

Introducing AgiLean to construction project management

Abstract

The complexity of construction projects is the main reason, why the construction industry is searching better ways of managing construction projects. Recently, the industry tries to get benefit from the adoption of two management methodologies. On the one hand there is Lean construction, which works well for stable and predictable project environments. On the other hand, there is Agile project management [PM], which works well for dynamic and uncertain project environments. Construction projects, however, are exposed to predictable and paradoxically uncertain environments at the same time. Hence there is a need for a methodology which merges Lean and Agile to a holistic unit. The objective of this contribution is to introduce such a methodology. Such a methodology does not exist so far and is different from the “Leagile” approach, which uses Lean and Agile methods in the execution phase sequentially. Through undertaking a comprehensive literature review and through conducting 22 interviews with practitioners in the field of construction PM, Lean, Agile a new methodology is introduced, which is conceptualised as “AgiLean PM”.

Keywords: Agile, AgiLean, Leagile, Lean, Qualitative Research.

1. Introduction

In search for new management methodologies to manage construction projects, two different management methodologies 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 (Andersson et al., 2006; Hines et al., 2004). 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 rationale for the development of a new approach, which is currently under investigation at the Built Environment and Sustainable Technologies [BEST] Research Institute. This research project proposes 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. Hence it is a so called “mechaorganic” PM system, which is taking advantage out of both, organic (flexibility-oriented) and mechanistic (forecast-oriented), PM systems 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. The aim of this paper is to introduce AgiLean PM, through providing a salient understanding of Lean and Agile, and through comparing AgiLean PM with Leagile.

Conceptual background

This section will provide a salient understanding of Lean construction, Agile, and Leagile.

Lean construction

Lean has its origins in the automotive or manufacturing industry (Womack et al., 1990; Womack and Jones, 2003). 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 precede it*” (Ballard and Howell, 2003: 120), i.e. to add value without waste (Liker, 2004). The general approach of the Lean management philosophy is to eliminate waste in the following areas (Ohno, 1988: 129): “*overproduction, waiting, transporting, too much machining (over processing), inventories, moving, making defective parts and products*”.

Womack and Jones (2003) identified the five Lean principles of manufacturing as: specifying value, identifying the value stream, flow, pull and pursuing perfection. The production (plant) environment, however, is static, because “[...] *raw materials are progressively transformed over a series of separable steps into the final product*” (Eccles, 1981, p. 337). This results in a sequence of activities arranged to produce the prototype repetitively as efficiently as possible (Womack et al., 1990). The Lean approach (to eliminate waste) and the Lean principles are developed in that environment of manufacturing.

The construction project environment, in turn, is dynamic because construction “[...] *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 [...]*” (Gann, 1996: 438). Furthermore the constructed facility is built at the point of consumption which is in contrast to manufacturing where finished products are transported to market (Gann, 1996). Hence the straight implementation of Lean production to construction would result in failure, because of the environmental differences between construction and manufacturing. The result is that the view on the construction environment needs to be changed to enable the implementation of Lean to construction. The construction environment needs to become static.

To achieve this, construction projects need to be viewed as so called “temporary production systems” (Ballard and Howell, 2003). This view on construction projects, will create a stable platform allowing a forecasted identification of tasks which can then be categorised into value adding, non-value adding and waste activities (Koskela, 2000). Following such a way of process thinking, results in a philosophy, which pursues perfection (Womack and Jones, 2003). A project, however, “*is itself a process of continuous change*” (Gabriel, 1997: 208). Changes or changes caused because of uncertainty create a dynamic project environment (Collyer and Warren, 2009). Hence dynamics in a construction project cannot be avoided (Bertelsen, 2003). Paradoxically Lean construction tries to cope with a dynamic environment through using a static, rigid and sequential PM system (Denyer, et al., 2011). Therefore there is a demand for new methodologies, which put the dynamic aspect of a project to the fore (Cullmann, 2013). These dynamic methodologies are summarised with the umbrella term “Agile”. Agile methodologies are receiving more and more attention by PM scholars and practitioners (Garel, 2013; Sheffield and Lemetayer, 2013; Denyer et al., 2011; Cui and Olsson, 2009).

