RE- CONCEPTUALISING AGILE FOR LEAN CONSTRUCTION: THE CASE FOR "AGILEAN" PROJECT MANAGEMENT

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To address limitations of Lean in construction, new paradigms linked to Agile management methods are receiving increased attention. Agile approaches to management in manufacturing and information technology [IT] developed independently and with different objectives. However in applying Agile to construction, theorists have not made a distinction between the two paradigms. Hence the aim of this research is to analyse the appropriateness of Agile manufacturing and Agile IT to construction. A review of the extant literature on both is undertaken and from this it is concluded that Agile IT is more suitable to construction project management [PM] than Agile manufacturing. Then interviews were undertaken with Agile experts and project managers to assess how Agile IT could be applied. The results of the interviews suggest that concepts from Agile IT need to be integrated with those of Lean to be effective in the construction environment, i.e. Agile needs to be re-conceptualised for Lean construction. This paper presents a potentially unifying framework, called "AgiLean PM", which illustrates how waste elimination, through Lean, and the ability to react to change, through Agile, is achieved at the operational level; with PM methods providing the necessary strategic oversight.

Keywords: agile, agilean, leagile, lean, project management.

INTRODUCTION

Over the past two decades there has been a great deal of attention paid by theorists to developing Lean construction. However theoretical advances have not been reflected by widespread adoption of Lean in practice (Demir *et al.* 2012). Indeed the industry is still struggling to implement the complex combination of Lean thinking, principles and tools too much of construction-related activity (ibid.). This failure to gain traction may well be related to the roots of the theoretical developments, as Lean construction is clearly derived from Lean production.

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 origins of these methods are in manufacturing and in IT; although they developed

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independently of each other and with different objectives. In applying Agile to construction, theorists and practitioners have not made a distinction between these completely different modern paradigms (Owen and Koskela, 2006a, Owen and Koskela, 2006b; Owen *et al.* 2006; Ribeiro and Fernandes, 2010). Indeed they have often been mixed together and used at the same time (ibid.). This results in a farrago of management methods which makes it difficult to assess the appropriateness of Agile to construction. It also inhibits the establishment of a solid theoretical foundation for Agile construction.

Hence this paper seeks to explore the appropriateness of Agile manufacturing and Agile IT approaches for construction. This is facilitated through a comprehensive literature review with the conclusion being that Agile IT is more applicable. The research focuses on exploring Agile IT through conducting interviews with Agile professionals and construction project managers. Clear potential advantages, limits and barriers for Agile IT in construction are identified. The authors conclude that Agile approaches in general are most useful when combined with elements of Lean. The combination of waste elimination, through Lean, and the ability to react to change at the operative level, through Agile, when underpinned with universal project management [PM] methods at the strategic level, is a potentially unifying framework. As such a new approach, called AgiLean PM is introduced in this paper. AgiLean PM is a wider research project conducted in the BEST Research Institute at Liverpool John Moores University. This paper summarises one part of it. The paper is structured as follows: first the appropriateness of Agile IT and Agile manufacturing are analysed; second, the research method is explained; then the results of the collected data are shown, followed by the discussion of the findings; finally, conclusions are drawn.

