Project Management Development – Practice and Perspectives
Sixth International Scientific Conference on Project Management in the Baltic Countries
April 27-28, 2017, Riga, University of Latvia
ISSN 2256-0513, e-ISSN 2501-0263

CONTINUOUS IMPROVEMENT AND WASTE REDUCTION FOR LEANER IT ORGANIZATIONS – AN INTRODUCTION TO LEAN IT

Guedes F. Jorge, ISCTE - Instituto Universitário de Lisboa

Abstract

The Information Technology (IT) sector has been seen as in need of optimization for the past decades, with practices that can be improved for an enhanced competitive advantage. In order to achieve an improved efficiency, not only coding activities should be optimized – the overall processes, methodologies, project management activities and practices should be reviewed, aiming for a leaner organization, orchestration and execution of activities. In this sense, the achievements from several manufacturing companies around the globe when applying Lean can be replicated to the IT sector, with equally promising results. The current paper, based on an unpublished research conducted in 2010 for a MsC Thesis dissertation, so far unpublished due to confidentiality reasons, aims to offer academics and practitioners an introduction to the concepts of Lean and its adaption to the Information Technologies sector by presenting a literature review, some quantitative data related to waste and risks in IT projects with a special interest in project management methodologies, terminating with the offering of some guidance for future research.

Key words: *Lean IT; Lean Manufacturing; Lean Transformation; Information Technologies; Project Management.*
JEL code: M0

Introduction and motivation

The use of Lean concepts is already widely used by the global industry, aiming to optimize costs, quality, and customer service constantly. These goals can be achieved by "engaging and equipping employees to focus on creating and delivering value in the eyes of the customer and eliminating whatever doesn't contribute to this goal" (Bhatia and Drew, 2006). In this sense, "manufacturing is no different from banks and insurance companies. It is therefore not surprising that financial services, healthcare, construction and even public services are all looking to manufacturing to learn about Lean thinking" (Jones, 2004), and information technologies are no exception. Lacking optimization, IT also has less promising performance indicators – A study conducted by the Standish Group (Hastie and Wojewonda, 2016) suggests that only 29% of IT projects are successful (on time, on budget with a satisfactory result), while 52% are challenged and 19% simply fail. Impressive to see that it has actually not improved much since the 90's, considering that the same study, published by the Standish Group (1995) shows that 29% of IT projects succeed, with 53% being completed with delays or budget increases and 18% simply failing, with 31.1% of projects being cancelled before they ever get completed. Further findings from the same study (Standish Group, 1995) indicate that 52.7% of projects will cost 189% of their original estimates, building up the picture of lack of efficiency on IT projects. These results are obviously translated in a very negative impact on organizations, as shown by the example of the Denver airport that costed the city $1.1 million per day due to the failure to produce reliable software to handle baggage (Standish Group, 1995), reflecting the magnitude of the impact on businesses.

ISSN 2256-0513, e-ISSN 2501-0263

It is in this sense that continuous improvement and reduction of waste must be introduced in order to increase the efficiency of these activities. These processes are difficult to see and difficult to manage, but an adaptation of Lean Manufacturing concepts can be achieved, promising a considerable increase in competitive advantage. To be noted that it is suggested that the bridge to Lean IT might be fairly simple to cross since the "principles are the same, and many of the lessons about reconfiguring processes are too" (Jones, 2004). It is even more important to adopt these philosophies when we confirm that, at present, IT is not only a support function for business but in many sectors, such as banking, it supports and drives business itself. To be noted that software development is only one of the areas that can be optimized – All the surrounding processes, as well as the methodologies used, should also be analysed in a critical perspective of continuous improvement and reduction of waste.

Lean as a widespread management philosophy

The concept of Lean is already widely used by engineers and managers around the world and has become indispensable in any glossary of top performers. Since its generalization in 1990 by Womack, Jones and Roos (Womack et al., 1990), in the book "The Machine that Changed the World", its implementation became very clear to practitioners, being composed by a set of simple concepts and tools – unfortunately, these concepts are not so simple to implement and maintain. In fact, this is one of the secrets to a successful Lean Transformation - The maintenance of the principles implemented, requiring method and commitment from stakeholders, having continuous improvement always in sight. With this new philosophy shaping the world's industry, the same principles were adopted in other areas - Education, Health, Construction, Services, among others - and in all these cases efficiency and effectiveness gains were achieved, as well as a reduction in costs and defects. Little time passed until the information technologies surrendered to the benefits of Lean methodologies as well. But when has it all started, and what is Lean after all?