Agile

In sharp contrast to Lean products, there is a requirement for highly variable products (Booth, 1996). As construction projects are exposed to changes over their lifecycle (Gidado, 1996; Arditi and Gunaydin, 1998; Chin, 2004; Andersson et al., 2006; Hunt, 2006; Cullmann, 2013), there is a requirement for new management methodologies, which put this dynamic aspect of a project to the fore, one of which is “Agile”. The agility concepts are not new to manufacturing (Iacocca Institute, 1992), nor to Information Technology [IT] (Agile Alliance, 2001). They are, however, in their infancy within construction (Ribeiro and Fernandes, 2010). The developments in IT and manufacturing took place independently (Kettunen, 2009). The origin of agile management methodologies in construction can be linked to the developments in IT and manufacturing (Owen and Koskela, 2006a; Owen and Koskela, 2006b; Owen et al., 2006). Tangible principles, tools and methods are, however, still missing.

Agile manufacturing is focused more on setting up a business strategy to penetrate new market segmentations (Iacocca Institute, 1992). Agile manufacturing is still at a conceptual stage (Kettunen, 2009). As a result, further considerations will be on Agile from the IT sector.

IT scholars and practitioners understood that different types of projects exist. Namely projects which are linear, iterative, incremental and adaptive (Wysocki, 2006). IT projects are perceived as iterative and incremental projects, requiring Agile PM systems (ibid.; Fernandez and Fernandez, 2008; Sheffield and Lemetayer, 2013). This realisation was the starting point of a growing movement called “Agile Software Development Alliance” (Agile Alliance, 2001). This movement produced a manifesto having 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 (ibid.). These principles 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 several

different software development methodologies, such as eXtreme Programming, Adaptive Software development, Crystal and Scrum (Boehm, 2005). Agile PM involves planning, design and documentation, but only as much as it is required (Karlesky and Voord, 2008). The focus is on delivering working features to a paying customer as soon as possible (ibid.). It “[...] *is not an all-or-nothing methodology*” (Chin, 2004: 13).

The applicability of Agile PM concepts to construction have been analysed by Owen and Koskela (2006a), Owen and Koskela (2006b) and Owen et al. (2006), with the conclusion that it is more applicable to the design phase than to the execution phase.

Leagile

The idea of combining Lean and Agile paradigms together is not a novel approach. Naylor et al. (1999) first coined the term “Leagile” (Goldsby et al. 2006). The demand for Leagile came through viewing the whole supply chain (van Hoek, 2000), with the conclusion that the market place within which organisations are operating consists of both, on the one hand where demand is relatively stable, predictable and variety is low (Atiken et al., 2002), and on the other where demand is volatile and the customer requirement for variety is high (ibid.). Therefore researchers involved in supply chain management disciplines tried to benefit from Lean and Agile management paradigms through combining them with each other (Naylor et al., 1999; van Hoek, 2000; Mason-Jones et al., 2000; Goldsby et al., 2006). This has led to the decoupling point model by Naylor et al. (1999). In the decoupling point, the supply chain switches from one paradigm to the other (Mason-Jones et al., 2000). Naylor et al. (1999: 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 to the downstream of 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.

The implementation of Leagile to the supply chain has been successfully proven in computer manufacturing (Naylor et al. 1999; Qi et al., 2007), in telecommunications (Robertson and Jones, 1999), in construction (Naim and Barlow, 2003; Court et al., 2009), in the banking and finance sector (Parnell-Klabo, 2006) as well as in a heating, ventilation and air conditioning manufacture (Goldsby et al., 2006).

“Agile”, however, is still new to construction (Ribeiro and Fernandes, 2010). Therefore, Leagile construction is in the very early stages of development.

The construction PM discipline faces two environmental typologies. On the one hand it is highly dynamic, but on the other it becomes increasingly more static as the project proceeds (Sidwell, 1990). This has been considered by Naim et al. (1999) as well as Naim and Barlow (2003) who proposed a decoupling point model for housing where a switch from Lean to Agile paradigm, or vice versa, takes places; combining the methods sequentially. The research of Naim et al. (1999) and Naim and Barlow (2003) delivered an approach for managing the supply chain in construction mainly focused on the execution phase and not on the whole project lifecycle.