LITERATURE REVIEW

Agile in Manufacturing

Agile in manufacturing was initiated through market research, where the Iacocca Institute (1992) established that the future markets for manufacturing required a production system which is not only able to produce the right volume but also to supply the right variety into its market niches (Booth, 1996). The United States [US] saw the possibility "[...] to regain the leadership it lost in the 1970s and '80s" in manufacturing (Iacocca Institute, 1992, p. 1), i.e. to develop a paradigm which was able to compete with Lean (Booth, 1996). 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). Therefore the implementation of Lean requires a stable platform, in which it is possible to maximise efficiency (Andersson *et al.* 2006). Highly dynamic conditions or a highly dynamic environment, as the demand driven future markets represent, cannot be dealt by Lean, "[...] as there is no room for flexibility due to the focus on perfection [...]" (Andersson *et al.* 2006, p. 289). 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). Hence Lean can be seen as a contrasting paradigm to Agile. 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 cooperate knowledge (ibid.). The concepts of Agile manufacturing are, according to the Iacocca Institute (1992), 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 the crucial enabler is the concept of the virtual enterprise. Hence it is built around the synthesis of a number of enterprises, each have some core competencies. It uses each co-operators knowledge and resources in order to fill the newly occurred need in the market, through changing and adopting the required business strategy (Kidd, 1994). This creates a virtual enterprise which is formed only for this particular demand in the market, which is Agile as the virtual enterprise can be formed and changed rapidly. For example, the virtual enterprise can have the design competency of one company, the manufacturing competency of another, with the distribution and logistics competency of third, creating a new innovative product, produced and brought to the market as efficiently and effectively as possible (ibid.). Therefore Agile manufacturing can be also called Agile enterprise (Ross, 1994), because it is more related to business strategy.

Agile in IT

Agile IT developments can be related to the understanding that different types of projects exist, each with different characteristics (Wysocki, 2006), namely: 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). Agile methods focus on iterative and incremental solutions (ibid.; Fernandez and Fernandez, 2008). The attention of the Agile IT PM community arose through a misinterpretation of the waterfall model (Larman and Basili, 2003; Owen and Koskela, 2006a), which was developed by Royce (1970). 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 PM system (Aoyama, 1998) which allows no feedback (Wysocki, 2006) and assumes 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, hence there is a need of flexibility when undertaking a project (Chin, 2004). 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 centuries ago (Larman and Basili, 2003). The formalisation of those practices took place under the framework of a movement called 'Agile Software Development Alliance' (Agile Alliance, 2001). This movement 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 were identified. The Agile values do not specify a method; rather they provide 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 methodologies, for instance eXtreme Programming, Adaptive Software Development, Crystal and Scrum (Boehm, 2005). Those methods have quite similar practices such as daily meetings, backlogs, user stories, and iteration planning (Weyrauch, 2006), which reflect the Agile principles and therefore the Agile values. If an organisation wants to implement Agile, then all the practices of the method have to be in place, otherwise it will result in project failure (Coffin, 2006).

Agile PM involves planning, design and documentation only as much as is required (Karlesky and Voord, 2008). The focus is on delivering working features to a paying

customer as soon as possible (ibid). This is facilitated through designing and planning modular elements of the overall task rather than the whole as monolithic (Aoyama, 1998). So to conclude, 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 assume that variability cannot be reduced, therefore the aim is not to minimise or eliminate change; rather it is about managing and allowing change in a systematic way (Highsmith and Cockburn, 2001).

Why Agile IT instead of Agile manufacturing for construction?

The applicability of Agile concepts to construction have been analysed by Owen and Koskela (2006a), Owen and Koskela (2006b) and 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 on the other hand that Agile methods show high potential 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 conclusions drawn consider concepts of both paradigms. A comparison of Agile IT and Manufacturing based on a synthesis of the salient literature on the topic is provided in Table 1 below.

Table 1: Comparison between Agile Manufacturing and Agile IT

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 Environment criterion in Table 1, 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, the need of construction is not in finding new methods for business management, nor in managing 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 of new management paradigms. This can be reflected through the report of the Construction Task Force (1998), which concluded that the construction industry is performing poorer in comparison with other industries.

Therefore there is a need for management practices which will improve performance at the operative level when executing a project (Pan *et al.* 2007). Agile manufacturing cannot fulfil this need, as there are no exact definitions, methods and techniques developed (Kettunen, 2009) and because it is more about a certain vision (Zhang, 2011; Kidd, 1994). Furthermore Agile manufacturing 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 an iterative project planning (Wysocki, 2006), which leads to project success. It fits with a project-based environment like construction, as the products of construction can be defined as "a temporary endeavour undertaken to create a unique product, service, or result" (Project Management Institute, 2008, p. 5). The aim of the Agile IT movement is the development of new practices, which are able to deal with iterative and incremental projects (Wysocki, 2006). Agile has a clear theoretical basement and is used widely in IT practice; and involves clear values and principles. Therefore being Agile is defined by adhering to the values expressed in the Agile manifesto (Adolph, 2006). 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.