It can be considered that Lean concepts and the operational excellence developed by Toyota in the post-World War II period are closely linked. Lean Manufacturing is, by the end of the day, the result of an in-depth study of the famous Toyota Production System (TPS), which refuses mass production, focuses on flexibility and productivity, using a low volume strategy guided by pull systems. However, presenting a synthetic definition of Lean is not easy. Lean can be considered to be: A philosophy that rejects any action that does not increase value for the client, always seeking perfection; A Management style that asks the "why", thinks and acts quickly, involving and motivating the workforce in the "Gemba" (for example the use of the famous "Quality Circles"); An approach that encourages process reengineering and promotes change, towards continuous improvement; or even a tool that allows and promotes the visibility of performance. More concisely, Lean Manufacturing can be seen as a philosophy that reduces time from order to delivery to the customer, eliminating sources of waste in the production as suggested by Liker (1996). On the other hand, we can also define waste as something that "represents any excess interruption, misalignment, unnecessary work, or ingrained redundancies that add no value for customers" (Kleiner, 2005). By eliminating waste, we can achieve better levels of competitiveness and "when you make things flow in a smoother, more effective way, you can gain market share dramatically against your competitors" (Kleiner, 2005). This concept of constant detection and elimination of waste can be considered as the great motto of the Lean. There will certainly be several definitions of waste but according to several authors (Bhasin and Burcher, 2006), waste can be summarized in 7 types, also known as the 7 "MUDA":

ISSN 2256-0513, e-ISSN 2501-0263

- Excessive production;
- Waiting;
- Transport;
- Over-Processing;
- Inventory;
- Reprocessing;
- Defects.

A correct detection, correction and elimination of waste, framed in a successful adoption of this philosophy, can lead to several benefits. However, we can also consider that the real benefit of Lean is not simply waste reduction; it is in fact the overall strengthening of the system as suggested by Meier and Forrester (2002). The impact of these practices can be outstanding, as suggested by Lathin and Mitchell (2001), who reports that traditional production can expect a 90% reduction in Lead Time, 90% in inventory, 90% in cost of quality and a 50% in labour productivity. On the other hand, lean manufacturing can help to reduce waste by 40 per cent, cut costs by between 15 and 70 per cent, decrease space and inventory requirements by 60 per cent, push productivity up between 15 and 40 per cent whilst cutting process changeovers by 60 per cent, as pointed out by Ferch, alongside Claudius Consulting (Bhasin and Burcher, 2006). Benefits can also be considered in other areas, such as the benefits of implementing Lean on a commercial fishing vessel that has reduced workloads, improved the quality of work of fishermen, reduced the time needed on the high seas by 25 % for the same objectives, increased crew salaries by 75% and raised annual revenues per vessel by more than $ 2 million as suggested by Bell (2006).

While these results are compelling and there is already a great amount of literature on Lean tools and methodologies, there is no such thing as a "cookbook" to explain each step of the lean process and exactly how to apply the tools and harvest the benefits (Bhasin and Burcher, 2006). It has to be adapted to each situation, structured specifically for each case and management has to be totally committed to change. More important, lean should be seen as a direction, rather than as a state to be reached after a certain time, as pointed out by Karlson and Ashlstrom (1996). Only in this perspective of continuous improvement, of personal and organizational change in a methodical and sustained way can the above results be achieved – As pointed out by Elliot (2001), the organization must live, breathe and teach Lean in all its aspects. This is actually one of the most important topics, without full commitment for the transformation; it will not be able to deliver its full potential.

Like all philosophies, there are also some more sceptical thinkers, especially about its viability and performance. First, Katayama and Bennett (1996) argue that when the study that originated The Machine that Changed the World was conducted, the market was in Bull and interest rates were down, suggesting that much of LEAN implementation was due to market conditions and not to the benefits of change. Other authors still suggest that the attempt to restructure and reengineer companies effectively makes them "Leaner" but also "meaner". This statement, widely used by opponents of the Lean, is based on the premise that resorting to these new forms of management will inevitably end up doing lay-offs of personnel leaving two groups of people - the victims and the survivors, where the victims were forced to leave the company and the survivors feel fortunate but also frightened about who will be the next one (Allen, 1997). Still, by not only taking Lean as a mean to reduce costs but mainly to increase

