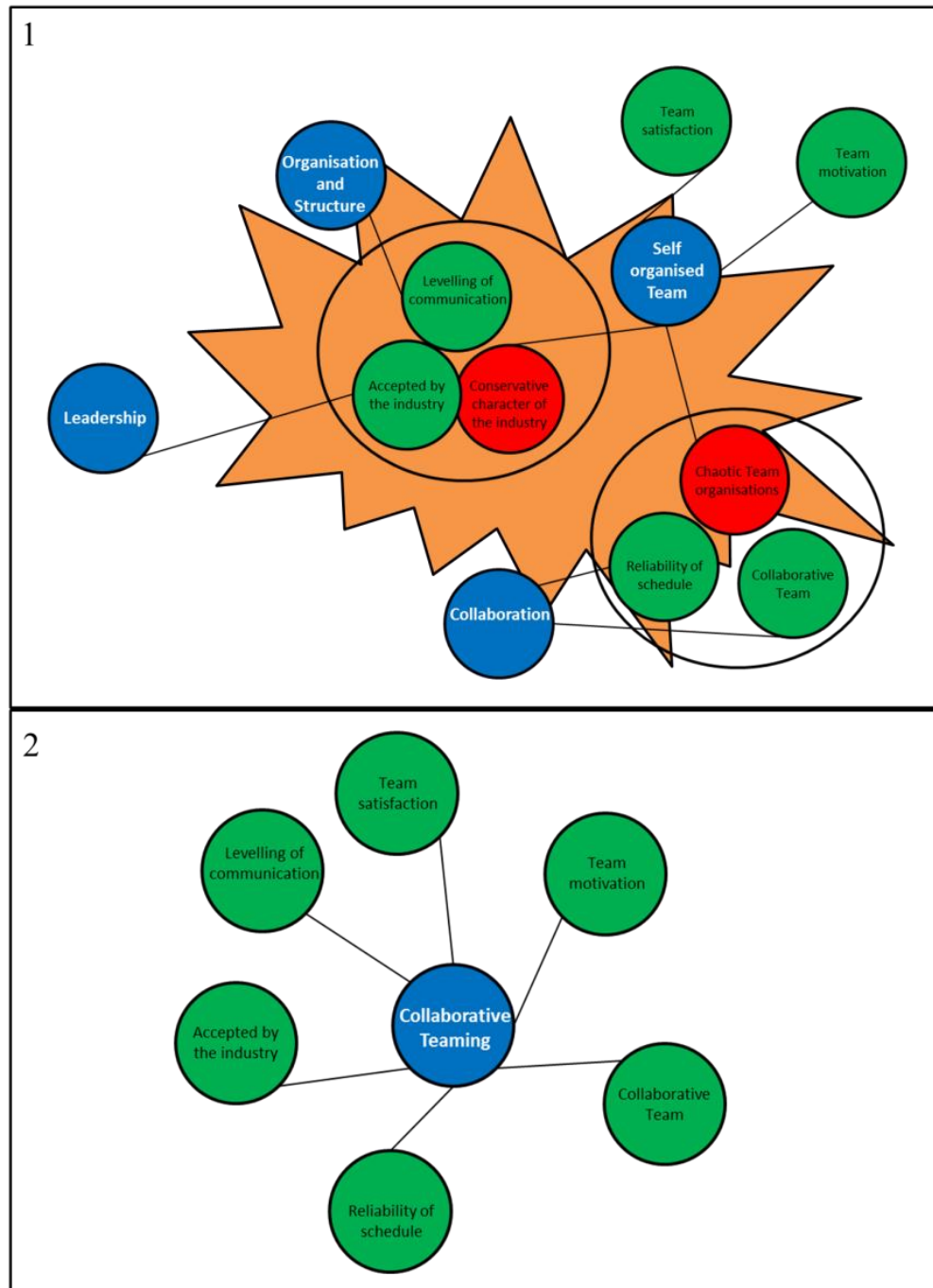


Figure 6-22 Agile merger: Self-organised team

The collaboration principle of Lean construction has the strengths of creating a collaborative team and reliability within the work program. Hence the weakness of having chaotic team organisations can be removed with these two characteristics of the collaboration principle (see Figure 6-22), because besides the project responsibility, those two characteristics will reinforce also the

responsibility between the team members, which will force the team to be self-disciplined. The weakness of coping with the conservative character of the construction industry can be eliminated through involving two PM principles, namely the principle of leadership and the principle of organisation and structure. The principle of leadership is accepted by the industry and will force the participants to do what is good for them. The organisation and structure principle will eliminate the interfaces between the different project levels and support the team in working with no disruptions. Hence through the application of the merger approach to this context, a new principle evolved called “collaborative teaming”.

#### **6.3.3.5 *Lessons learned***

The literature (e.g. Agile Alliance, 2001; Murphy, 2004; Hunt, 2006; Fernandes and Sousa, 2010) and the primary data collected emphasised the importance of so called “retrospective meetings”. These meetings take place at the end of the iterations. The strength of this principle is that it promotes continuous improvement. No weakness has been allocated to this principle.

### **6.4 Development of the AgiLean PM framework: re-merger of principles**

The application of the merger approach to the derived paradigm atoms created new principles which consist in theory only on strengths. The result of the merger approach is illustrated in Figure 6-23 (see p. - 266 -).

The application of the merger approach shows that the weaknesses of a paradigm can be eliminated through the strengths of another paradigm. However, within this bunch of principles there are several principles, which contain the same characteristics. The aim of this section is to refine these principles and merge them together. This will be facilitated through applying again the merger approach, but this time the principles with the same characteristics will be merged together. This approach has been labelled for the purposes of this research as “re-merger”.



### 6.4.1 Collaborative Teaming

In Figure 6-23 (p. - 266 -), three principles, which are called collaborative teaming have been identified. Those consist also of similar characteristics. The re-merger approach will cause a reaction, where the similar characteristics will merge with each other. This is shown in the following figure.

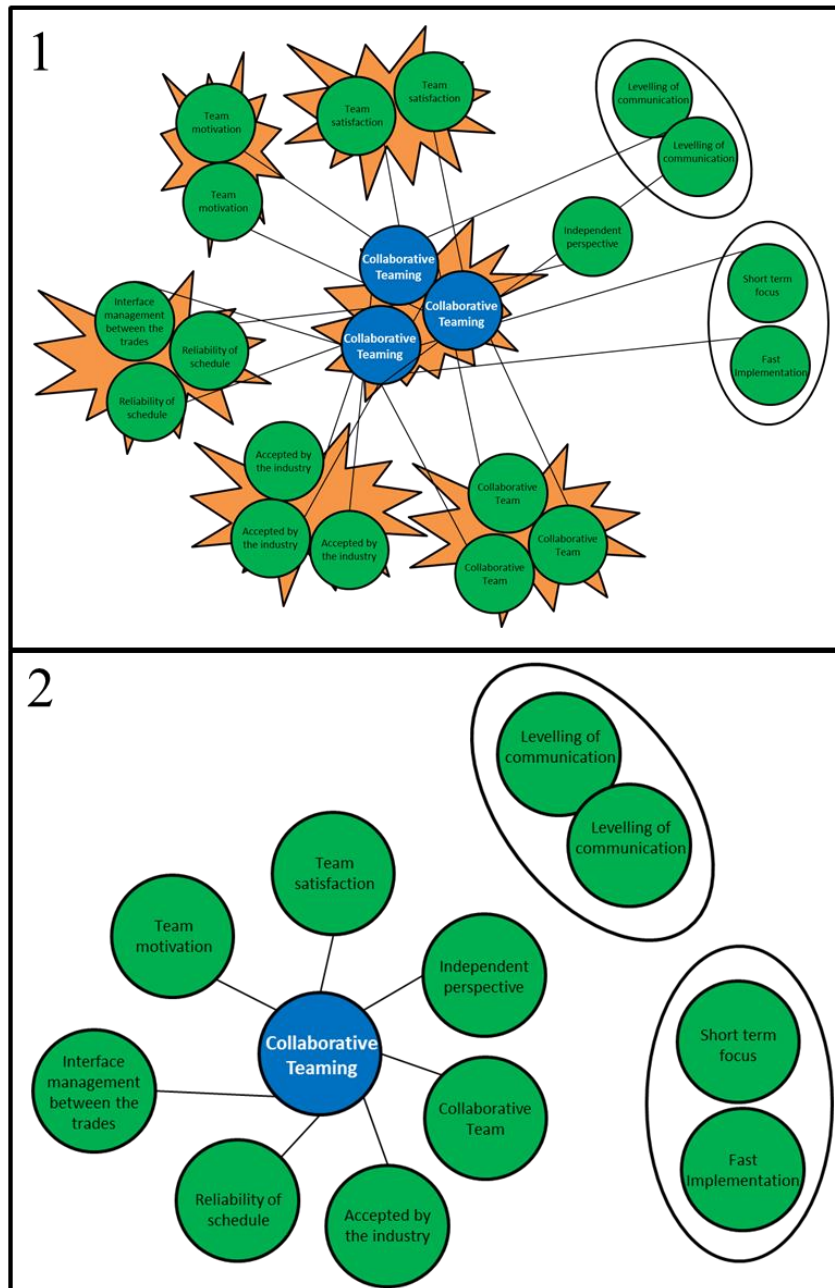


Figure 6-24 Re-merger: Collaborative teaming

The application of the re-merger approach on the three nuclei created a new principle, which is still called “collaborative teaming” (see Figure 6-24). The focus is on creating a collaborative team. This will be forced with “old school” leadership, which will result in that the parties involved in construction will not judge its acceptance. This enforcement needs to be stipulated into the contracts, but it does not require particular contracts, which are based on a bonus system. The focus of the team has to be on the project as a whole. Even if this seems quite unfeasible, due to the culture of the industry, it can be achieved through building reliability between the team members. The reliability will be achieved through agreeing within the team on achievable goals. Each party has to contribute its part, so that the next party can continue working. This approach changes the autocratic to a more democratic environment, where each participant has agreed on the targets by themselves and said that they can provide the agreed work. This creates subconscious dynamics, where each party has to show that they are a competent partner of the team. These interactions eliminate also the interfaces between the trades or between the different service providers, because those are actively engaging into the process and communicating with each other. Within the collaborative team there is the separation between strategic and operative levels. The facilitator for this is the “project consultant”. This issue can be illustrated with the following diagram.

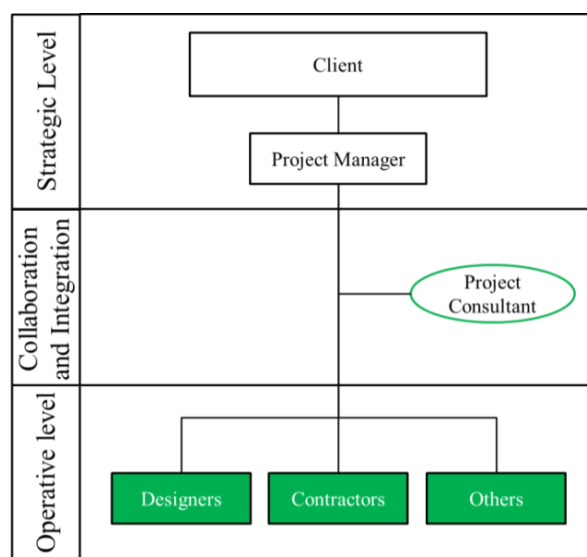


Figure 6-25 organisation chart for AgiLean PM

The Project Consultant [PC] (as shown in Figure 6-25) is a new person involved into the project. The PC is an integrator, working to eliminate any barriers that may exist at the interface between strategic and operative level, when implementing the Agile PM framework. Traditional project manager(s) will still exist, as the representative of the owners. However, the project work itself will be directed by the PC. Communication and reporting between the PM and the organisations on the operative level will be channelled through this new organisational structure. The PC will facilitate the distinction between the strategic and operative level. The operative level will be based on self-organised collaborative teams. However, the PC still gives the framework in which those organisations have to act or which methodology they have to follow. The interfaces between those teams will be eliminated by the PC. The difference between the PC and normal consultants is that in the ideal case the PC will actively engage in the process with responsibility and not just tell the others what to do. The PC has to enrich the project with an independent perspective, which is independent of the owner, designer, contractor or other perspectives.

The creation of collaborative teams, which are self-organised, will result in that the project participants have their own bit of responsibility and contribute to the successful completion of the project. Consequently will this lead to high levels of team motivation and satisfaction. The PC has to be considered at early project phases. The other participants can be integrated into the project at the appropriate stages.

The characteristics of “levelling of communication”, “fast implementation” and “short term focus” (see Figure 6-24) have been not considered for this principle, because those fit better to different principles. However, those characteristics will be part of the framework and therefore impact also on this principle, but more indirectly.

### 6.4.2 Project compilation

Figure 6-23 (p. - 266 -) shows that the principles “transparency”, “task breakdown organisation” and “dynamic organisation and structuring” show similar characteristics. The application of the re-merger approach is illustrated with the following figure.