METHOD

The wider research project aims to develop a new method for the management of construction projects, which will focus, on the one hand, on the elimination of waste through aiming for perfection in the internal processes, whilst on the other, focusing on being flexible and reacting to changes in the project circumstances. As part of the project, a detailed understanding of the salient concepts of Agile manufacturing and Agile IT is required. 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 trends in current 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. In order to get a deeper understanding of practice, semi structured interviews were conducted with 4 Agile Practitioners [APs] and 5 PM Practitioners [PMPs]. The APs were software developers/experts working in IT and the PMPs were working as Client representatives in construction. When collecting the data, the aim was to get a deeper understanding of the applicability of Agile IT to construction projects. The interviews with the APs and the PMPs focused on the definitions, potential benefit, impact, environment, limits and barriers of Agile IT approaches to construction. The interviews were recorded, transcribed and then analysed in relation to each of these three sub-topics.

FINDINGS

A typical definition was articulated by AP 4, who described Agile PM as "a model to proceed, in which one is planning not so much the aim but more the way through rhythmic meetings". This results in, according to AP 1, that "one is only doing management per demand and not more". Agile was further described by AP 2 as a more action-oriented approach to the management of the project. This was confirmed by AP 4 who argued that Agile methodologies focus on the planning and implementation of small manageable tasks rather than big aims and objectives; thus

making the scope more tangible for the project team. All the APs stated that the main benefit of Agile lies in its ability to react to change in a systematic and structured way. Furthermore it creates, according to AP 3, more efficiency in PM, as needless activities will be rejected. In terms of impact, the APs shared the common experience of consistently receiving high customer satisfaction when they applied Agile to a project. AP 1 related that satisfaction to the "short cycles, where parts are delivered and feedback is received". AP 2 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 the APs concluded that Agile paradigms are best in dynamic project environments. This was articulated by AP 4 as follows: "If my environment is dynamic or if it becomes more and more dynamic Agile gets more and more important. Then where my environment is static, it might be that it harms". In terms of limits, even though some PMPs stated that they are working already with Agile, a common view was the undesirability of change to key stakeholders. PMP 3 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 three quarters of a year. 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".

AP 2 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 to practice. All the APs agreed that the greatest barrier to the implementation of Agile methods is the attitude of the Client. AP 2 explained this as it being difficult to tell to the Client that "we do not have any planning, we just do it".

DISCUSSION

Previous research has tried to simultaneously draw from both Agile manufacturing and Agile IT paradigms. However a review of this research suggests an Agile PM originating in Agile IT as most appropriate for construction PM. The findings lend weight to this conclusion, indicating that the use of Agile IT methods has potential advantages to construction, such as the ability to adapt to changing customer requirements. However, the findings also show that there are potential limitations, which are related to the nature of construction, in particular construction's complexities in terms of planning and executing the work. Given that all the Agile IT values, principles and hence practices of Agile need to be in place if success is to be achieved (Coffin, 2006) suggests clear limiting factors to its implementation in construction. The literature review and interview data show that those limiting factors can be generally related to the different typology of a construction project. Even a small construction project requires a large number of contributors, with a high variety of workmanship and experts (Walker, 2007). Considering that Agile professionals do not recommend using Agile practices for project teams where more than 50 people are involved (Chin, 2004) creates a barrier for implementation even before those practices have been introduced. The high separation between design and execution (Ankrah *et al.* 2005) makes the ability to react to change more difficult. But the high separation is required because a construction project is designed from the top, as the loads of the facility have to be determined at the beginning; even though it is erected from bottom to top later. This is in contrast with the plan-as-you-go principle of Agile - which limits the flexibility over the whole project view. Furthermore, this creates a barrier for the "welcome change" attitude of Agile IT practices to construction, because in the