Other studies about Leagile in construction (Lu et al.; 2011; Ndiokubwayo, 2010; Court et al., 2009; Chen et al., 2007; Court et al., 2006; Barlow, 1998), focused mainly on the adaption of the decoupling point model, with the primary focus on the execution phase. No studies so far, have proposed a holistic system to merge PM, Lean and Agile into one unit.

Method

The aim of this paper is to introduce a new methodology for managing construction projects. To facilitate this, a detailed understanding of the salient concepts of Agile, Lean as well Leagile is required. This has been achieved through reviewing the literature. However, there are still gaps between theory and practice. In order to understand why things happen in the way they do (Saunders, et al., 2009) semi structured interviews have been conducted. The interest is in gaining insights into how practitioners from the industry view and perform PM, Lean and Agile.

Sample and profile of interviewees

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]. The profile of the interviewees are listed in Table 1.

Table 1 Profile of the interviewees

Name	Organisation	Position	Background	Experience
PMP1	Construction PM	CEO	Civil Engineer	20 years
PMP2	Construction PM	General Agent	Civil Engineer	40 years
PMP3	Construction PM	Authorized Representative	PM	12 years
PMP4	Management Consultancy	Project Manager	Architect, PM, MBA	12 years
PMP5	Construction PM	CEO	Civil Engineer	32 years
PMP6	Design and Consulting	CEO	MEP Engineer	35 years
PMP7	Construction PM	Director	Architect, PM	15 years
PMP8	None Profit Institution	Project Manager	Building Surveying	20 years
PMP9	Construction Consultancy	Project Manager	Construction PM	17 years
LP1	Construction Consultancy	CEO	Psychologist	35 years
LP2	Consultancy	Lean Project Manager	Architect	30 years
LP3	Consultancy	Director	Production Technique	7 years
LP4	Consultancy	Director	Civil Engineer	15 years
LP5	Consultancy	Project Manager	Mechanical Engineer	10 years
LP6	Social housing	Director	Quantity Surveyor	30 years
LP7	Construction Consultancy	Founder and Consultant	Manufacturing Engineer	22 years
AP1	Consultancy	Founder and CEO	Computer Engineer, PM	23 years
AP2	Consultancy	Founder and CEO	Computer Engineer, PM	16 years
AP3	IT PM	Founder and CEO	IT-Technology, PM	19 years
AP4	IT Consultancy	Project Manager	IT-Technology, PM	21 years
AP5	Academic Institution	Senior Research Fellow	IT-Technology, PM	10 years
AP6	IT PM	Project Manager	Business and finance	15 years

Key: Project Management Practitioner = PMP, Agile Practitioners = AP, Lean Practitioners = LP, Chief Executive Officer = CEO

Table 1 shows that a wide range of people from different hierarchical positions, different organisations, and different backgrounds have been interviewed to explore PM, Lean and Agile from different perspectives.

Preparation

Three different types of interview questions have been prepared which contained similar but also specific questions for each group (PMPs, APs, LPs). The interviews with the LPs and the PMPs focused on the potential benefits, limits and barriers of Lean to construction. The interviewed PMPs were also asked about their knowledge and experience of Agile. The interviews with the APs also focused on benefits, limits and barriers to construction, but in this case of Agile only.

Analysis

The interviews have been voice recorded and transcribed. The transcribed data were then coded using the software package NVivo, which enabled to review the data in an objective way. The coding of the data happened in the following stages:

- The interview data has been read so that a general overview about the collected data could be gained.
- The codes for the categories “PM”, “Lean” and “Agile” have been defined as “concepts”, “principles”, “strengths”, and “weaknesses” 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.

The findings of the interviews coupled with the results of the literature review are combined to introduce the AgiLean PM methodology.

Validity

The following actions have been undertaken for validating the interview data.

- Credibility has been achieved through sending the transcripts back to the interviewees, so that they can check if all has been typewritten adequately.
- Dependability has been achieved through storing the data and keeping it accessible for other parties. This will be done for three years (Spiers and Young, 2012).
- Confirmability has been achieved through not influencing the interviewees during the interview to focus upon the perception and perspective of the interviewee.