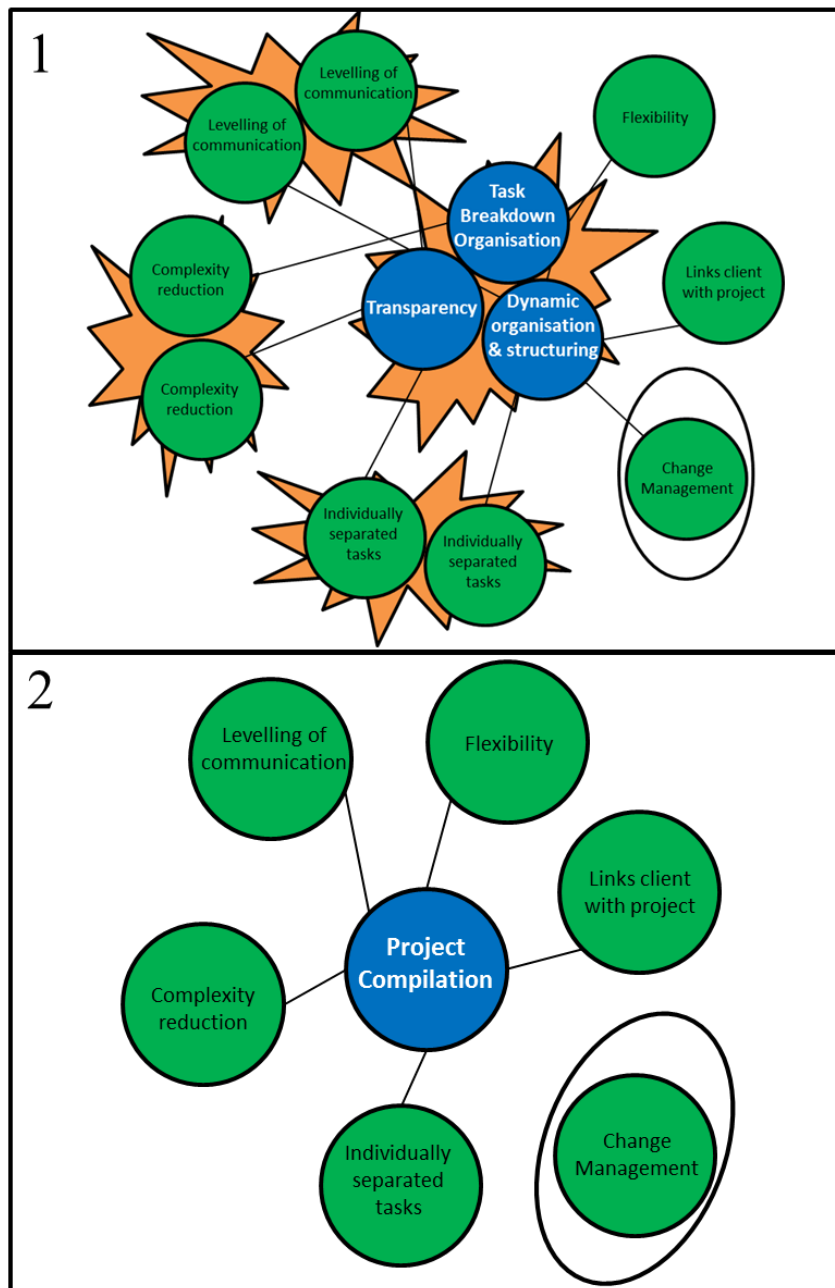


Figure 6-26 Re-merger: Transparent organisation and structure

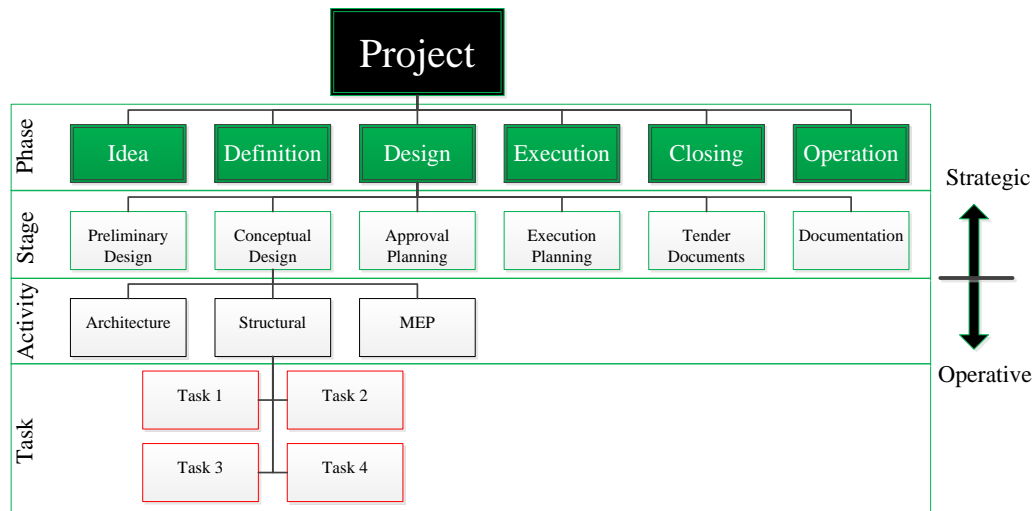
The application of the re-merger approach, to the three nuclei, created a new principle called “project compilation”<sup>4</sup> (see Figure 6-26). The principle of project compilation builds the appropriate PM system from scratch and/or translates existing PM systems into the AgiLean PM context. The issue of translation seems crucial, because most of the interviewed practitioners complained that their PM systems are used reactively (like the fire brigade). Hence, the AgiLean PM framework needs the ability to fit into existing PM systems reactively. The principle of project compilation can be divided into two levels, namely strategic and operative.

On the strategic level it is underpinned with universal PM methodologies, such as those of the PMI (2008) or APM (2006). Hence, issues such as the master schedule, cost calculations, project structure, project organisation, contract typologies, and decision management have to be undertaken within this principle at the strategic level. Those help integrate the project with the client’s organisation and create consequently a linkage between project and client. In addition, the communication flows will be set up by the PC. This facilitates that each involved party will receive the required amount of information at the right time.

The framework for the operative level will be set by the PC. This starts with reducing the complexity of the project. The high separation between the design and the execution, the result is that a division of individual, modular and independent elements seems not feasible. However, instead of the trial to break the project down into object oriented elements, AgiLean PM will use an activity oriented project structure. An example of this is illustrated below.

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<sup>4</sup> To name this principle “project compilation” is inspired by the word compiler, which is used in software development to translate computer languages.



**Figure 6-27 AgiLean Project Breakdown**

The highest level of the project structure consists of the different phases (see Figure 2-8, p. - 28 -), which is followed by the different project stages<sup>5</sup>. The activities will be categorised through the different designers or different trades. The tasks of the activities describe the work which needs to be done, which is comparable to the assignment approach of the LPS (Ballard, 2000a). The top two elements are on the strategic level and the first two elements from the bottom are on the operative level. The interfaces between strategic and operative level will be mitigated through the PC. The AgiLean Project Breakdown will be undertaken after the object oriented project breakdown structure has been developed for the project. This makes the creation of the AgiLean Project Breakdown simpler.

In general this approach is comparable with the project Backlogs approach of Scrum (Schwaber, 2004, see section 0). The difference is that instead of dividing a project into individual and independent elements, the applied approach here, is to emphasise a project as a number of different activities. The progress will be measured on the finished activities and not anymore on the completed building elements. The activities can be related back to the object. This facilitates flexibility, as diverse activities can be sequenced in the most appropriate way.

<sup>5</sup> The stages in Figure 6-27 have been adopted by the German regulation for “Fee Structure for Architects and Engineers”.

The characteristic of change management (see Figure 6-26, p. - 270 -) has been used for other principles, as it appeared on those more than one time.

### 6.4.3 Collaborative iteration planning

Figure 6-23 (p. - 266 -) shows that the principles “structured iteration planning” and “collaborative adjusted planning” show similar characteristics. The application of the re-merger approach is illustrated with the following figure.

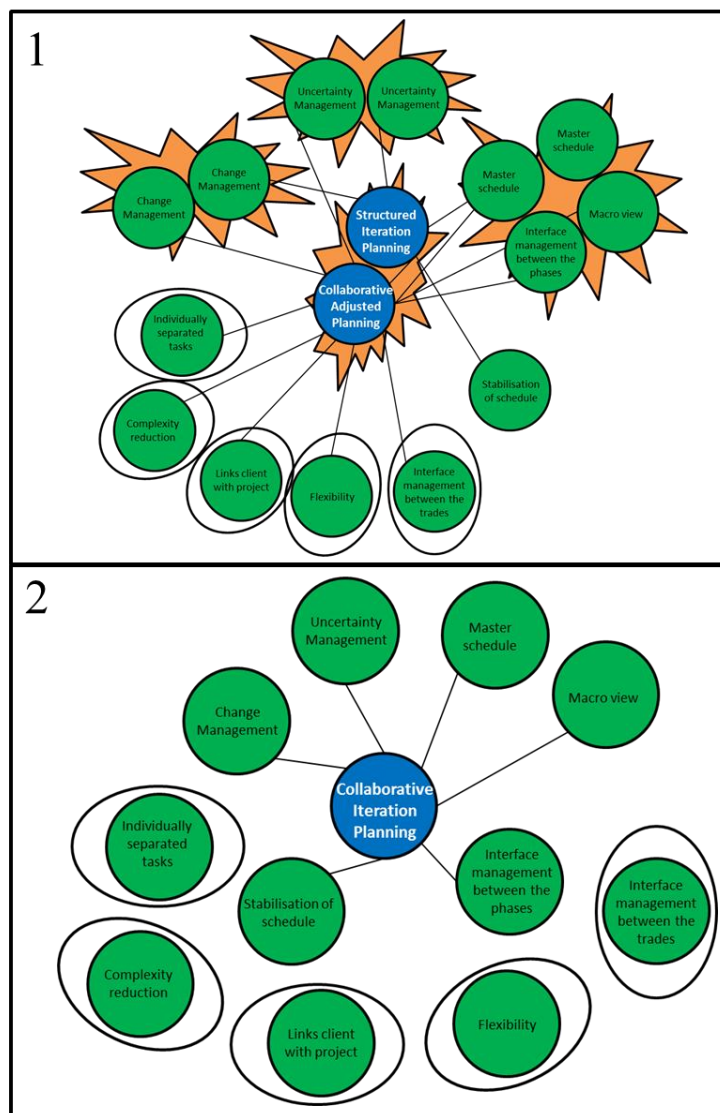


Figure 6-28 Re-merger: Collaborative iteration planning

A new principle called “collaborative iteration planning” evolved through the application of the re-merger approach (see Figure 6-28). The previous two

principles are the enablers for this principle. Collaborative teaming needs to be in place so that there is a certain amount of reliability between the team members. Project compilation is required so that the strategic issues and the operative framework are established.

The aim of this principle is to plan the iterations, which will take place. This will happen in a collaborative environment, because the collaborative environment is reliable. This reliability can be used to stabilise the program during the iterations. During the iterations there is no allowance to have changes. Uncertainties cannot be avoided. However, the detailed planning will take place, the closer one gets to the work (Ballard, 2000a), which results in that most of the uncertainties can be transferred to risks, as estimations of the probabilities can be done.

The more dynamic the environment is the smaller have to be the time horizons of the iterations. Especially at early project stages, it might be the case to have short iterations, because those stages have to be more responsive to change. The PC has to moderate the collaborative environment. The focus has to be on the project as a whole, which will be facilitated through the master schedule. The master schedule will inform about the key milestones and will provide an overview about the interfaces between the different phases. The planning done is activity based. The iterations focus also on activities and the task, which belongs to those. The combination of the master schedule with the AgiLean Project Breakdown (see Figure 6-27, p. - 272 -) will provide a transparent overview about what has to be performed.

The client or the project manager will provide the key milestones which need to be achieved. These will be then the goals for the collaborative team. The collaborative team will plan together with the PC the iterations in a way, so that those will achieve the key milestones. The PC is responsible for setting achievable goals. The collaborative team will plan in detail the required tasks which need to be performed within the iteration. After the iteration, the defined goal has to be achieved. Hence the project will be planned by a set of certain goals, which will be defined and prioritised by the client and/or the PM.

The characteristics of “individually separated tasks”, “complexity reduction”, “links client with project”, flexibility”, “interface management” have been or will be considered for other principles (see Figure 6-28).

#### 6.4.4 Controlled iterative pull

Figure 6-23 (p. - 266 -) shows that the principles “iterative pull”, “controlled iterative flow” and “iterative controlling” have similar characteristics. The application of the re-merger approach to merge those nuclei together is shown in the following figure, which creates a new principle called “controlled iterative pull”,

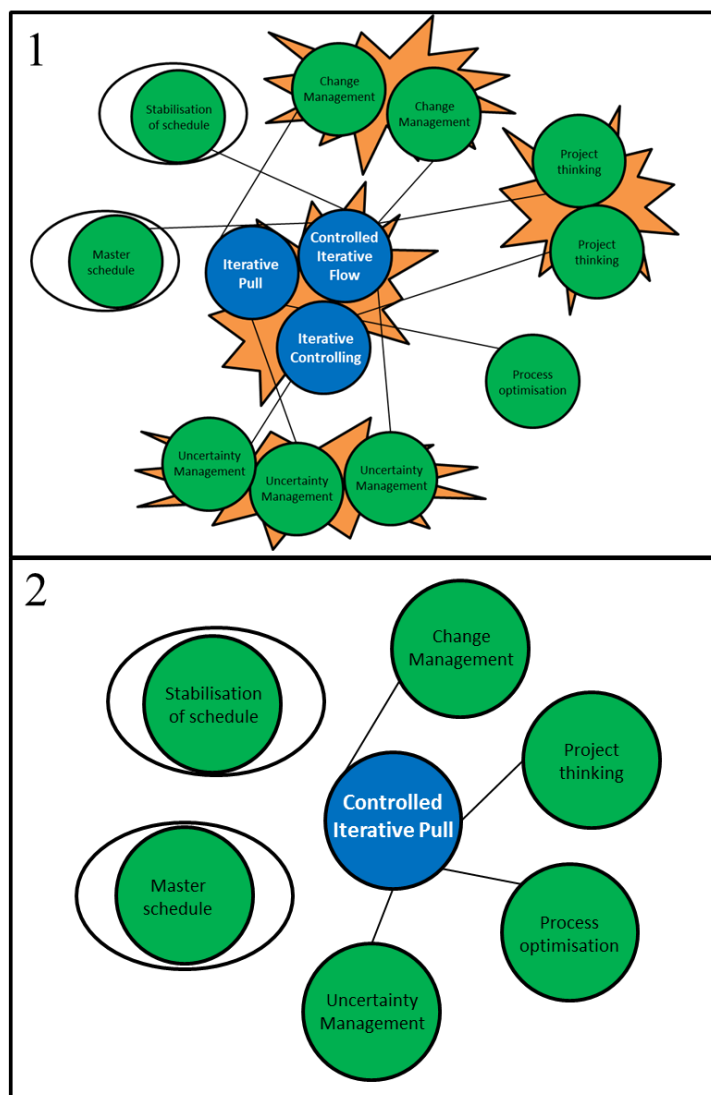


Figure 6-29 Re-merger: Controlled iterative pull

On the strategic level, the PC has to install an appropriate controlling instrument, which is in line with the customer requirements. The controlling instrument will track the project, show if the expected meets the actual performance, and manage risks proactively.

On the operative level, the collaborative team will optimise together the process of getting the tasks done. This will be facilitated through the application of the pull principle of Lean construction for tasks and for the logistics (Ballard, 2000a), but only during the iterations. Hence, the length of the iterations will be defined by the supply chain. It depends on lead times for design and materials. The reason for this is that a construction project is characterised with high levels of uncertainty (Winch, 2006). Hence a detailed planning in advance seems not feasible for construction projects (Rodrigues and Bowers, 1996; Chapman, 1998; Atkinson et al., 2006). Consequently the application of the pull principle also seems limited for construction projects, as just in time deliveries have no room to cope with changes. However, optimising the work within the execution of the iterations provides better forecasts and allows detailed planning, because the iterations consist of short time intervals. Hence uncertainties and changes can be handled and the process can be optimised.