execution phase particularly, the impacts and consequences of those changes are high. Another major difference between IT and construction projects is that the implementation of IT projects is built upon scenario-building and testing (Wysocki, 2006), i.e. a program code can be tested and afterwards improvements can be made. This action is clearly not applicable to construction PM, because if something is designed and erected, the last possible solution would be to demolish and rebuilding it; although the rise of Building Information Modelling (BIM) may mitigate for this factor in the future.

The key success factor of Agile Software PM methods lies in the feedback loop (Wysocki, 2006). The feedback loop allows the reaction to change and uncertainty, as well as delivering high customer satisfaction, i.e. allows agility. During the design phase of a construction project, there is a high demand for communication and getting feedback by all the parties involved. There is more room for accepting change in the design phase than in the execution. Therefore many organisations have formal and informal approaches for gaining feedback in the design rather than the execution phase (Kartam, 1998); so there is a good fit with Agile IT practices and design (Owen and Koskela, 2006b). But managing the design is not managing the whole project, as it is just one out of several project phases. Therefore Agile PM concepts may not be suitable for all types of project. It is the project type and type of organisational stakeholders which determines whether Agile concepts should be used or not (Dyba and Dingsoyr, 2008).

So considering that Agile IT "[…] is not an all-or-nothing methodology" (Chin, 2004, p. 13) leads to the conclusion that one should combine classical PM and Agile PM concepts to fulfil the project requirements as best as possible (Chin, 2004). An effective construction PM plan needs to be focused on value for the client and be performance driven (i.e. focused on effective and efficient processes) (Winch, 2006). Given that the core strength of Lean management lies in efficiency as well as effectiveness (Naim and Barlow, 2003) and the strength of Agile lies in customer satisfaction (ibid.), suggests that a good PM plan should allow the implementation of both Lean and Agile at the same time. This has been considered by Naim and Barlow (2003) who developed the "Leagile" supply chain for construction. As such, Leagile combines both paradigms, through using the decoupling point model, where a switch from one paradigm into the other takes place. The focus of the Leagile supply chain is mainly on the execution phase, where the material supply is managed with Agile and the execution on site with Lean principles, which results in a non-holistic view on a construction project.

However, viewing a construction project holistically, fluctuating demands create changes in the project; hence creating different tasks and situations. So just as the requirements of the project can change over the project life cycle (Gidado, 1996; Dubois and Gadde, 2002), the PM Plan must be iterative (Project Management Institute, 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. This is the rationale for the development of a new approach labelled by the authors as – "AgiLean". Instead of combining Lean and Agile sequentially, AgiLean merges them together. The aim of AgiLean is to make Lean more flexible, irregular and rapid, using Agile IT concepts to agitate Lean practices. "AgiLean PM" has two different levels, namely strategic and operative. On the strategic level it is underpinned with universal PM methodologies i.e. from the Project Management Institute (PMI) or Association of Project Management (APM). On the operative level it allows 1) Lean

and Agile working sequentially i.e. Leagile; 2) in combination i.e. AgiLean; or 3) completely independently of each other.

CONCLUSION

The aim of Agile IT is in improving the performance at the project level. Agile manufacturing has the aim of improving performance at the business strategy level. The concepts of Agile manufacturing are not new to the construction industry, as the future markets of manufacturing are clearly reflecting what the construction industry has been facing for many years. However, in terms of moving the Agile research agenda forward in relation to construction PM the focus would more usefully be on adapting Agile IT rather than Agile manufacturing. Nonetheless the different typologies between an IT project and a construction project show clear limitations and barriers for its implementation. Construction projects don't generally have the same amount of flexibility as IT projects, though there are specific project phases where this flexibility might be possible. Therefore Agile can potentially be implemented for managing particular phases, work packages or situations, but not for managing the whole project. A similar perspective can be derived for Lean construction, which is clearly focused on managing particular project phases separately. Lean does not take a holistic view of a project, as is taken with universal PM methodologies. Therefore a new unifying strategic framework is required. The focus of AgiLean PM is particularly on highly dynamic projects, where the dynamism is characterised by uncertainty and the uncertainty causes changes. This characteristic can occur on several different types of construction projects, where besides the functionality, aesthetics have also to be considered.