Findings

PMPs

All construction PMPs perceive their industry better than those of others, when it comes to PM performance. PMP1 related this to the reason that construction is “*used to think in projects, which is*

not common in other industries". The PMPs stated that their PM systems include already essentials of Lean thinking and/or Agile thinking. This has been confirmed for instance by PMP5 after a brief presentation about Agile was given, as follows: *"now I know how to call and promote it, that is actually what we have been doing all the time"*. PMP1 stated, after a brief presentation about Lean construction was given, the following: *"I do definitely see similar elements in the way how we do our project management"*. The PMPS related the difficulty of managing construction projects to the development of the PM system, which depends on customer requirements and project type. The PMPs perceive PM as an essential, or important, strategic element for each project. PMP2 explained that below this strategic level there is the operative level, where processes might be repeated from project to project.

The PMPs and LPs as well as APs, stated that the construction industry is characterised by its conservativeness. AP3 explained for instance that the *"structures are more classic"* and that it is *"more a well-established business, which does not include that much excitement anymore, as people are only doing that what it has been told to them"*. The high fragmentation of the industry, the high number of project participants, the separation between design and execution, as well as the conservative character of the industry have been seen as major weakness of the construction industry by all interview participants. PMP3 explored further that *"price pressures, competition, and the difference between supply and demand"* have a negative impact on the PM system, which results in that the planned PM system has to be iterative as it needs to be changed or modified to react to the changes in the project life cycle.

Lean Construction

LP4 stated that Lean methodologies have *"the focal point of orientation on the building"* and that *"the building has to be seen as a product"*. LP4 explained further that the focus of the parties involved in construction should be on the project as a whole and not on the organisational aims of one's company. According to PMP2, PMP3 and PMP5 this requires a complete new way of thinking in construction. All interviewed LPs stated that the best environment for implementing Lean management methodologies is a stable/static environment. For instance LP4 and LP5 stated that they are mostly consulting Lean methods for plant construction projects, where the building itself can be seen as shell, and where the focus is more on putting the machines (plant) together. When explaining their Lean methods, the focus of the interviewed persons was more on the execution phase than on the design phase. All PMPs and LPs agreed on the fact that there is a lot of

waste when carrying out all phases of a construction project. The focus on the process creates high transparency, which creates, according to LP2 more value, because it allows to see *“what is required, what do I get and what is too much”*. LP3 sees the strength of Lean in the setting of standards, *“which allows you to focus on the customer”*. The core capability of Lean, to eliminate waste, has been seen as attractive by all PMPs, but PMP1 concluded that *“there might be processes which can be made “leaner”, also in construction, but I do not believe that the efficiency by Lean will create a breakthrough, rather it will create improvements in a more detailed level”*.

Most of the LPs as well as PMPs argued that the construction industry needs to be restructured if a Lean journey wants to be started. Specifically, prefabrication of some building elements was highlighted by the LPs. LP1 saw the barrier to entry for Lean in construction due to the *“conservative character of the industry”*, and the confrontational relationships between the parties involved, i.e. *“architect versus contractor, contractor versus subcontractor”*. All LPs had a common opinion in that the high number of project participants in a construction project makes the implementation of Lean more complex than in the static production industry. Also the changing project teams have been highlighted as a difficulty for Lean in construction, where LP2 argued that partnering might be the right way in future to manage construction projects, explaining further that *“one needs to take also the people around on board, this means that one needs to create a Lean environment”*. However, the PMPs concluded that the current way the industry is operating does not fit into Lean. For instance PMP2 stated that *“with the current structures, the way how the construction industry thinks, they can forget about Lean in construction”*. LP4 articulated that especially the structures are not really supportive for Lean, as the stipulations, regulations and standards tell one *“the fee system, the tasks of the construction management, which limits these modern management methods”*. LP4 stated that Lean methods and tools cannot be taken from production directly and adapted to construction. Therefore the organisation of L4 was following the approach that Lean tools need to be reengineered and adopted to the construction industry.