If possible, changes should not occur during the iterations, because they will impact the process. Nevertheless, changes can be planned before or after the short iterations. Iterations should not be delayed by any party involved, because it is difficult to catch up any delay within the iterations.

The “stabilisation of schedule” and “master schedule” characteristics have been used for different principles.

### 6.4.5 Value driven improvement

Figure 6-23 (p. - 266 -) shows that the principles “organised value”, “lessons learned”, “customer value”, “value improvement”, and “value driven aims” have similar characteristics.

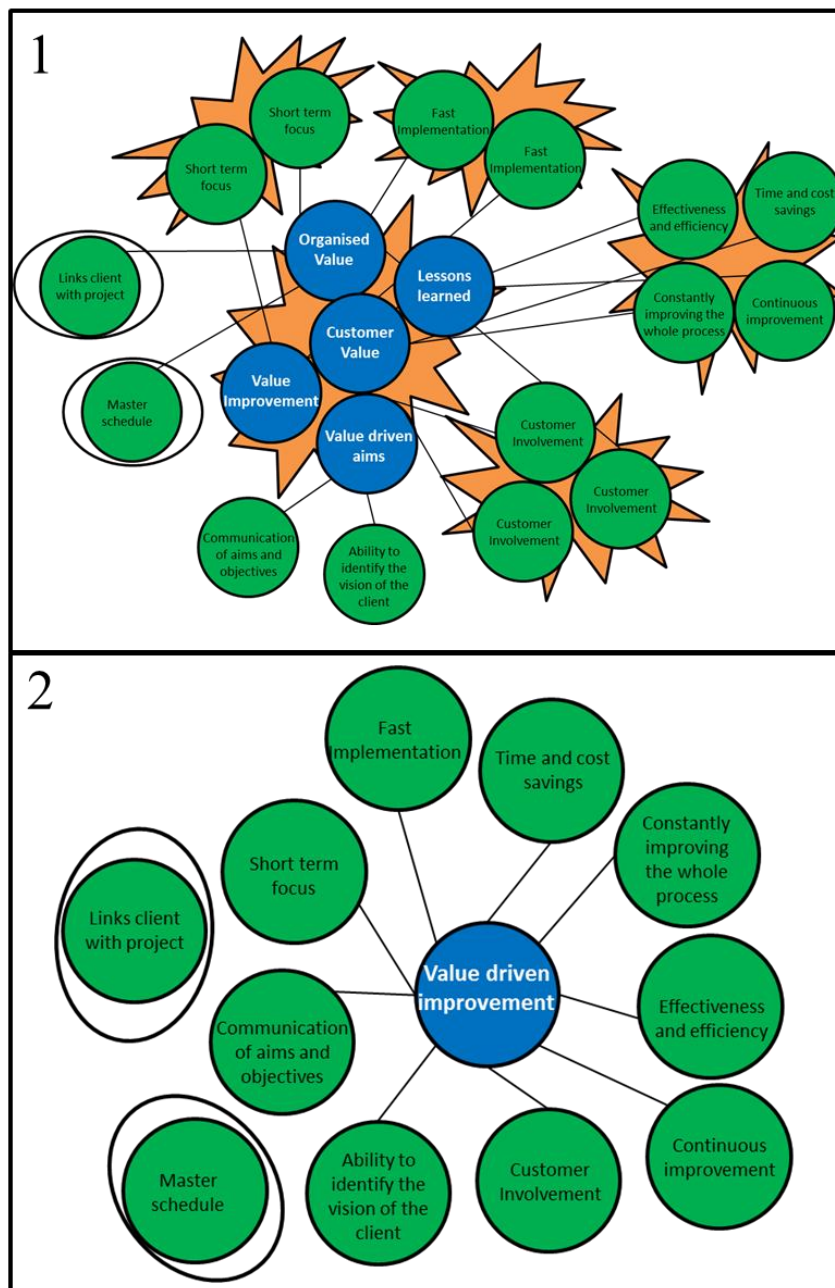


Figure 6-30 Re-merger: Value driven improvement

Using the re-merger approach on these principles creates a new principle called “value driven improvement” (see Figure 6-30). The focus of this principle is on the client. Different clients might have different aims or define project success differently. As an example, for the 2012 Olympics in London, project success was in part measured by time, because the opening ceremony had to take place on the 27<sup>th</sup> July 2012. Hence, even if the project would deliver higher quality standards or impressive cost savings, the project would have been still perceived as unsuccessful, if it had not met the key milestones. Therefore the PC and PM have to define together with the client the aims and objectives of the project. This is a crucial task and sets the foundation for the project compilation. In addition, the vision of the client has to be derived. The gathered data indicated that this happens in practice normally with a kick-off workshop.

The vision, aims and objectives have to be then articulated to the collaborative team, so that everybody in the project is aware of what has to be constructed. The collaborative team has to focus on project success, which goes beyond the Iron-Triangle of PM (deWit, 1988; Chan and Chan, 2004). The attitude which guides the behaviour has to satisfy the client. Following this philosophy, improvements have to be made continuously.

However, the primary data indicated also that the aims and objectives can change over the project life cycle, because at the beginning the clients cannot have a clear picture. Therefore is the definition of the aims and objectives a cyclic process, where a constant follow up needs to take place.

The principle of project compilation allows the fast implementation of the AgiLean PM framework, because the focus of the AgiLean PM framework is on the short term, i.e. on the project period. As mentioned in the previous sections there is the desire to plan everything in detail. This desire results in that the parties involved in construction pursue a stable and static environment for construction. If this could be achieved then continuous improvement for instance through using the Plan-Do-Check-Act [PDCA] Cycle (or Deming Cycle) could be implemented (Slack et al., 2008). The Deming Cycle is shown in the figure below.

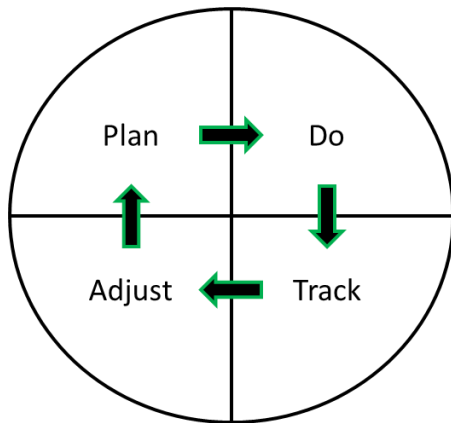
The figure originally presented here cannot be made freely available via LJMU Digital Collections because of copyright. The figure was sourced at: Slack, N., Chambers, S., Johnson, R., & Betts, A. (2008). *Operations and process management - principles and practice for strategic impact* (2nd ed.), p. 432. Harlow: Pearson Education.

Figure 6-31 PDCA -Cycle (Slack et al., 2008, p. 432)

The PDCA-Cycle starts with planning the work. Then it continues with executing or doing the work. After this, the done work will be checked, for instance through the definition of value added, non-value added and waste activities; so that finally improvements can be made. However, the PDCA-Cycle assumes also that there is more than one chance for improving the outcome. This is applicable for manufacturing or for Lean production, because a prototype can be improved several times and the production lines output can be improved over time, too. This is also applicable for IT projects which are managed with Agile methods, because the work is separated into individual components, which can be improved independently. Hence, even though the PDCA is cyclic in its nature, it is still rigid and monolithic and not really flexible.

However, as discussed widely in the literature review (see section 2.1.4), construction projects are highly dynamic undertakings (Baccarini, 1996; Gidado, 1996; Raiden et al., 2004). This dynamism of construction projects is mainly caused because of uncertainties. These uncertainties cause changes. These changes cause in turn a dynamic environment. Hence the reason for dynamism in construction projects is cyclic.

Considering this background and comparing it with the practical insights gained from the interviews, the result is that there is a slightly different version of the PDCA-Cycle already in place for construction, which is illustrated with the following figure.



**Figure 6-32 PDTA - Cycle**

Even if there is the desire to plan everything in advance, the plan needs to allow room for changes (Olsson, 2006). What the construction project environment requests is a concept, which allows planning the work, then doing the work, tracking while doing the work, and adjusting to any uncertainties or actions, which will cause improvements. This is the main model behind the value driven improvement principle of the AgiLean PM framework.

## 6.5 The concepts of the AgiLean PM Framework

To sum up so far, the derived principles of the AgiLean PM framework are shown below.

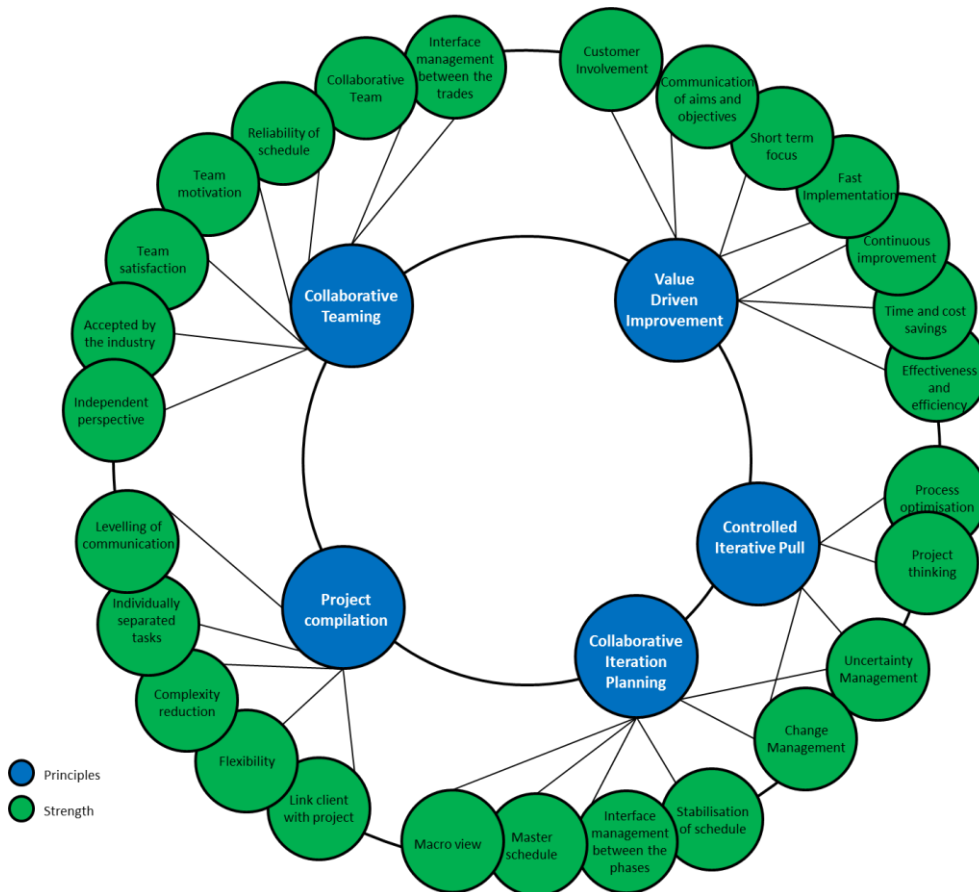


Figure 6-33 principles of the AgiLean PM framework

The five principles of the AgiLean PM framework will lead to the concepts, which are discussed in the following sections. The concepts cannot be related to a particular principle, because they are generic.

### 6.5.1 Organisation

AgiLean PM does not claim to make sense for any type of project. The focus of the AgiLean PM framework is on highly dynamic projects, where the unknown factors exceed the known factors (see Figure 2-3, p. - 20 -). To emphasise when to use the AgiLean PM paradigm, the product-process-matrix of Slack et al. (2008)

has been modified, so that the upstream has been categorised as Agile and the downstream has been categorised as Lean. This is conceptualised as “AgiLean Matrix” and is illustrated in the following figure.

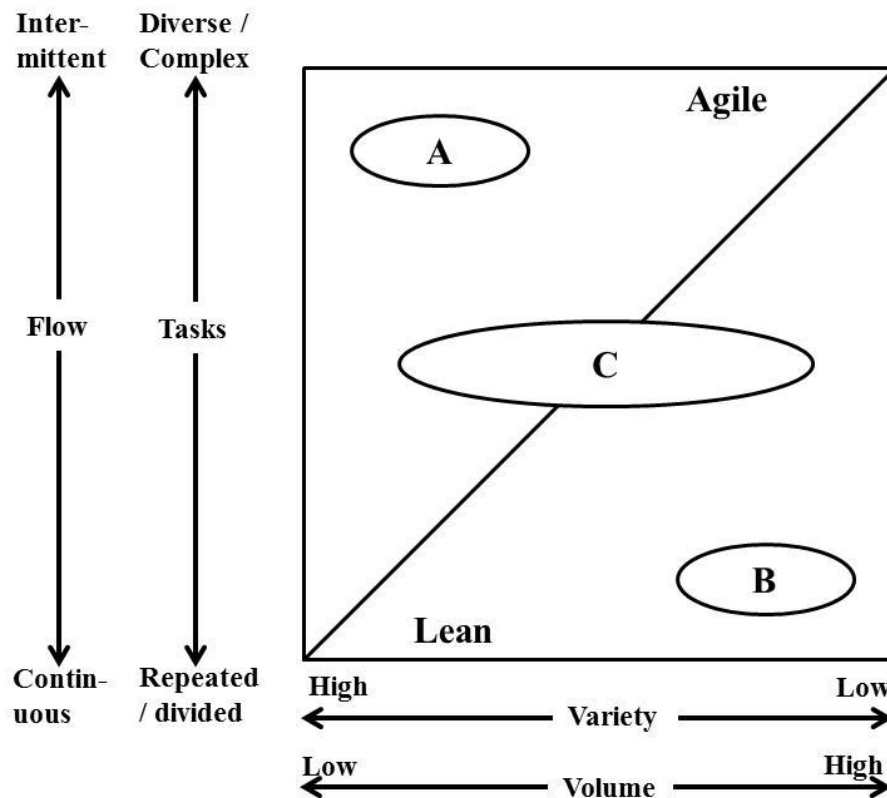


Figure 6-34 AgiLean Matrix

The AgiLean Matrix (see Figure 6-34) gives a transparent overview to the PM about when to use which paradigm. The evaluation can be based on phases, tasks or situations. If a situation is classified as upstream, e.g. see (A) in Figure 6-34, then Agile methodologies might be more appropriate. If a situation is classified as downstream, like (B), then Lean methodologies may be the best. However, if a situation is in between, for instance like (C), then AgiLean PM should come on board. This is of course a qualitative approach, which will support a transparent decision making in selecting the right paradigm for a project.