AgiLean PM allows the elimination of waste, is able to react to change and focuses on the whole project lifecycle. Such an approach could be the best way of dealing with complex construction projects to achieve maximum performance. AgiLean PM builds on the strengths and addresses the weaknessess of Lean and Agile through a process of synthesization. It benefits from being underpinned by universal strategic PM approaches which will eliminate waste. Perfection is pursued through the adaption of Lean principles and being capable of dealing with uncertainty through the adoption of Agile principles. The AgiLean PM framework is still a work in progress, which covers the development of values and principles. Once the detailed AgiLean PM framework is established, the development of AgiLean tools or the agitation of Lean practices will be a fruitful field for further study. To conclude, managing construction projects under the umbrella of AgiLean PM is a potential response to dealing with the increasingly complex nature of construction projects.

REFERENCES

Adolph, S. (2006). What lessons can the agile community learn from a maverick fighter pilot? *Proceedings of Agile 2006 Conference* (pp. 1-6). Minneapolis: IEEE.

Agile Alliance, :. (2001). *www.agilemanifesto.org*. Retrieved 10 1, 2010, from http://www.agilemanifesto.org/

Andersson, R., Eriksson, H., & Torstensson, H. (2006). Similarities and differences between TQM, six sigma and lean. *The TQM Magazine,* ***18***(3), 282-296.

Ankrah, N., Proverbs, D., Antwi, A., & Debrah, Y. (2005). Factors Influencing Organisational Culture: A Construction Project Perspective. *Building Research Summaries*, pp. 729-742.

Aoyama, M. (1998). Web-Based Agile Software Development. *IEE Software, **15***(6), 56-65.

Boehm, R. E. (2005). *www.kuperpresents.com.* Retrieved 10 02, 2010, from http://kuperpresents.com/nycspin/Resources/RayBohem%20-%20AgileProjMgmt.pdf

Booth, R. (1996). Agile Manufacturing. *Engineering Management Journal, **6***(2), 117.

Chin, G. (2004). *Agile Project Management:how to Succeed in the Face of Changing Project Requirements.* New York: AMACOM.

Christopher, M., & Towill, D. (2001). An integrated model for the design of agile supply chains. *International Journal fo Physical Distribution & Logistics, **31***(4), 235-246.

Cockburn, A., & Highsmith, J. (2001). Agile Software Development: The people Factor. *Computer, **34***(11), 131-133.

Coffin, R. (2006). A tale of two projects. *Proceedings of Agile 2006 Conference* (pp. 155-164). Minneapolis: IEEE.

Construction Task Force. (1998). *Rethinking Construction.* London: Construction Task Force.

Demir, S. T., Bryde, D. J., & Fearon, D. J. (2012). Re-conceptualizing Lean in Construction Environments – „the case for "AgiLean" Project Management". *48th ASC Annual International Conference Proceedings* (pp. 1-9). Birmingham: Associated Schools of Construction.

Dubois, A., & Gadde, L.-E. (2002). The construction industry as a loosely coupled system:implications for productivity and innovation. *Construction Management and Economics, **20***(7), 621-631.

Dyba, T., & Dingsoyr, T. (2008). Empirical studies of agile software development: A systematic review. *Information and Software Technology, **50***, 833-859.

Fernandez, D. J., & Fernandez, J. D. (2008). Agile Project Management - Agilisim versus traditional approaches. *Journal of Computer Information Systems, Winter 2008 - 2009*, 10-17.