Agile PM

AP4 defined Agile PM as *“a model to proceed, in which one is planning less the aim but more the way through rhythmic meetings”*. This results according to AP1 in, that *“one is only doing management per demand, and not more”*. Agile was described by Interviewee AP2 as a more action-oriented approach to manage projects. This was confirmed by AP4 who argued that Agile methodologies focus on the planning and implementation of small manageable tasks rather than on

big aims and objectives; thus making the scope more tangible for the project team. All APs stated that the critical success factor of Agile methodologies lies in its ability to react to change, in a systematic and structured way. Furthermore, it creates according to AP3 more efficiency in PM, as needless activities will be rejected. The APs shared the common experience that they had received always high customer satisfaction when they have applied an Agile methodology to a project. AP1 related that to the “*short cycles where parts are delivered and feedback is received*”. AP2 explained that the customers are highly satisfied “*because they can see how it grows, they see where it grows and they can influence it*”. All APs concluded that Agile paradigms are best in dynamic project environments, as stated for instance by AP4 as follows:

“If my environment is dynamic or if it becomes more and more dynamic, there it might be that Agile gets more and more important. There, where my environment is static, there it might be that it harms”.

However, even if some PMPs stated that they are working already with Agile paradigms, PMP3 stated that

“changes are not welcome at each stage of the project, because it is difficult to explain to the clients, landlords or decision makers, that they have to decide today for actions which will occur after ¾ year. For instance the building structure has to be calculated from top to down, but I am building from down to top. Therefore the structural engineer needs to know the loads of the top today”

AP2 explained further that it limits Agile methods, “*if the task is getting too big*”, i.e. if there are too many project team members, because it makes it too complex. AP3 said that at such big projects it is also difficult to define the right Agile method for the project. This means that experienced staff is required, even if the project team is self-organising and learning over time. AP4 stated that if one operates within a highly bureaucratic project environment, “*then it is difficult to synchronise with Agile*”, because it requires a complete new organisational structure. According to AP3 one of the reasons why Agile might fail, “*is the so called adrenalin junkies*” who think that Agile means to react to everything rather than planning. This results in a chaotic sequence of activities and in chaotic project termination. All APs agreed that the largest barrier to the implementation of Agile methods is the client. AP2 explained this as that it is difficult to tell to the client that “*we do not have any planning, we just do it*”.

Discussion

Lean vs. Agile

The literature and the primary data collected emphasise that Lean is best in an environment where the production system is based on continuous flow and repeated tasks as well as where the product has a low variety and a high volume. These characteristics suit best to manufacturing, because the manufacturing environment is static. The manufacturing industry has a cyclic process of learning, as the product will be produced repetitively. This is unique for this industry. Hence processes can be optimised, if efficiency and effectiveness are approached strategically.

Construction, however, is highly dynamic, the product is immobile, and the place of production changes from project to project, i.e. the product is static, but the environment is dynamic. The result is that construction can be perceived as the opposite to production. Nevertheless, depending on the project, in construction practice, it is feasible to create a routine way of working for some activities over time. The phase which does have the highest impact (not influence) is the execution phase (after the operational phase) of a construction project. This might be the reason why the primary focus of the LPs has been on the implementation of Lean to the execution phase. Therefore was the focus of Lean construction more on the contractors rather than on PM companies.

Agile, in turn, originated from the IT sector which is project-based like construction. Therefore, there are similar theoretical characteristics between construction projects and IT projects. The major difference, however, is the complexity of construction projects. Generally construction projects have more work items, which makes the planning more difficult. Construction projects require big teams consisting of various parties as well as higher separation between the phases, which increases difficulty in the ability to react to change. Furthermore changes are not welcomed in each project phase of a construction project because of the adverse impacts of changes especially in the execution phase to the cost and time overruns. During the design phase it is relatively easier to react to changes and therefore Agile methodologies fit better in that phase (Owen and Koskela, 2006b). 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. Even if minor amendments are possible for a construction project, major changes cannot be achieved. The approach of scenario building and testing is not applicable

to construction. The result is that an IT project is unique too, but in construction one has only one chance to get things done right.

Both methodologies, Lean and Agile, believe that there is a desire for performance improvement through the adoption of Agile or Lean. The reason for this is that the advocates of Lean or Agile argue that current PM theory is obsolete in today's dynamic and globalised construction projects (Koskela and Howell, 2002, Owen and Koskela, 2006b), or because it is believed that construction is more backward in PM performance compared to other industries (Egan, 1998; Bertelsen, 2003; Winch, 2003; Ballard and Howell, 2004).

However, 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), and PM is always an essential part of construction (Winch, 2006). The perception that the construction PMPs are performing poorly in PM is not shared, as reflected by a recent survey by 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, which has been confirmed also through the interview findings in this study.