The AgiLean PM framework is integrative in its nature. It does not claim new structures, cultural changes or a defragmentation of the industry. This integration is facilitated through the introduction of the PC. The PC is the facilitator of the

AgiLean PM framework and is responsible for implementing the principles. Hence “organisation” has been indicated as a generic concept.

### **6.5.2 Collaboration**

A collaborative environment will allow the elimination of interfaces between the designers and building trades, will create trust, and will allow the delivery of better project performance. Lean and Agile have a collaborative environment in place, but it is approached in a democratic way. It requires the willingness of all participants to take part. Given the conservative character of the industry, the result is that it is challenging to gain the willingness of the project participants. In fact, most of the interviewed Agile and Lean practitioners emphasised that the conservative character of the industry is a main barrier for implementation. However, the AgiLean PM framework will force the project participants to have this collaborative environment in place. This will be facilitated through approaching it in an autocratic way at the beginning. To facilitate this, the PC will form the collaborative teams and set up the required meeting structures. Hence “collaboration” has been identified as a generic concept.

### **6.5.3 Iteration**

Iterations are another generic concept, which need to be built into the project. Iterations give the ability to plan the work in small manageable sizes. The iterations will be planned activity based. Hence the aim is not to create modular object oriented elements, but rather independent activities, which can be planned. Iterations give the ability to react to change and uncertainty. Hence the heart of the AgiLean PM framework is based on uncertainty management, which has been identified by Winch (2006) as a prerequisite for successful PM in construction. The more dynamic the environment, the shorter has to be the iteration cycles.

### **6.5.4 Stabilisation**

Changes will be kept to a minimum during the iterations. The desire here is to pursue a stable environment, where activities can be divided into value added,

non-value added and waste. Stabilisation will allow process optimisations and the increase of effectiveness and efficiency. The collaborative environment will also push for stabilisation through creating reliability. Keeping the iterations as short as possible will allow the transformation of uncertainties to risks. Hence another generic concept is “stabilisation”.

## 6.6 AgiLean PM vs. Leagile

A summary of the key differences between AgiLean PM and Leagile is shown in the following table.

**Table 6-1 Comparison of Leagile and AgiLean PM**

Comparing Criteria	Leagile	AgiLean PM
Origin	Manufacturing	Construction
Reason for development	To manage the whole supply chain of products	To improve Lean construction
Designed for	Managing the execution (for the case of construction)	Managing the whole project lifecycle
Components	Agile Manufacturing and Lean Production	PM, Lean Construction and Agile IT
Concept	To use Agile Manufacturing and Lean Production sequentially	To merge PM, Lean Construction and Agile IT into a holistic unit
Environment	Dynamic and static sequentially.	Dynamic

Table 6-1 shows that the key difference of AgiLean PM and Leagile lies in their concepts. Leagile tries to use Agile manufacturing and Lean production sequentially. This applies well for supply chains which are characterised through both, dynamic and then static, or static and then dynamic environments. The switch between the different environments is facilitated through the decoupling point model. AgiLean PM, in turn, has merged PM, Lean construction, and Agile IT to a holistic unit. It is designed for dynamic construction projects, which face difficulties in applying Lean construction. The outcome is the management of project uncertainty in an effective and efficient manner.

## 6.7 Verification of the AgiLean PM framework

The following sections will verify the developed framework from three different perspectives. The first section has the aim to verify if the ontology of this framework is in line with the world view of construction practice. Second, the practicality of the derived framework will be assessed. Finally, the transferability of the derived framework will be discussed.

### 6.7.1 The ontology of AgiLean PM

The concepts, principles and characteristics have been discussed widely in the previous sections. However, what is missing is the view on reality, i.e. the ontology of AgiLean PM, because the view on reality of AgiLean PM has to be in line with reality of construction projects. The reviewed literature and the interview findings stress that Agile and Lean differ in their view on reality.

The view on reality can be related to the environment where these paradigms have been initially developed. A synthesis of the reviewed literature and the interview findings is shown in the following table.

**Table 6-2 main characteristics of the different environments**

Industry	Series	Environment
Construction [PM]	One time	Dynamic
Production [Lean]	Several times	Static
Software development [Agile]	One time	Dynamic

Lean has its origins in the automotive or manufacturing industry (Womack et al. 1990; Womack and Jones, 2003). The environment of production (plant) is static, i.e. there is a sequence of activities which have been clocked in order to produce several times the prototype which has been developed once, as efficiently as it is possible (Womack et al. 1990). A tool is Lean when it fulfils the Lean production principles. The Lean production principles, which are to specify value, identify the value stream, flow, pull and pursuing perfection have been developed in a static environment for a dynamic product, which will be re-produced several

times. The overarching objective of Lean is to eliminate waste. The best environment for Lean is a static, stable environment, because it originated in that field. Such an environment allows the sequential forecasting of process steps, where then waste activities can be identified and eliminated. This requires a specific view on reality, namely that of objectivism, i.e. there is an existing project with no or low influences from its environment. If this can be facilitated, then Lean will show the highest benefits for construction projects. The interview findings and the literature highlight also that Lean advocates are profoundly convinced that if the Lean philosophy is implemented, the project will always result in more success, i.e. higher performance. To conclude then, the dominant view of Lean on the construction environment is characterised by objectivism, i.e. it does not depend on the context, people, or project dynamics to implement the Lean philosophy; and if the Lean philosophy is implemented, you will have always better performance.

Agile has been developed in the IT-sector by software practitioners (Agile Alliance, 2001). A tool or a method is Agile, when it fulfils the twelve Agile principles. By fulfilling the twelve principles the four Agile values are met. The IT environment is project-based like construction. A dynamic or flexible environment suits best for Agile PM methods, because the predominant objective of Agile is to identify and handle change. A dynamic environment faces changes, which can be caused by certain or uncertain factors. Agile allows you to act proactively, but also reactively to those changes. Hence the view on reality of Agile is characterised by subjectivism, i.e. a project is socially constructed and there will be different levels of influences by its environment. Agile believes that it makes no sense to have a detailed planning in advance. Agile is following a plan as you go philosophy, which is regarded as very flexible. The Agile advocates are certain that Agile paradigms do not fit to each type of project, because the dynamic aspect has to be to the fore.

To sum up so far, Lean is following a more objectivist ontological orientation, whereas Agile is a devotee of the subjectivist view on reality. This view on reality can be related to flexibility. Lean is rigid and Agile is flexible, in which this

rigidness or flexibility can be associated to the environment where those paradigms have originated from. This is illustrated with the following figure.

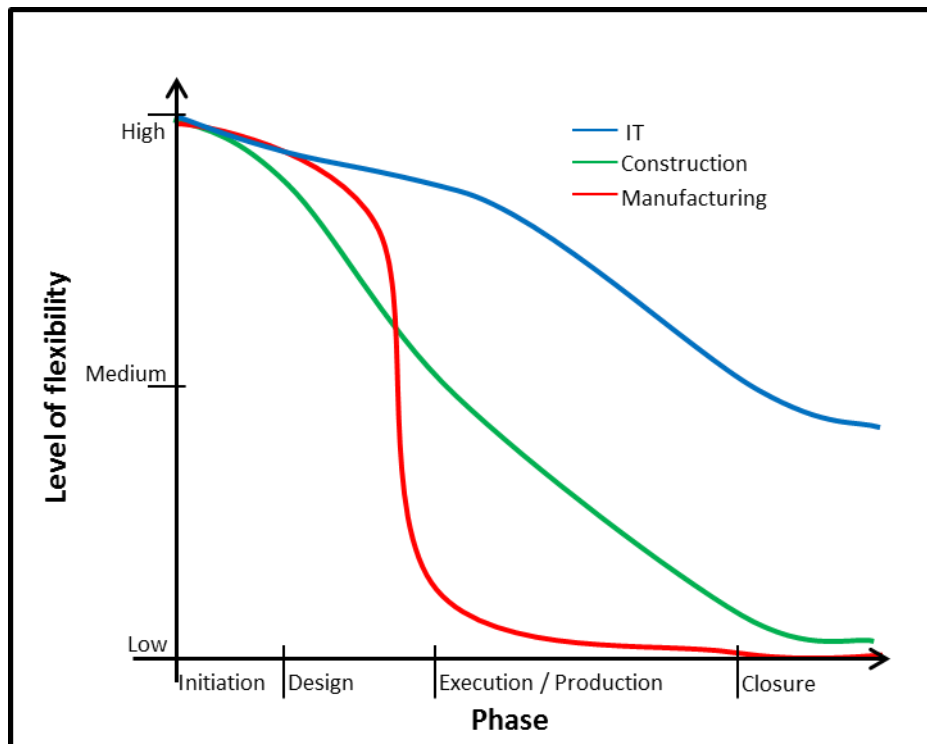


Figure 6-35 level of flexibility between the different environments

Figure 6-35 shows the level of flexibility in relation to the product within a particular phase. The following paragraphs will provide further detail.

All life cycles show similar characteristics at the beginning, i.e. initiation and design. The initiation and design are phases which are characterised more by mental rather physical work. Hence the process of changing or adjusting things is very feasible.

What stands out within the above figure is that the level of flexibility identified for production during the design is higher than for construction. The reason for this is that the design phase covers mainly the development of a prototype. Hence the prototype in production will be adjusted and modified until there are almost no crucial changes and uncertainties left for the execution or in the case of manufacturing production phase.

However at the execution the characteristics of those paradigms start to differ. IT projects, if well organised, for instance through Agile methods, allow even late changes as the whole project can be broken down into smaller elements, which are independent from each other. This independence creates huge amounts of flexibility, as even if the task has been completed, it can still be changed, because other parts are not affected by those. Agile paradigms are developed to manage the whole project life cycle.

Nevertheless, this is not feasible for construction projects, because construction projects generally have more project elements, which makes the planning more difficult. They have more involved parties, which results in bigger teams. There is a higher separation between the phases, which makes the ability to react to change more difficult. This separation is required, because a building has to be designed from the top down, but has to be built from bottom up. Furthermore changes are not welcomed in each project phase of a construction project, because in the execution phase particularly the impacts and consequences of those changes are high. During the initiation and design phase it is easier to react to changes and therefore fit Agile methodologies better in that phase (Owen and Koskela, 2006a). Another major difference between IT and construction projects is that the implementation of IT projects is built upon scenario building and testing, i.e. a program code can be tested and afterwards improvements can be made. This action is not applicable to construction. As a result, it seems like that the level of uniqueness is higher for construction projects than for IT projects, because specially during the execution construction projects face also the difficulty that there is only one chance of getting the task done appropriately. This might explain the identified desire of the parties involved in construction to plan everything in detail.

When setting the focus now on to manufacturing, what stands out here is that the manufacturing environment prefers to develop detailed planning in advance. This is called “development phase”. The development phase also covers the execution of a prototype. Hence, the development stage of manufacturing, i.e. the phase before production, seems actually more comparable to construction. Lean has

been developed to increase the profitability during the production phase. The production phase is undertaken under certain circumstances, i.e. most of the threats have been identified and eliminated already during the development phase. Hence the production phase can provide a static, stable environment where the processes can be optimised, through dividing the work into value added, non-value added and waste activities.

At the closure phase it can be highlighted that production allows no changes, because the product is produced and will be used with the customer. Construction allows only minor changes, where a finished element can be slightly modified, but no major changes. With IT projects it is the case that it is in general feasible, but it also depends on the level of effort.

Linking those given conditions to the management paradigms re-states the fact that Lean with its focus on production is characterised with an objectivist ontological view on a project. Agile in contrast, is focused on the whole project life cycle and is characterised with a subjectivist view on reality.

The question here is: are those views on reality really in line with the reality of construction projects? The literature about this issue states that construction projects have both views on reality and that a distinction is not appropriate (Raftery et al., 1997; Li and Love, 1998; Wing et al., 1998; Love et al., 2002b; Smyth and Morris, 2007; Lehmann, 2010; Dainty, 2008; Morris, 2010; Shepherd and Atkinson, 2011; Boyd and Bentley, 2012). Hence, the mismatch of Lean and Agile with construction can be related to their wrong perception about the reality for construction projects, i.e. about that what is truly going on in practice.

A paradigm for construction needs to be based objectivist and subjectivist world views because both are true (Winch, 2006; Geraldi, 2008; Koppenjan et al., 2011; Osipova and Eriksson, 2013). AgiLean PM considers both world views on reality, as those views have been merged together to a holistic and unifying strategic framework.

### 6.7.2 Practicality of the developed AgiLean PM framework

The literature review and the findings from the interviews indicated that Agile management methods are suited to dealing with high variety and high complexity projects or tasks. Lean is best at dealing with high volume and repeated tasks (see Figure 6-34, p. - 282 -). The interview data stresses that a construction project can be viewed as various tasks in different phases. The phases with the highest effort are design and execution, but the operational phase is crucial due to its length and often high proportion of life cycle costs. Hence the construction project environment is in between the environments of Lean (production) and Agile (IT). Given that the view on reality of Lean is characterised by objectivism and that of Agile by subjectivism (see section 6.7.1), and considering that the reality of construction projects lies in between, the result is that the ontology of AgiLean PM has to be based on both ontological viewpoints.

This can happen sequentially, because there is a consistency of opinion that Lean is best in the execution phase and Agile is more applicable for the design phase. This could lead to the conclusion that the decoupling point model (see Figure 2-27) should be applied i.e. the design phase is managed with Agile values and the execution with Lean thinking. The PM would still exist with its tools and methods, but would operate more on the strategic level and would find support from the PC. The Lean and Agile approaches would complement the strategic PM by focusing on the operational level. This has not so far been applied to construction, but seems like a good approach, in theory.

The design phase is characterised by changing requirements and non-routine working, which fits to the Agile conditions. However, in a construction project there is also a high degree of different contributors from different companies, caused by the fragmented nature of the industry. Therefore it cannot be generalised that the design phase could apply Agile principles, because it depends on the project type, size and number of contributors.

Lean seems more appropriate for the operational phase rather than the execution phase, because the execution phase is characterised with diverse complex tasks,

and as time progresses these tasks become more routine and repetition can eventually be identified.

This contrasting mix of activities during the execution phase creates a need for Lean but with Agile values. Therefore Lean needs to be complemented by Agile and PM, i.e. it needs to be “AgiLean PM”. The most commonly applied practice of Lean construction, which is the LPS (see section 2.2.6), follows actually this logic, which can be illustrated with the following figure.