Gidado, K. (1996). Project complexity: The focal point of construction product planning. *Construction Management and Economics, **14***(3),. 213-225.

Gunasekaran, A. (1999). Agile manufacturing: A framework for research and development. *International Journal of Production Economics, **62***(1), 87-105.

Highsmith, J., & Cockburn, A. (2001). Agiel Development: The Business of Innovation. *Computer, **34***(9), 120-122.

Hunt, J. (2006). *Agile Software Construction.* London: Springer Verlag.

Iacocca Institute. (1992). *21st Century Manufacturing Enterprise Strategy Report.* Bethlehem: Lehig University.

Karlesky, M., & Voord, M. V. (2008). Agile Project Management (or, Burining your Gantt Charts). *Embedded Systems Conference* (pp. 1-8). Boston: Atomic Object & X-Rite.

Kartam, N. A. (1998). Making effective use of construction lessons learned in project life cycle. *Journal of Construction Engineering and Management,* ***14***(2), 14-21.

Kettunen, P. (2009). Adopting key lessons from agile manufacturing to agile software product development - A comparative study. *Technovation,* ***29***(6), 408-422.

Kidd, P. T. (1994). *Agile Manufacturing - Forging New Frontiers.* Cornwall: Addison-Wesley.

Larman, C., & Basili, V. R. (2003). Iterative and Incremental Development: A Brief History. *Computer,* ***36***(6), 47-56.

Lindstrom, L., & Jeffries, R. (2004). Extreme programming and agile software development methodologies. *Information Management Systems,* ***21***(3), 41-52.

Naim, M., & Barlow, J. (2003). An innovative supply chain strategy for customized housing. *Construction Management and Economics,* ***21***(6), 593-602.

Owen, R., & Koskela, L. (2006a). Agile Construction Project Management. *6th International Postgraduate Research Conference in the Built and Human Environment* (pp. 22-33). Delft: University of Salford.

Owen, R., & Koskela, L. (2006b). An Agile Step Forward in Project Management. *2nd Specialty Conference on Leadership and Management in Construction and Engineering* (pp. 216-224). Grand Bahama: ASCE.

Owen, R., Koskela, L., Henrich, G., & Codinhoto, R. (2006). Is agile project management applicable to construction? *International Group for Lean in Construction 14* (pp. 51-66). Santiago,Chile: IGLC.

Pan, W., Gibb, A. G., & Dainty, A. R. (2007). Perspectives of UK houesebuilders on the use of offsite modern methods of construction. *Construction Management and Economics,* ***25***(2), 183-194.

Project Management Institute. (2008). *A guide to the project management body of knowledge* (4th ed.). Pennsylvania: Project Management Institute Inc.

Ribeiro, F. L., & Fernandes, M. T. (2010). Exploring agile methods in construction small and medium enterprises: a case study. *Journal of Enterprise Information Management,* ***23***(2), 161-180.

Ritz, G. J. (1994). *Total Construction Project Management.* San Francisco: McGraw-Hill Inc.

Ross, E. M. (1994). The Twenty-first Century Enterprise, Agile Manufacturing and Something Called CALS. *World Class Design to Manufacture,* ***1***(3), 5-10.

Royce, D. (1970). Managing the development of Large Software Systems. *IEEE WESCON* (pp 328-338). Lo Angeles: IEEE.

Walker, A. (2007). *Project Management in Construction* (5th ed.). Oxford: Blackwell Publishing.

Weyrauch, K. (2006). What are we arguing about? A framework for defining agile in our organization. *Proceedings of AGILE 2006 Conference* (pp. 213-220). Minneapolis: IEEE.

Winch, G. (2006). Towards a theory of construction as production by projects. *Building Research & Information,* ***34***(2), 164-174.

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

Zhang, D. Z. (2011). Towards theory building in agile manufacturing strategies - Case studies of an agility taxonomy. *International Journal of Production Economics,* ***131***(1), 303-312.