It is recommended that construction needs performance improvement, but not because construction is performing poorly. The primary data gathered indicate that the organisations involved in construction are exposed to different pressures by their external environment (i.e. globalisation and competition, external market influences, improving technology, stakeholder impacts). These pressures from the external environment, force the organisations involved in construction, to become more competitive through reducing their costs and increasing their profit. Modern or new management methodologies can help in meeting this demand for performance improvement. Nonetheless, the interview findings as well as the literature reveal that a holistic project view was missing when Lean, Agile or even Leagile paradigms have been applied to construction. The focus of Lean is more on the execution phase. Agile PM stresses that it is more applicable for the design phase rather than execution or the whole project life cycle. As a result, universal PM methodologies can be applied on the strategic level, and modern methodologies, such as Lean or Agile seem to be more in favour for managing particular operational phases.

Leagile vs. AgiLean

This research reveals that Agile is good at dealing with irregular flows, complex tasks, high variety and low volume products. Lean in turn, is good at dealing with continuous flows, repeated tasks and low variety and high volume products. This has been illustrated in the Figure 1.

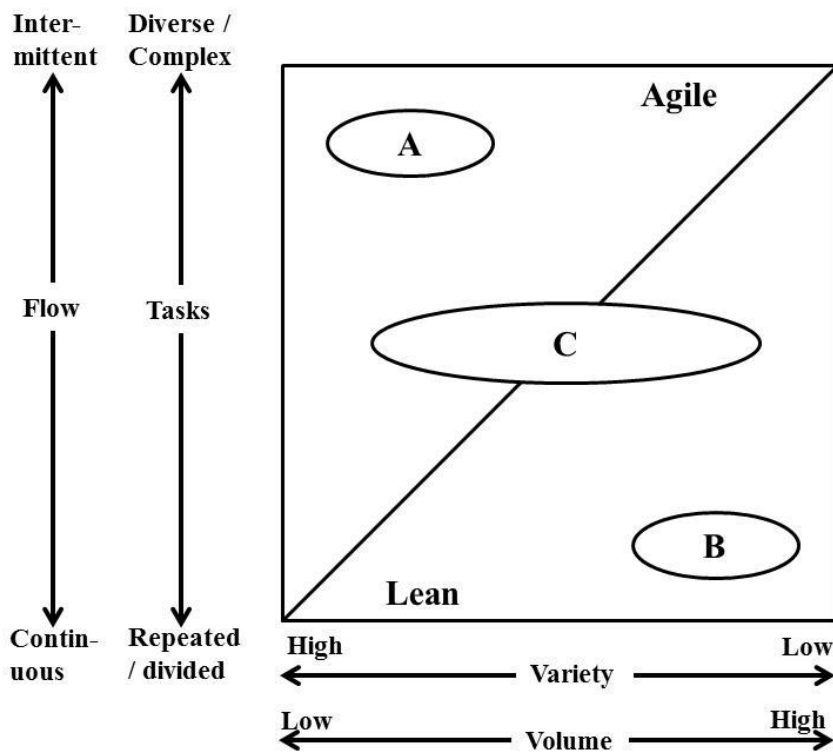


Figure 1: AgiLean Matrix

Figure 1 has been derived through modifying the product-process-matrix developed by Slack et al. (2008). The AgiLean Matrix gives a transparent overview to the PM, about when to use which paradigm, or if one should use any paradigm. The evaluation can be based on phases, tasks or situations. If a situation is classified in the upstream, e.g. like (A), then Agile methodologies might be more appropriate. If a situation is classified in the downstream, like (B), than Lean methodologies may be the best.