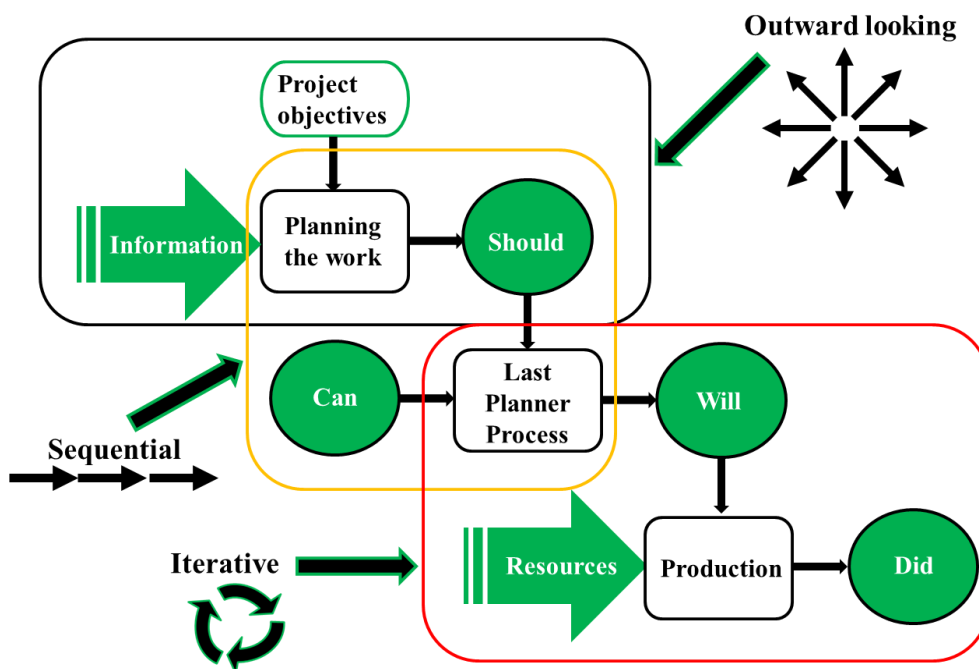


Figure 6-36 an AgiLean PM view on LPS (adapted from Ballard (2000a))

Figure 6-36 shows that in fact, when analysing the LPS, it shows clearly that it consists of three major elements. The starting point for the LPS is a project plan, which is related to the plan all in advance principle of PM. The Last Planner Process is in line with the Lean principles where the program will be made more stable and reliable. But, the last crucial element is iterative, where daily adjustments will be made, which is in line with Agile principles.

The same applies for Scrum (see section 2.3.2.3), which is the most commonly applied practice of Agile PM, as shown in the following figure.

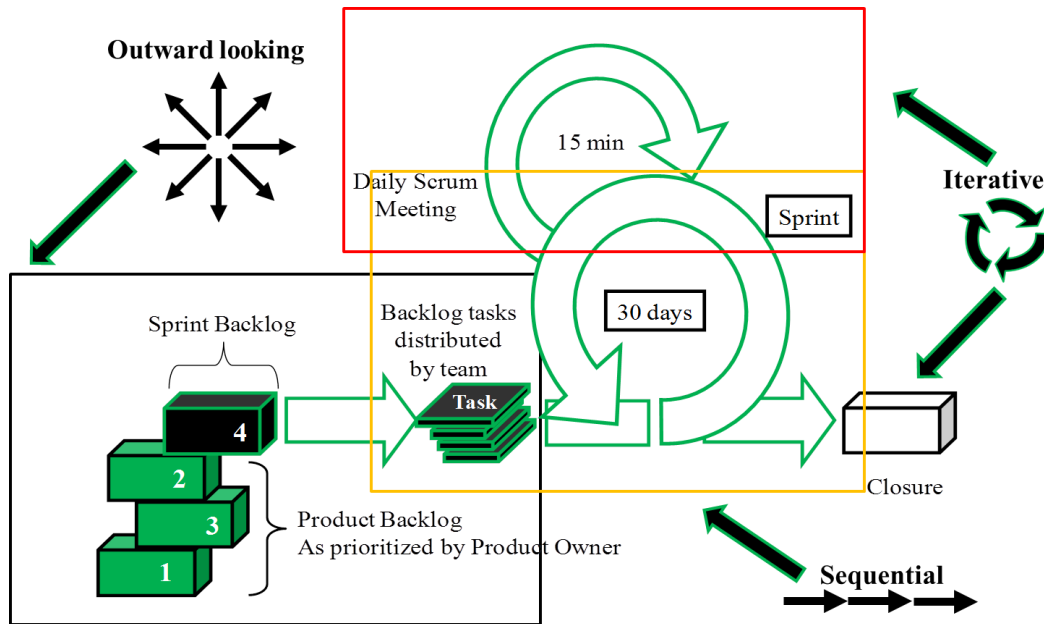


Figure 6-37 an Agile PM view on Scrum (adapted from Murphy (2004))

Again, Scrum consists also of three elements (see Figure 6-37), where it starts with arranging and organising the work for the defined sprints, which is in line with PM principles. Once this is done, then comes the crucial enabler of the Scrum process, namely that the software development will be made more reliable and stable, which is in line with Lean principles. The last element is the iterative approach of adjusting things during the closure through daily meetings and allowing the product owner to change afterwards.

Hence both main practices, LPS and Scrum, have realised that the concepts and principles of a single paradigm are not sufficient for a project environment. Therefore PM, Lean and Agile have been merged with each other. Both most used practices are completely in line with the concepts of the Agile PM framework. This gives an indication that it is possible to derive methods and practices for the developed Agile PM framework in future.

### 6.7.3 Transferability of the Agile PM Framework to other contexts

The aim of the survey was to validate the interview findings through fulfilling the transferability criterion (see section 4.1.5). A transferability criterion proves that

the findings of the interviews are applicable to other contexts and are not just single opinions of different individuals.

Hence, section 5.2.1.2 indicated that the assumptions made for the AgiLean PM framework are applicable for project types which are related to living (e.g. housing, hotels), work (e.g. office, professional buildings) and service (e.g. retail, shopping, hospitals).

Section 5.2.3 reflected that the majority of the interview findings are in agreement with many people from different contexts. As a result it is possible to state that the data gained from the interviews is transferable to a wide variety of different construction contexts.

Finally section 5.2.4 has proven that the interview findings, which are used to develop the AgiLean PM framework are universal. Consequently the result of this is that the AgiLean PM framework will be universal too. Conversely, this section highlighted also that the concepts and principles of the AgiLean PM framework tend to be more appropriate for project managers, who are acting on the owner's side. Therefore is the AgiLean PM framework applicable in each country, but is associated with the owner's side.

## **6.8 Summary of the discussion and framework development**

This chapter provided the paradigm atoms of PM, Lean and Agile through discussing the literature with the primary data collected. Then, the different paradigm atoms have been used further to apply sequentially separation, merger and re-merger. The output has been the principles of the AgiLean PM framework. After this, the principles have been used, to derive the generic concepts of the AgiLean PM framework.

The last section of this chapter focused on verifying the derived AgiLean PM framework. This has been undertaken from three different perspectives. First, a more philosophical perspective has been explored, where it has been discussed if the world view of the derived framework is in line with the world view of

construction practice. Then, the practicality of the derived framework has been assessed, with the aim to identify if it is feasible to derive Agile PM practices, which are based on the developed framework, in future. Finally the transferability and the universality has been proven, i.e. if the derived framework is universally applicable to other contexts.

# 7 Conclusion

This chapter will show the conclusions drawn out of this thesis. First, the objectives will be reviewed, where a comparison between the expected and the achieved will take place. Then, the limitations of this study, will be summarised. After this, the contribution to knowledge will be articulated. Finally, areas for further research will be suggested.

## 7.1 Meeting the objectives

The following sections will re-state the objectives and the drawn conclusions.

### **7.1.1 To assess the suitability of Agile manufacturing and Agile IT paradigms to construction.**

The applicability of Agile concepts to construction have been analysed by several researchers (e.g. Owen and Koskela, 2006a; Owen and Koskela, 2006b; Owen et al.; 2006), with the conclusion being that it is more applicable to the design phase than to the execution phase. Ribeiro and Fernandes (2010) argue in turn that Agile methods show high potential for implementation for managing the whole project, when applied by medium and small sized companies. However, these studies did not make a formal distinction between Agile manufacturing and Agile IT, as the conclusion drawn considered concepts of both paradigms. A synthesis of the comprehensive literature review is provided in the following table.

Table 7-1 Agile IT vs. Agile manufacturing

Comparing Criteria	Agile Manufacturing	Agile IT
Origin	Business Management	Software development
Reason for development	Solution for demand driven production markets in the future	Solution for iterative and incremental projects
Contrasting paradigm	Lean Production	Universal Project Management Methodologies and waterfall model
Acting Industry	Production	IT Project Management
Environment	Static (Plant) and dynamic (Business)	Dynamic
Series	Several times (same products)	Once (unique projects)
Good at	Getting into new market segments, delivering the right volume and the right variety	Uncertainty and change management in projects, achieving high degree of customer satisfaction

As shown in the above table, both paradigms have different elements, but the core concept is the same, namely that static project planning, where the requirements need to be determined in advance, cannot cope with dynamic project environments, which are characterised by uncertainty and change. The concept of Agile manufacturing is related to strategic entrepreneurial issues, as it is also called Agile enterprise (Ross, 1994). Therefore Agile manufacturing might be used for construction business strategy research. However, this research is focused on deriving a management paradigm which will improve performance on the project. Agile manufacturing cannot fulfil this need, because it is more appropriate for setting up a business strategy to penetrate new market segmentations.

Agile IT on the other hand provides new solutions with a high degree of customer satisfaction through iterative project planning (Wysocki, 2006), which leads to project success. So, considering that the IT environment is project-based in a similar fashion to construction and Agile developments are presenting practices, which do improve performance, leads to the conclusion that Agile IT is more appropriate for construction PM than Agile manufacturing. The more dynamic the project environment, the more Agile IT suits the project. The highest dynamics

are during early project stages, consequently it has been identified that Agile IT or Agile PM is best suited to these stages.

### 7.1.2 To identify the strengths and weaknesses of traditional PM, Lean and Agile in relation to the management of complex construction projects.

The findings of this research stressed that a construction project is in between different project typologies, if viewed holistically. This can be illustrated through the following figure.

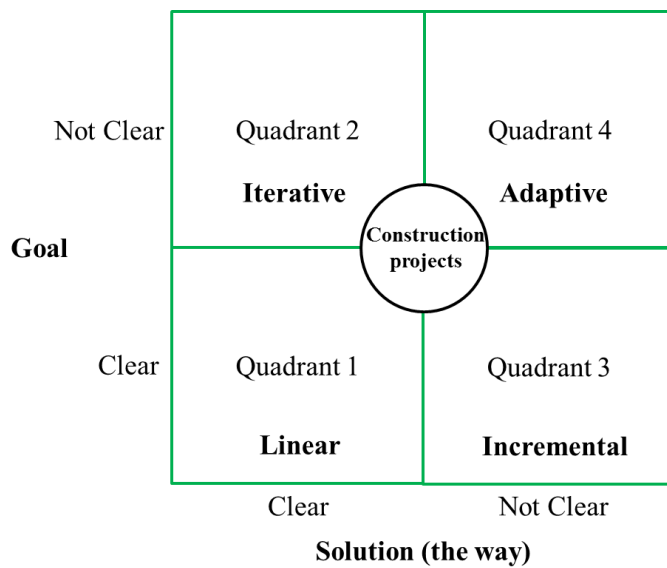


Figure 7-1 the nature of construction projects (adapted from Wysocki (2006))

It seems not feasible to locate a construction project to a particular typology in Figure 7-1. A construction project is adaptive at the initial stages. Workshops and meetings have to be conducted to articulate the vision of the client to the project participants. During the design stages the project shifts between being iterative and incremental, because the customer wishes change more frequently at early design stages. The more the construction project progresses, the more linear becomes the project, because the number of uncertainties will decrease, too.

Lean has been explored from four different perspectives, namely the topicality, industry, labour and culture, as well as management. Those four perspectives

helped in grounding the problem in theory, where different weaknesses have been identified. The results can be illustrated with the following fishbone diagram.

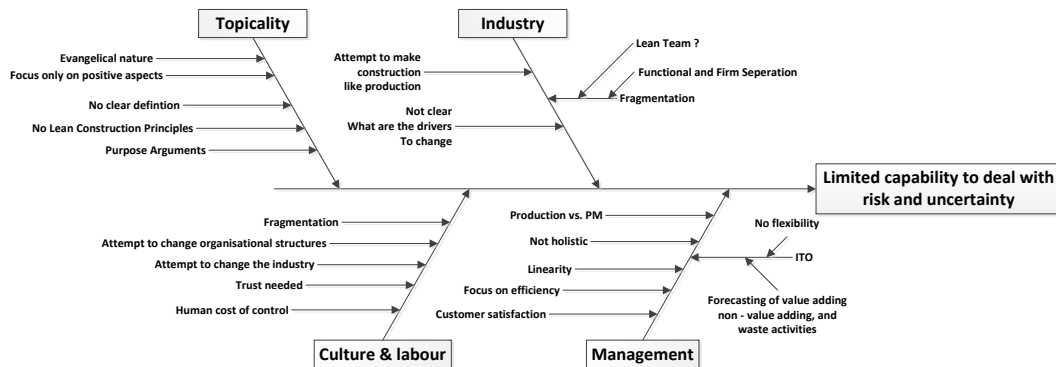


Figure 7-2 weaknesses of Lean construction

The diagram shows that weaknesses of Lean construction have been brought back to the project dynamics. Lean construction is more associated with the execution and operation phase, because the project uncertainties and consequently the project dynamics decrease. This weakness has been realised by the Lean advocates. The action undertaken was to re-conceptualise the construction industry to a model which exists in manufacturing. However, recommendations made in landmark reports (Latham, 1994; Egan, 1998) have not been particularly successful (Wolstenholme, 2009).

PM has an integrative character. It has been found out that PM is good in managing the interfaces between the phases, but has difficulties in mitigating the interfaces between the trades. Hence the strengths of PM can be related to the strategic level, but difficulties exist in dealing with the operative level.

This could lead to the conclusion that the Leagile decoupling point model should be applied i.e. the design phase is managed with Agile values and the execution with Lean. PM would still exist with its tools and methods, but would operate more on the strategic level. The Lean and Agile approaches would complement the strategic PM by focusing on the operational level. This has not so far been applied to construction, but seems like a good approach, in theory.

The design phase of construction is characterised by changing requirements and non-routine working, which fits to the conditions for the application of Agile. In a construction project, however, there are also different contributors from different companies, caused by the fragmented nature of the industry. Therefore it cannot be generalised that the design phase could always apply Agile principles, because it depends on the project type, size and number of contributors. The execution phase of a construction project starts with diverse complex tasks, and as time progresses these tasks become more routine and repetition can eventually be identified. This contrasting mix of activities during the execution phase creates a need for Lean, but with Agile values. Therefore Lean needs to be complemented by Agile, i.e. it needs to be “AgiLean”.

When there is a phase, activity or a task in which a separation between Lean and Agile is not possible the Leagile decoupling point model is of limited use. It is not possible to define where to start with Lean and where to continue with Agile, or vice versa. This is the starting point at which Lean needs to become more flexible, where it needs to be agitated and become more Agile, i.e. AgiLean.

### **7.1.3 To explore the perceptions of traditional PM, Lean and Agile among industry practitioners.**

Semi structured interviews have been utilised to enable the exploration of perceptions about traditional PM, Lean and Agile among industry practitioners. To validate the transferability of the collected data a quantitative survey have been conducted with 213 useful responses. The survey was developed out of the interview findings. Central tendency tests have been performed to investigate the transferability of the interview findings to a wider population. The result is that 64 items out of 67 can be transferred to a wider population and are not just the opinion of the interviewees. Hence the central tendency tests helped in refining the interview data to create a solid basis of primary data for developing the AgiLean PM framework.

**7.1.4 To analyse the influence of moderating variables, such as country context and party involved on the perceptions of traditional PM, Lean and Agile.**

The assumption made for the interview findings is that construction PM, Lean construction, and Agile PM are universal. This means for example that Lean construction in Europe is principally the same as it is in Asia. To this point, there is little research undertaken which has addressed this issue. To close this gap the following hypotheses were derived:

- H1: There is no relationship between a respondent's attitudes towards the construction environment and the project context in which they work.
- H2: There is no relationship between a respondent's attitudes towards PM and the project context in which they work.
- H3: There is no relationship between a respondent's attitudes towards Lean construction and the project context in which they work.
- H4: There is no relationship between a respondent's attitudes towards Agile PM and the project context in which they work.

H1, H2, H4 have been confirmed. H3 has been rejected (because of three items) in the case of North America. The findings indicate that the perceptions about Lean construction concepts and principles are in general everywhere the same, but differ for the Lean philosophy. Given that the AgiLean PM framework aimed to develop concepts and principles, the results confirmed that the interview findings are universal in their nature, i.e. it does not depend on the country. This leads to the conclusion that if the primary data collected is universal, then the AgiLean PM framework is universal, too.

Another assumption of the interview findings was that the perceptions about PM, Lean and Agile do not depend on the occupational background, i.e. for instance is Lean construction perceived the same by the architects as it is by the contractors. There is little research about this issue, too. To address this issue, the following hypotheses have been derived:

- H5: There is no relationship between a respondent's attitude towards the construction environment and their involvement in construction.
- H6: There is no relationship between a respondent's attitude towards PM and their involvement in construction.
- H7: There is no relationship between a respondent's attitude towards Lean construction and their involvement in construction.
- H8: There is no relationship between a respondent's attitude towards Agile PM and their involvement in construction.

H5 has been confirmed. H6, H7, and H8 have been rejected. The perception about the construction environment is for all parties the same. However, the perception about PM, Lean or Agile depend on the occupational background. The result is that the questionnaire indicated that the interview findings are more associated with the parties, who are acting on the client's side. Hence, the AgiLean PM model is universal, but not applicable for the parties involved in construction, which are acting primarily on the designer's or contractor's side.

#### **7.1.5 To develop a framework for the management of complex construction projects based on PM, Lean and Agile principles.**

The assumption that the introduction of a new management paradigm, such as Lean and Agile, means that former approaches need to be rejected is not shared by this study. It is proposed that as well as developing new management paradigms, universal PM methods have to be an essential element of construction PM. However, such methods should focus at the strategic rather than at the operative level. The concept of Leagile suggests combining Agile with Lean, through using the Decoupling Point Model. It is argued that the phase-based implementation of those modern management methods might be too complex. Hence, it is suggested that the management style should be iterative, in order to be able to cope with the project dynamics, caused through changes over the project lifecycle. However, PM, Lean and Agile are completely different in their nature. They have been derived to solve different problems and have different concepts and principles. Therefore a new approach was required, which enables the synthesis of those

paradigms with each other. A novel approach for this has been derived out of nuclear physics. The nuclear fission and fusion approaches have been translated to a PM context. This approach allowed a transparent synthesis of PM, Lean and Agile, resulting in AgiLean PM.

The final objective of this research, is to synthesise PM, Lean and Agile to develop a management framework, which is based on the principle of these paradigms. Hence, this objective can be considered as the overarching objective, which will answer the research question:

*How can a universal and unifying strategic framework based on PM, Lean and Agile be generated?*

PM, Lean and Agile have been synthesised through using the nuclear physics approaches of fission and fusion. For each management paradigm, a paradigm atom has been derived, which consisted of concepts, principles, strengths and weaknesses. Through the application of the nuclear fission approach, the nuclei have been split into their fragments. The application of the fusion approach afterwards, enabled that the weakness of a paradigm's principle could be eliminated through the strength(s) of another. The last step was the usage of the re-fusion approach where the principles have been refined.

The outcome is conceptualised as “AgiLean PM”. AgiLean PM is defined as a unifying strategic framework which is based on construction PM, Lean construction and Agile PM. AgiLean PM believes that reality is based on subjectivist and objectivist ontological considerations. AgiLean PM in the context of this thesis is a framework, which comprises concepts, principles and characteristics. It consists of four generic concepts, five principles and 27 characteristics, which are related to the principles. The AgiLean PM framework is illustrated in the following figure.

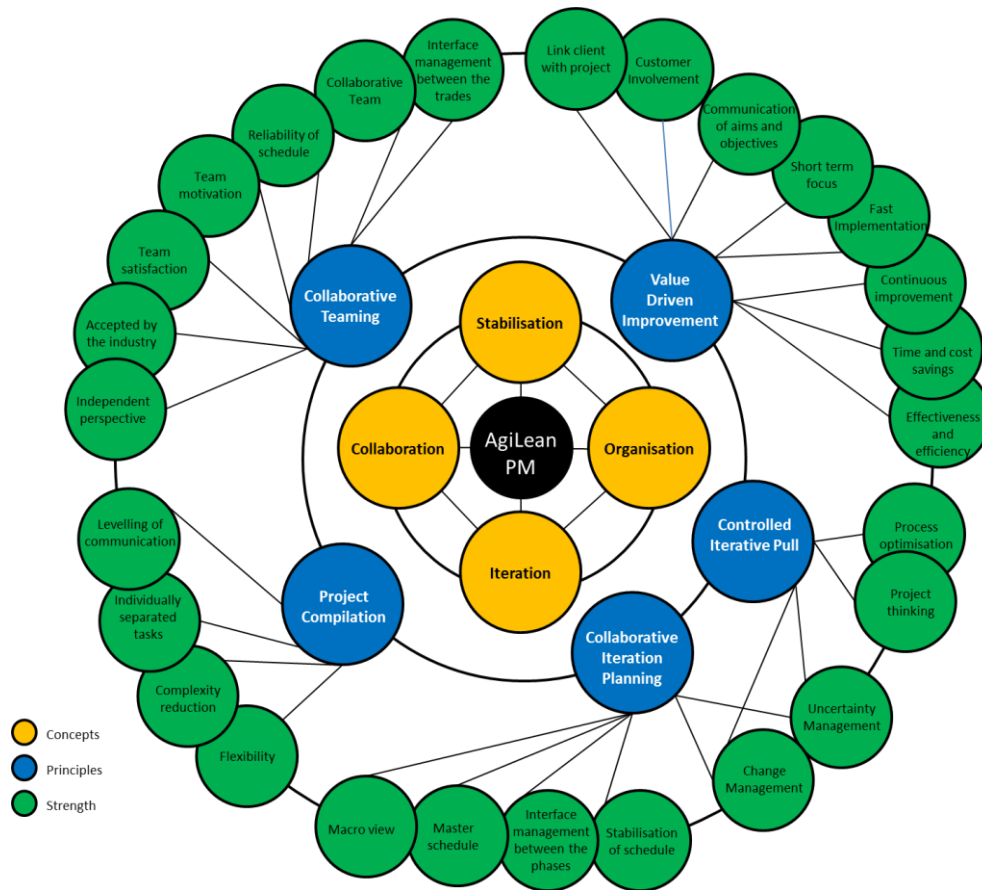


Figure 7-3 AgiLean PM framework

Figure 7-3 shows the elements of the AgiLean PM framework. The framework has been derived through a bottom up approach, where first the principles and then the concepts have been derived. The four concepts are generic, i.e. they are in line with each principle. Hence, a principle is AgiLean PM when it fulfils the AgiLean PM concepts.

## 7.2 Limitations of this study

Each research project has limitations, because it has to be conducted in a predefined time period and with a limited set of resources. This is also true for this research. Two main limitations of this study have been identified.

The first limitation is related to the number of survey respondents for creating transferability of the findings. Even if the number of 213 useful responses seemed high, it is not sufficient enough to claim a generalisability of the findings. In the case of this research it was not possible to define a population. Hence a convenient sampling technique has been utilised. However, even if it is not possible to generalise out of a convenient sampling technique, Bryman (2012) found out that after a set of 1000 useful responses, the tendencies are clearer and further responses will have only a low impact on the survey findings. Hence one limitation of this study is that the survey findings do not lead to generalisations, but they reinforce the qualitative interview findings. A set of 1000 useful responses could not be reached, because of the limited time framework.

The second limitation of this study is related to framework validation. The data has been validated, which leads to the conclusion that the data is true and if the data is true then the framework will be true, too. The framework has been brought in relation with the current good practice of Lean construction (LPS) and Agile PM (Scrum), where it has been indicated that those practices are in line with the concepts and principles of the AgiLean PM framework. However, the finalised framework has been verified, but not been validated. It has not been tested or presented to a different set of experts. The quality of the framework could have been increased through validating it with five case studies (Eisenhardt, 1989) or with five focus group sessions (Bryman, 2012). Nevertheless, the validation of this framework can be interpreted as a new research project.

### 7.3 Contribution to knowledge

The contributions to knowledge of this research can be compared with an iceberg in a metaphoric way, as illustrated in Figure 7-4.

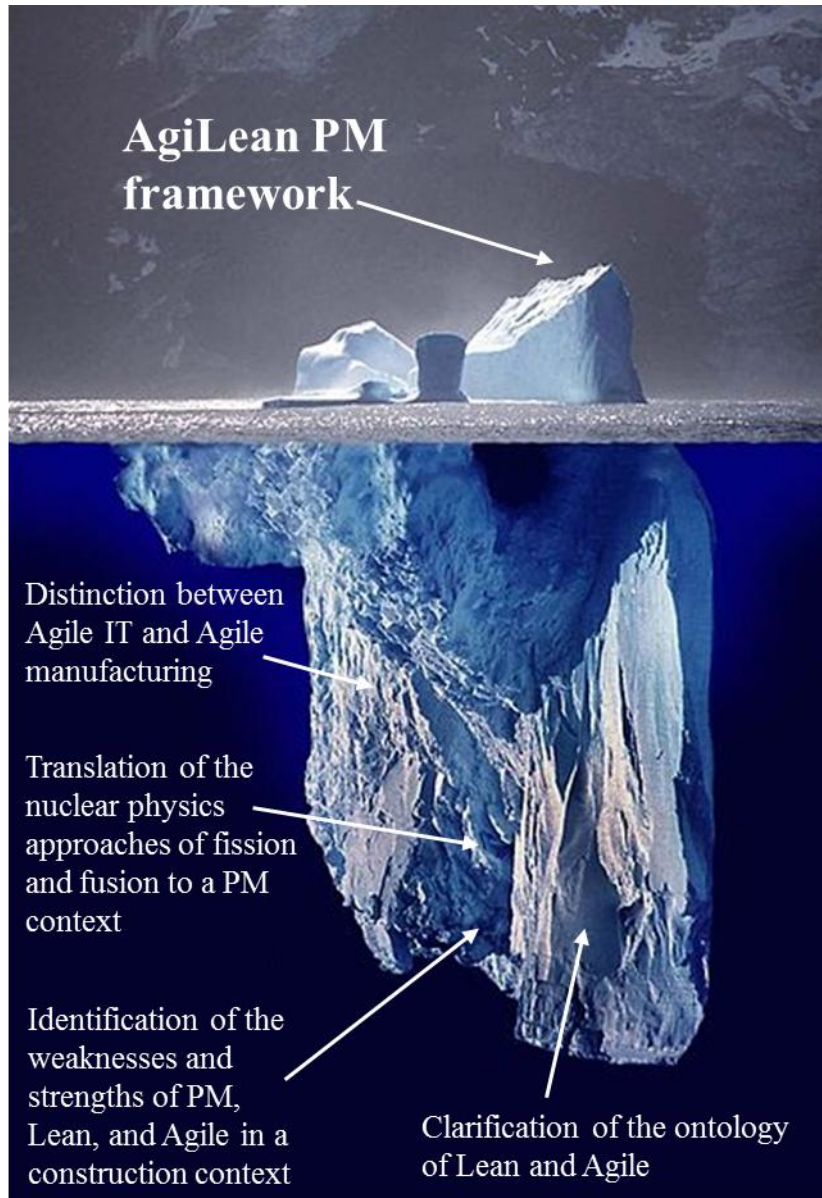


Figure 7-4 contribution to knowledge (figure: own figure, picture: adapted from Kils (2013))

As shown in Figure 7-4 the most visible contribution to knowledge is a framework, which has merged PM, Lean and Agile paradigms to one unit. This has been conceptualised as the AgiLean PM framework. Even if the AgiLean PM framework is related to a few limitations (as shown in section 7.2), this study

showed that it is feasible to merge modern management paradigms together. In addition this study coined the term “AgiLean PM” and described the context of this terminology. The concepts and principles of the AgiLean PM framework have been defined. This sets the cornerstone for further studies and contributes to the further development of the discipline. Out of the reviewed literature, the following timeline has been created.