A construction project can be viewed as various tasks in different phases. The interview data emphasised that the phases with the highest effort are design and execution, but as well as the operational phase due to its length. The primary and the secondary data stresses that Lean construction is best in execution and Agile is more applicable to the design phase. This could lead

to the conclusion that the decoupling point model should be applied; the design phase should be managed with Agile values and the execution with Lean thinking. The PM would still exist with its tools and methods, but would operate more at the strategic level. The modern management methods would deal with their methodologies at the operational level. This differs from the Leagile approach as suggested by Naim et al. (1999), because the focus of the Leagile approach is the execution phase, where Agile deals with the material supply and Lean deals with the execution. Further, the Leagile approach focused more on Agile manufacturing rather than on Agile PM. Agile manufacturing is more about managing companies to penetrate new market segmentations quickly. Agile IT on the other hand is focused on managing change and uncertainty in projects. Therefore the holistic application of the Leagile approach seems to be a feasible approach in theory for managing construction projects, where the design is managed with Agile PM and the execution with Lean construction. The theory of Leagile views a construction project from the supply chain perspective, which consists of different production elements, hence different processes. The complexity in construction can be reduced through sub dividing it into smaller sub projects, and work packages, but those also have different characteristics, which change over the project life cycle depending on the contemporary needs of the project. In addition, even if there is a high separation between the project phases, those phases are also highly linked to each other. This makes change management or uncertainty management a crucial issue, because late identified changes will always result in cost overruns and/or delays. Furthermore, considering that construction projects have powerful clients (Ankrah et al., 2005), the result is that scope variations are a common issue.

The Leagile approach is in dilemma with the newly evolved generic characteristics of construction projects. The design and execution phases need to be separated. The building has to be designed from top to down, and erected from bottom to top. Hence, there is a requirement for keeping the different phases separated. The industry, however, tries more and more to synchronise these phases. The aim is to run the different phases at the same time, because of particular project demands. As a result, meanwhile, the implementation of the “stockholding decoupling point model” is a complex task for construction. There are phases, work packages or tasks where a separation between Lean and Agile is not possible (Figure 1 (C)). This limits the potential application of the decoupling point model, i.e. Leagile. It is not possible to define where to start with Lean and where to continue with Agile, or vice versa. Hence, being flexible or “agile” during the design and rigid or “lean” during the execution seems not to be feasible, because the whole PM system needs to be flexible, too. If

uncertainties cause a design change, then this design change will always have an impact on the execution.

This is the starting point where Lean needs to get more flexible, where it needs to become more Agile, i.e. AgiLean. The term “AgiLean” is carefully chosen as Lean needs to be “agitated” i.e. become more irregular and rapid.

The combination of PM, Lean and Agile which is conceptualised as “AgiLean PM” eliminates waste in the processes and is able to react to change. This new innovative management methodology could be the best way of dealing with the complexity in construction projects to achieve maximum performance in future. AgiLean PM is underpinned by universal PM methodologies, such as those from the Project Management Institute (PMI) at the strategic level. At the operational level it synthesises modern management paradigms, such as Agile and Lean. This enables holistic project view and 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.

5. Conclusions and Recommendations

The aim of the paper was to introduce a new management methodology, which is conceptualised as “AgiLean PM”. With this aim, following the literature survey, semi-structured interviews have been carried out with 22 practitioners.

The findings reveal that Agile suits best to dynamic environments, where the flows are irregular, the tasks are complex, and the produced outputs have a high variety and low volume. Lean is best in coping with static environments, where the flows are continuous, the tasks are repeated, and the produced outputs have low variety and high volume. The concept of Leagile suggests combining Agile with Lean sequentially, through using the decoupling point model. The highest dynamics are during the design. The execution is characterised with a more static environment. This could lead to the conclusion to implement the Leagile approach, where the design could be managed with Agile PM and the execution with Lean construction. This paper, however, indicated that the phase based implementation of the decoupling point model, (i.e. Leagile) is not really feasible in today’s time compressed and complex construction projects. This paper introduced a new methodology, which is conceptualised as AgiLean PM. In contrast to Leagile, the AgiLean PM approach suggests, merging

Lean with Agile to make Lean more flexible (to make it AgiLean). AgiLean PM shall build on the strengths and address the weaknesses of Lean and Agile through a process of synthesis. This keeps universal PM methodologies at the strategic level. A methodology, which is based on PM, Lean and Agile, has the following advantages:

- Emergence of an PM approach which benefits from a synthesis of existing tools
- Adoption of Lean principles in terms of waste and the pursuit of perfection
- Adoption of Agile principles to enable the reaction to change.

AgiLean PM tools have not been developed yet. These tools are needed for the implementation of this methodology into practice. Hence, future studies are recommended to develop the AgiLean PM methodology further and assess its feasibility for construction.