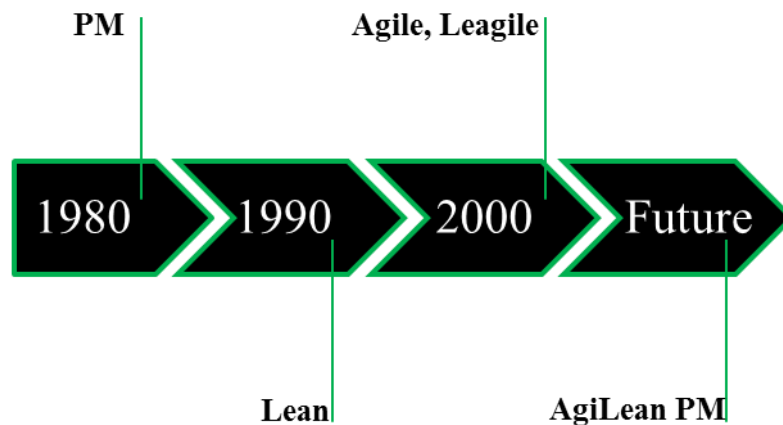


Figure 7-5 trends in construction PM

The reviewed literature in chapter two shows that construction followed different trends over the decades (see Figure 7-5). In the early 80s the trend was PM. This was caused because associations or institutions (such as PMI (2008) or APM (2006)) have been founded in this decade. In the 90s Lean became highly popular in construction, which was caused through works of such as Howell (1999) and Koskela (1996). Institutions such as the International Group for Lean Construction [IGLC] have been founded in these years, too. After the millennium, Lean was more and more criticised and other opportunities have been sought, which related to concepts of Agile and/or Leagile. The next trend might be AgiLean PM, which will be caused by this research.

Nevertheless, Figure 7-4 shows also that this study made contributions to knowledge which are not directly visible. This study emphasised the difference between Agile manufacturing and Agile in IT. It has been concluded that Agile manufacturing is more appropriate for setting up a business strategy, but also that this way of working happens already informally in construction practice. Agile IT

has been identified as being more appropriate for deriving methods, which could increase performance in construction PM.

This study adds to the small body of literature, which consciously emphasised the limitations and barriers of Lean to construction. This was inspired by previous publications of Green (1999a; 1999b; 2000; 2002). In fact, it is very difficult to find any critical literature about Lean construction (e.g. Green, 2002). Hence this research enriched the critical perspectives of Lean construction. In addition, this research explored also the strengths and weaknesses of construction PM, Lean and Agile.

Previous researchers focused on the ontology of the PMBoK (Cicmil et al., 2006; Smyth and Morris, 2007; Morris, 2010; Shepherd and Atkinson, 2011). This study enhanced this view through the derivation of the ontological viewpoints of Lean and Agile. It was concluded that Lean follows a more objectivist ontological view on reality, where in turn Agile is more related to a subjectivist view on reality.

This leads to the difficulty of how to combine such paradigms, which are actually completely different in their nature. To facilitate the merging of PM, Lean and Agile, an approach has been derived from nuclear physics, namely fission and fusion. The systematic and analytic approach of merging these paradigms together, shows great potential for other fields of research and can be applied to other contexts.

The dissemination of the knowledge related to the research took place, in part, through publications in academic journals and presentations at academic conferences. These are listed in Appendix 5.

#### **7.4 Suggested areas for further research**

The AgiLean PM framework sets the cornerstone of a new journey. Hence there are loads of areas which could be investigated further.

The derived framework needs further validation (as explained in section 7.2). Hence other researchers might focus on how to improve this framework further and how to test its applicability to reality.

The derivation of AgiLean PM methods and guides is an area which needs further attention. Important here, is that a method can only be associated with AgiLean PM, when it fulfils the AgiLean PM principles, as those are also in line with the concepts of the AgiLean PM framework.

More professional research can be undertaken on marketing strategies of the AgiLean PM, i.e. how can this framework be shared and further improved with a wider community. Hence research on setting up ideal strategic vehicles (such as working groups, conferences, journals, or workshops) can be undertaken.

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# Appendixes

## Appendix 1. Interview questions

### PMPs

The following 19 questions have been asked of the PMPs.

- **Personal Background**
  - Can you please give me an overview about your organisation and your personal background? The data which you will tell me, will be treated with confidentiality and anonymity.
- **The industries**
  - How would you describe the characteristic of the construction industry?
  - Do you believe that construction lags behind other industries? If yes, why do you think so? If not why not?
  - What are the key difficulties in managing a construction project which you have experienced mostly? What is easy?
  - From a project management perspective, in comparison with other industries (especially manufacturing/production and IT) do you think that there is a difference in managing a construction project? Or are there no differences (project is project)?
- **Definition of project management**
  - How would you define construction project management? What does the term mean for you?
  - How would you define the scope of construction project management? When comparing it with other industries, do you think that there is a difference in the scope of construction project management?
  - What are the critical success factors for a “good project management” system? For instance 6 to 10 things which need to be established (tools, management support etc.).

- **Background project management**

- Did you have experience of projects in which the parties involved have not accepted project management as a discipline? If yes, why do you think so? If no, what do you think were the reasons for its acceptance?
- Do you think that each construction project needs project management as a separate functional hierarchy? If yes why? If no why not?

- **Tools and methods**

- Which project management tools and methods are available in your organisation? And how many of them are you really using in practice? How do you decide which tools and methods you will implement?
- Do you think that there is a need of a new tool in an area (costing, risk, performance measurement, methodologies) of construction project management in order to increase performance? Or do you think the current methods and tools are enough?

- **Lean**

- What do you know about Lean management?
- Explain if required a bit of background and principles...
- Do you think it is useful for construction? If yes why? If not why not?
- Does your organisation try to implement Lean? If yes why? If not why not?

- **Agile**

- What do you know about Agile management?
- Explain if required a bit of background and principles...
- Do you think it is useful for construction? If yes why? If not why not?
- Does your organisation try to implement Agile? If yes why? If not why not?

- **Conclusion**

- Do you have any other feedback, comments etc., which you would like to share with me?

## LPs

The following 17 questions have been asked the LPs.

- **Personal Background**

- Can you please give me an overview about your organisation and your personal background? The data which you will tell me, will be treated with confidentiality and anonymity.

- **The industries**

- What makes construction project management difficult, in comparison to project management from other industries? What is special? Or are there no differences (project is project)?
- Is it really possible to compare and to look for similarities between production and construction? Because construction projects have one of a kind character, they are unique, they are projects. Does it not make more sense to compare the development of a car with a construction project?
- Do you believe that construction lags behind manufacturing? If yes, why do you think so? If not why not?

- **Definition of Lean**

- How would you define “Lean”? What does the term “Lean” mean for you?
- What do you think about Lean Construction (strengths, weaknesses)? What are critical success factors for Lean construction (For instance 6-10 things which need to be in place so that Lean construction will work, like top management support, training etc.)? Do you think that it will be the method of the future for construction?
- Definition of Lean thinking by (Womack and Jones, 2003, p. 15):
- Lean thinking “[...] provides a way to specify value, line up value-creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively. In short, Lean thinking is “Lean” because it provides a way to do more and more with less and less - less human effort, less equipment, less time, and less space - while coming closer and closer to providing customers with exactly what they want.”

- Do you believe that Lean thinking in manufacturing is similar to Lean thinking in construction, because what we first do need to understand is, which type of production is construction? Can we really apply the Input-Transformation-Output Model to our projects?
- **Background Lean**
  - By looking to the history and development of Lean [... Explain a bit Krafcik etc.], is it not true that Lean in the way exists now, is a formalisation of the tools of the TPS? If yes why? If not why not?
  - Considering your answer before, do you think that a construction project is Lean, by using only tools, because when using the tools one is fulfilling all of the Lean principles? If yes why? If not why not?
  - Can you give me specific examples where it was worth implementing Lean (positive example(s))? If yes, what was the reason that it worked so well?
  - Can you give me specific example where you have implemented Lean but did not achieve the expected? If yes, what was the reason that it did not work as expected?
- **Lean Tools and Management**
  - What do you think about the last planner system? Is it really required to be able to practice “Lean” in construction?
  - By considering the parties involved in construction, who should take the role of the ‘last planner’ (owner, designer, contractor, project manager) when managing construction projects under “Lean”? Is the project manager (owner’s representative) the right person?
  - How can Lean be integrated with other PM methods?
  - When managing projects under Lean, what role does the way of contracting play? Does it need to be a collaborative way of contracting?
  - Is there more effort for the management of projects under “Lean”? How much effort does an organisation need to implement the “Lean” philosophy? What are the steps?

- **Conclusion**

- Do you have any other feedback, comments etc. which you would like to share with me?

## **APs**

The following 14 questions have been asked the APs.

- **Personal Background**

- Can you please give me an overview about your organisation and your personal background? The data which you will tell me, will be treated with confidentiality and anonymity.

- **The industries**

- Do you think that there is a difference between managing a construction project and IT project, from a project manager's perspective? Or do you think that a project is a project, the tasks are the same only the product is different?
- What were the key difficulties in managing a project which you have experienced mostly?

- **Definition of Agile**

- How would you define "Agile"? What does the term "Agile" mean for you?
- What do you think about Agile in general (strengths, weaknesses)? Do you believe that it is also applicable for other industries?
- How is Agile integrated with other project management systems?

- **Background Agile**

- Why implement "Agile"? What are the strengths of Agile methods?
- What are critical success factors for implementing Agile? (For instance 6 to ten things which need to be in place, if Agile wants to be implemented, like top management support, cultural change etc.)
- What is Agile construction? How does it work?
- What are the tools of Agile Construction?

- **Agile Management**

- Did you implement Agile methods in construction? If yes can you provide me an example where it did not work well? If yes, can you provide me an example where it worked well?
- What are the limits of “Agile” methods? Are there any limits, or is it possible to implement “Agile” for each type of project (regarding size, complexity etc.)?
- How much effort does an organisation need to implement “Agile” management methods for their projects? What are the steps? Is there a need for cultural change in the organisation first?

- **Conclusion**

- Do you have any other feedback, comments etc. which you would like to share with me?

## Appendix 2. Questionnaire

### Part one

**AgiLean PM**



[Edit this page](#)

#### Participant information

This survey will provide a solid basis of primary data to develop the AgiLean PM framework.

The survey is completed anonymously, can be saved part way through and takes around 15 minutes to complete.

The survey has been approved by the Ethical Committee of Liverpool John Moores University (a top 100 university in the world under the age of 50). All data collected in this survey will be held anonymously and securely. Cookies, personal data stored by your Web browser are not used in this survey. The questionnaire data will be coded and anonymised so that no individuals can be identified in future reports and in publications of the findings.

Note that once you have clicked on the CONTINUE button at the bottom of each page you can not return to review or amend that page.

#### Contact Details of Researcher

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1. I have read the above information and I am happy to proceed.

☐ Yes.

[Continue >](#)

Survey testing only

[Check Answers & Continue >](#)

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## Part two

### AgiLean PM

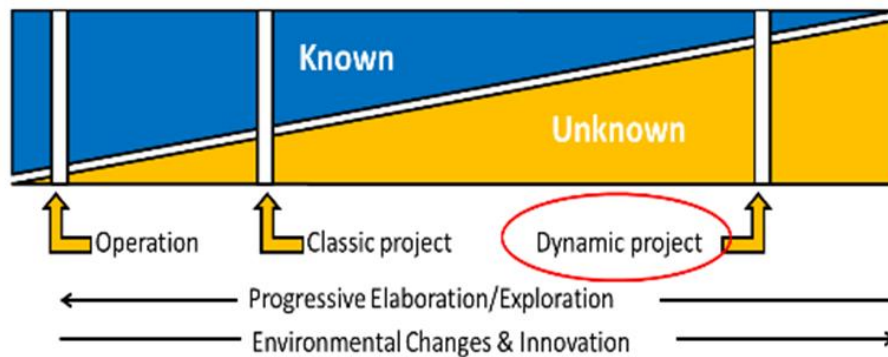


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### Survey

Please think about a typical "large scale" construction project (more than £40 Million investment volume) when answering the questions.

Please note that in the context of this survey: dynamic projects are those which face more unknown than known factors (as illustrated by the diagram below).



Collier, S., & Warren, C. M. J. (2009). Project management approaches for dynamic environments. *International Journal of Project Management*, 27(4), 335-364.

## Construction Environment

The following questions are about the construction environment of a typical large scale, complex project.

2. Please indicate your level of agreement with the following statements.

	1 = Strongly agree ... 5 = Strongly disagree				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
<b>a.</b> Construction is a highly competitive industry.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>b.</b> The construction environment is focused on the "lowest price wins" attitude.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>c.</b> Construction has a claim management culture, where one first provides an offer with a low price and then seeks to make the profit with claims.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>d.</b> The construction environment is very focused on the short term.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>e.</b> The character of construction means there are often changes in the parties involved in projects.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>f.</b> Construction is like a fight from the beginning, which makes it much more difficult to manage in comparison with other industries, where partnerships are used more readily.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>g.</b> Construction is very conventional in its character.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>h.</b> Today's construction projects show increasing levels of complexity.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>i.</b> The separation between design and execution creates difficulties in construction which are not present in other industries.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>j.</b> Many parties are involved in a construction project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>k.</b> Each construction project is unique.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### Project Management

The following questions are about effective project management [PM] on a typical large scale and complex construction project. PM in this context means the client's representative within the parties involved in construction.

3. Please indicate your level of agreement with the following statements.

	1 = Strongly agree ... 5 = Strongly disagree				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
a. PM is something universal, i.e. it does not depend in which industry the project is undertaken (project is a project).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. PM provides the required knowledge about construction to the clients.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. A holistic view of the project is required for the client, which starts at the first project idea through to handover to operations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. PM creates a link between the client's organisation and the project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. PM helps the client to articulate her/his vision.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. PM communicates the client's expectations to the other project participants.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. PM is independent of design and execution perspectives, which enriches the project with a different perspective.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. PM provides the right information to the right people with the relevant level of detail.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. The aim of PM is to ensure actions are undertaken to meet a developed plan.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j. The expectations on the project will change over the project life cycle.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k. Construction projects are characterised with uncertainties, which create difficulties to go through a developed plan until the end.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<b>i.</b> It will be good to avoid any changes during the execution phase of a project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>m.</b> Planning everything in detail in advance is inappropriate for construction projects, as they have to cope with high levels of change.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>n.</b> Many uncertainties are caused by the external environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>o.</b> Uncertainties influence the PM system.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>p.</b> One of the biggest challenges in construction projects is to manage change.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>q.</b> Uncertainties can be caused by the client.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>r.</b> Uncertainties can cause change(s).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>s.</b> On large scale, complex projects, the schedule quickly loses transparency.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>t.</b> The focus on the lowest price results in the best possible party not always being contracted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>u.</b> The project participants mainly follow their own economic interests.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>v.</b> PM is good at mitigating the interfaces between different project phases.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>w.</b> PM faces difficulties in managing the interfaces between the trades.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### Lean construction

The following questions are about "Lean construction" on a typical large scale and complex construction project. You do not need to know something about Lean construction to be able to respond to the following questions. There is no right or wrong. It is just about your opinion.

4. Please indicate your level of agreement with the following statements.

	1 = Strongly agree ... 5 = Strongly disagree				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
a. I have heard about Lean construction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. I know what Lean construction is.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. Production (e.g. manufacturing a car) and construction (e.g. managing a complex construction project) is comparable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. Lean production techniques can be directly transferred to the construction context.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. Construction projects can be seen as temporary production systems, where the focus is on the building as a product.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. There is a huge amount of waste in construction.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. Having a good team is essential for success.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. The interfaces between the trades do not work well together.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. Dividing the work into smaller elements reduces complexity.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j. During the execution phase changes should be kept to a minimum.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k. The current most used types of contracts are not supportive for cooperation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<b>l.</b> The number of projects using contracts where the profit and the risks are shared is very low in the industry.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>m.</b> The construction environment is characterised by high levels of distrust.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>n.</b> Working with the same partners from project to project is the ideal scenario.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>o.</b> ...But it cannot be achieved.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>p.</b> Not reacting to customer wishes, which cause changes, is not an option in construction, because the relationship between client and other project participants is far more personal than in other sectors.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>q.</b> Lean construction is more useful for builders.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>r.</b> The construction environment is characterised by high levels of conflicts.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>s.</b> Only a few things can be prefabricated in construction projects.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>t.</b> Construction is only dealing with prototypes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>u.</b> Even if the constructed product is static, the environment of construction is highly dynamic.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>v.</b> Construction means to build things in an ill-defined environment somewhere in the world under unsure circumstances.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>w.</b> Managing a construction project requires flexibility in some project stages.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

### Agile Project Management

The following questions are about Agile Project Management [PM]. Again, you do not need to know something about Agile PM to be able to respond to the following questions. There is no right or wrong. It is just about your opinion.

5. Please indicate your level of agreement with the following statements.

	1 = Strongly agree ... 5 = Strongly disagree				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
<b>a.</b> I have heard about Agile PM.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>b.</b> I know what Agile PM is.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>c.</b> Construction projects are dynamic endeavours.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>d.</b> A lot of changes can be related to the client.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>e.</b> A lot of changes can be also related to external influences, i.e. uncertainties/risks.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>f.</b> Projects require not only planning but also situation-related acting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>g.</b> Breaking the work down into smaller elements or activities helps in reducing complexity.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>h.</b> Changes are something which are unavoidable in construction projects.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>i.</b> The level of uncertainty goes down the closer the project comes to the end.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>j.</b> At present there are too many PM systems that are too rigid and therefore not really suitable for the initial stages of the project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>k.</b> The project team is more motivated if they can work with low levels of disruptions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>l.</b> Existing organisational hierarchies limit the ability to create self-organised teams.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>m.</b> If you always change things then you never get the task done well.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>n.</b> It is not possible to have the design and the building phase in parallel.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>o.</b> Changes are welcomed, but only at early stages of the project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<b>p.</b> The further into the project life cycle, the higher will be the impact of changes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Part three

AgiLean PM



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### About the participant

Almost done! Only a bit more background information about you is required.

#### Background

6. In what main project context were your responses made?  
I thought mainly about the project context in...

- ☐ Africa
- ☐ Asia
- ☐ Australia
- ☐ Europe
- ☐ North America
- ☐ South America

Please type in the country too.

7. In what type of projects have you gained work experience? (The project basic life functions have been listed)

Please indicate your level of experience (1 = no experience ... 5 = A great deal of experience).					
	no experience	A little experience	Reasonable experience	High experience	A great deal of experience
a. Living (Housing, Hostels, Hotels...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. Working (Office, Professional Buildings, Laboratories...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. Service (Retail, Shopping, Hospital, Energy Providers...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. Education (City Halls, University, Museum, Theatre...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. Relax (Sport Facilities, Parks, Resorts...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. Traffic participation (Streets, Roads, Bridges, Rail routes...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. Community (Church, Courthouse...)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. Where are you typically located in regard to the parties involved in construction?

- ☐ Owner's side  
☐ Architect's, Designer's side  
☐ Contractor's, builder's side  
☐ Other (*please specify*):

9. How long is your work experience?

- ☐ I have no work experience  
☐ less than 6 years  
☐ between 6 to 10 years  
☐ 11 years or more

10. What is your age? Between...

### Contact

11. If you are interested in getting a free soft-copy of the dissertation, please enter your email address below. (*Optional*)

12. If you have any other feedback, comment etc. please use the field below. (*Optional*)

## Part four

AgiLean PM



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Final Page

Thank you for completing this survey.

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### Appendix 3. Quantitative overview about the qualitative data

No	Name	Date	Time	Duration	Words in total	Words Interviewer	Words Interviewee
1	AP1	23.05.2012	10:00	0:47:43	7,061	1,043	6,018
2	AP2	25.05.2011	09:00	0:48:02	7,104	1,273	5,831
3	AP3	30.05.2011	10:30	0:51:40	8,624	817	7,807
4	AP4	22.07.2011	15:00	0:45:07	5,883	1,335	4,548
5	AP5	20.06.2012	11:30	0:42:39	6,233	973	5,260
6	AP6	22.06.2012	17:00	0:26:39	3,295	791	2,504
7	LP1	24.05.2011	13:30	0:44:20	5,816	1,487	4,329
8	LP2	27.05.2011	08:00	0:58:12	9,439	1,339	8,100
9	LP3	27.05.2011	13:00	1:12:56	12,041	2,888	9,153
10	LP4	30.05.2011	16:30	0:43:48	7,415	1,647	5,768
11	LP5	27.07.2011	10:00	1:05:28	7,864	2,666	5,198
12	LP6	10.05.2012	10:00	1:12:46	9,949	2,470	7,479
13	LP7	22.06.2012	10:00	1:23:56	14,721	1,591	13,130
14	PMP1	20.07.2011	08:45	0:34:22	4,711	2,764	1,947
15	PMP2	20.07.2011	10:00	0:47:25	7,587	1,806	5,781
16	PMP3	21.07.2011	17:00	0:40:57	5,134	2,174	2,960
17	PMP4	22.07.2011	08:45	0:39:45	5,625	2,248	3,377
18	PMP5	26.07.2011	11:00	1:57:42	23,995	3,413	20,582
19	PMP6	27.07.2011	16:00	1:11:48	12,292	2,154	10,138
20	PMP7	28.07.2011	10:00	0:52:46	8,400	2,851	5,549
21	PMP8	06.08.2012	14:00	0:54:52	8,223	3,480	4,743
22	PMP9	14.08.2012	08:00	0:58:56	7,693	3,315	4,378
<b>Summary</b>				<b>20:21:49</b>	<b>189,105</b>	<b>44,525</b>	<b>144,580</b>
Agile Practitioners				4:21:50	38,200	6,232	31,968
Lean Practitioners				7:21:26	67,245	14,088	53,157
Project Management Practitioners				8:38:33	83,660	24,205	59,455
<b>Average</b>				<b>0:55:32</b>	<b>8,596</b>	<b>2,024</b>	<b>6,572</b>
Agile Practitioners				0:43:38	6,367	1,039	5,328
Lean Practitioners				1:03:04	9,606	2,013	7,594
Project Management Practitioners				0:57:37	9,296	2,689	6,606

## Appendix 4. Total – item statistics for section 5.2.2.5

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
5.a. I have heard about Agile PM.	33.48	34.411	.272	.798	.660
5.b. I know what Agile PM is.	33.19	35.219	.244	.793	.664
5.c. Construction projects are dynamic endeavours.	34.41	37.376	.400	.319	.646
5.d. A lot of changes can be related to the client.	34.31	37.762	.312	.314	.653
5.e. A lot of changes can be also related to external influences, i.e. uncertainties/risks.	34.35	37.001	.471	.380	.641
5.f. Projects require not only planning but also situation-related acting.	34.58	38.329	.358	.303	.653
5.g. Breaking the work down into smaller elements or activities helps in reducing complexity.	34.07	37.779	.184	.129	.667
5.h. Changes are something which are unavoidable in construction projects.	34.08	37.442	.225	.196	.662
5.i. The level of uncertainty goes down the closer the project comes to the end.	34.18	37.018	.261	.130	.657
5.j. At present there are too many PM systems that are too rigid and therefore not really suitable for the initial stages of the project.	33.80	36.470	.373	.237	.644
5.k. The project team is more motivated if they can work with low levels of disruptions.	34.26	37.289	.340	.238	.649
5.l. Existing organisational hierarchies limit the ability to create self-organised teams.	33.89	36.704	.294	.227	.653
5.m. If you always change things then you never get the task done well.	33.83	37.248	.252	.210	.658
5.n. It is not possible to have the design and the building phase in parallel.	32.97	37.829	.139	.216	.676
5.o. Changes are welcomed, but only at early stages of the project.	33.58	36.056	.311	.342	.650
5.p. The further into the project life cycle, the higher will be the impact of changes.	34.33	36.712	.269	.256	.656

## Appendix 5. Publications

### Conference publications:

1. Demir, S. T., Bryde, D. J., & Fearon, D. (2011). “LEAGILE” PM – Time for change in construction project management. *Built Environment and Natural Environment Conference [BEAN]*. Liverpool: Liverpool John Moores University.  
**Major contribution of this thesis. The field of research has been described.**
2. Demir, S. T., Bryde, D., Fearon, D., & Ochieng, E. (2011). 3dSA: A Tool for Integrating Stakeholder Analysis and Risk Management. *Salford Postgraduate Annual Research Conference (SPARC)* (pp. 116-127). Manchester: The University of Salford.  
**Minor contribution of this thesis. The reviewed PM literature has been used to ground the problem in theory.**
3. Demir, T., Bryde, D. J., Fearon, D., & Ochieng, E. G. (2011). COMP(TQC) - A new way for integrating time, quality and cost perspectives when doing qualitative risk analysis. *Procs 27th Annual ARCOM Conference* (pp. 1013-1022). Bristol: Association of Researchers in Construction Management.  
**Minor contribution of this thesis. The reviewed PM literature has been used to ground the problem in theory.**
4. Demir, S. T., Bryde, D. J., Fearon, D., & Ochieng, E. G. (2012). The limits of Lean in construction. *Built Environment and Natural Environment Conference [BEAN]*. Liverpool: Liverpool John Moores University.  
**Major contribution of this thesis. The results of this time have been presented. The term “AgiLean PM” has been published the first time.**
5. Demir, S. T., Bryde, D. J., Fearon, D., & Ochieng, E. G. (2012). Collaborative Risk Management: A team framework for managing risks on construction projects. *Proceedings of the Salford Postgraduate Annual Research Conference (SPARC) 2012*. Manchester: The University of Salford (**still in review**).  
**Moderate contribution of this thesis. The reviewed PM literature has been used to ground the problem in theory. The same methodology of this thesis has been applied. The importance of collaboration has been explored.**
6. Demir, S. T., Bryde, D. J., Fearon, D., & Ochieng, E. G. (2012). Re-conceptualizing Lean in Construction Environments – the case for “AgiLean” Project Management. *48th ASC Annual International Conference Proceedings*. Birmingham: Associated Schools of Construction.  
**Major contribution of this thesis. The current results of have been presented. The term “AgiLean PM” has been published the first time.**

7. Demir, S. T., Bryde, D. J., Fearon, D., & Ochieng, E. G. (2012). "AgiLean Project Management" – Time for change in construction projects. *Creative Construction Conference 2012*. Budapest: Creative Construction Conference.  
**Major contribution of this thesis. The field of research has been explored. The current results of have been presented. The context of "AgiLean PM" has been explored.**
8. Demir, S. T., Bryde, D. J., Fearon, D., & Ochieng, E. G. (2012). Re-conceptualising Agile for Lean Construction: The case for "AgiLean" Project Management. *Procs 28th Annual ARCOM Conference* (pp. 1013-1023). Edinburgh: Association of Researchers in Construction Management  
**Major contribution of this thesis. The current results have been presented. A distinction between Agile IT and Agile manufacturing has been provided. The term "AgiLean PM" has been explained.**
9. Demir, S. T., & Bryde, D. J. (2012). Yalın İnşaatın limitleri ve engelleri üzerine bir araştırma (A research on the limits and barriers of Lean construction). 2. *Proje ve Yapım Yönetimi Kongresi [PYYK]*. İzmir: İzmir Yüksek Teknoloji Enstitüsü.  
**Major contribution of this thesis. The current results have been presented.**
10. Demir, S., & Bryde, D. J. (2012). AgiLean PM – Eine neue Managementmethodik für das Bauprojektmanagement [AgiLean PM - A new management methodology for construction project management. *PM Forum*. Nurnberg: German Association for Project Management [IPMA].  
**Major contribution of this thesis. The current findings have been presented. The term "AgiLean PM" has been explored.**
11. Nesensohn, C., Demir, S. T., & Bryde, D. (2012). Developing a 'True North' Best Practice Lean Company with Navigational Compass. *20th Annual Conference of the International Group for Lean Construction* (pp. 251-260). San Diego: International Group for Lean Construction.  
**Moderate contribution of this thesis. The reviewed Lean construction literature has been used to ground the problem in theory. The concept of the Project Consultant has been explored.**
12. Nesensohn, C., Bryde, D. J., & Demir, S. T. (2013). Teaching Lean and Last Planner® by using the hands-on simulation Villego®. *Innovation in Built Environment Education*. London: University of Westminster.  
**Minor contribution of this thesis. The reviewed literature about the Last Planner System and Lean construction has been used to ground the problem in theory.**

13. Demir, S. T., Bryde, D. J., Fearon, D., & Ochieng, E. G. (2013). The "AgiLean PM" Matrix. *Built Environment and Natural Environment Conference [BEAN]*. Liverpool: Liverpool John Moores University.
- Major contribution of this thesis. The context of AgiLean PM has been explained.**

**Journal Publications:**

1. Nesensohn, C., Demir, S. T., & Bryde, D. J. (2013). Developing the True North route map as a navigational compass in a construction project. *Lean Construction Journal*, 10(1), 01-18
- Moderate contribution of this thesis. The reviewed Lean construction literature has been used to ground the problem in theory. The concept of the Project Consultant has been explored.**
2. Demir, S. T., Bryde, D. J., Fearon, D. J., & Ochieng, E. G. (2014). A tool for integrating time, cost and quality perspectives in Probability Impact (P-I) Tables. *International Journal of Project Organisation and Management*, 6(4).
- Minor contribution of this thesis. The reviewed PM literature has been used to ground the problem in theory.**
3. Demir, S. T., Bryde, D. J., Fearon, D. J., & Ochieng, E. G. (2015). Three dimensional stakeholder analysis. *3dSA: adding the risk dimension for stakeholder analysis*, 7(1).
- Minor contribution of this thesis. The reviewed PM literature has been used to ground the problem in theory.**