ISSN 2256-0513, e-ISSN 2501-0263

productivity, efficiency and competitiveness in the long run, managers around the world continue to orchestrate strategies based on the concepts of this philosophy and get positive results from its application. However, their implementation is also difficult and overcoming the resistance to change found in most cases proves to be a time consuming process. Additionally, "the major difficulties companies encounter in attempting to apply lean are a lack of direction, a lack of planning and a lack of adequate project sequencing" (Bhasin and Burcher, 2006). For its implementation to be successful it is "indispensable to see Lean as a long-term journey, to install a continuous improvement point of view and make numerous cultural changes embracing empowerment and sponsor the lean principles through-out the value chain" (Bhasin and Burcher, 2006). Still, it should be noted that there are several examples of organizations that have successfully implemented Lean, often exceeding expectations. It may be suggested that almost every major manufacturing company operating today owe at least part of its competitive advantage and efficiency to at least some concepts of this philosophy, but Toyota should be highlighted as a benchmark of excellence in Lean. Finally, it is also important to mention that these concepts have also been successfully adapted across cross-sectional areas, showing that all other subsystems have to change so that an organization can harvest the full benefits of Lean, increasing their competitive advantage, as suggested by Hancock and Zaycko (1998) - Information technologies should be no exception.

The information technology sector and the need for improvement

After reviewing Lean philosophy and its benefits in the industry, the same principles were quickly replicated in other sectors and the benefits were equally considerable. According to Pat Quinn, VP of information and technology systems at Acuity Brands Lightning, waste optimization does not just apply to scrap metal - It may also mean eliminating wastes of intellectual property, or human resources, or anything else (Overby, 2007). These process optimizations, waste reductions and increases in efficiency and competitive advantage have lured and captivated practitioners in one of the sectors with the highest rates of failure and waste - Information Technology.

According to the CHAOS report conducted by the Standish Group (1995) only 29% of IT projects succeed, with 53% being completed with delays or budget increases and 18% simply failing. These figures are already well above the 16% success rate in 1994, with 53% slippage and 31% failure. Impressive to validate that these numbers have not significantly improved, as confirmed by the latest CHAOS report (Hastie and Wojewonda, 2016) with data presented until 2015, in which we can confirm very similar values – 29% succeed, 52% challenged and 19% failed, with a poor evolution over the past 5 years as outlines on the Table 1:

Table 1

Project success evolution (Hastie and Wojewonda, 2016)

	2011	2012	2013	2014	2015
Successful	29%	27%	31%	28%	29%
Challenged	49%	56%	50%	55%	52%
Failed	22%	17%	19%	19%	19%

ISSN 2256-0513, e-ISSN 2501-0263

To be noted that these numbers are alarming and represent a clear opportunity for improvement, with clear waste sources - poor application planning, for instance, can be considered as a source of inefficiency since, according to the same studies, 64% of applications developed are not used or are rarely used.

Another study published in 2001 indicates that only 5% of the code was useful or even used (Cohen and Ware, 2001). Note that each line of code developed has a cost, added to the cost of designing, implementing and maintaining it – these statistics should be raising concerns on the management teams across the globe.

Furthermore, some authors suggest that "origin of this low yield can be traced to massing the adoption of the waterfall model for software development" (Hibbs et al., 2009). This fairly simple methodology, attractive for its simplicity and functionality, never revises previous steps, allowing no changes or iterations during the project. It is therefore a rigid model, not flexible and with many restrictions, and it is rare that the projects follow the defined sequence. It is currently considered by many practitioners as inadequate for the extreme dynamism and rapid change required in some software development projects – meaning that the need for a more flexible and iterative model started to grow. In response to these limitations, the also simple V model emerges, an optimization of the cascade model that derives from the direct relationship of each phase with the associated tests, extending the verification and validation throughout the software life cycle.

Going even further in time, the AGILE methodologies, which allow iterations, adaptations and changes required by software development, appeared at the turn of the century. All of these methodologies, including SCRUM, XP, CRYSTAL, follow some basic principles (defined for instance in the "Manifesto for Agile Software Development"), allowing a more fit for purpose development and assisting in reducing waste. Obviously, using these principles, the inherent flaws and weaknesses presented in traditional methodologies have been substantially reduced but the current indicators will not deviate much from the trend presented by the CHAOS study (Hastie and Wojewonda, 2016), which also offers a breakdown per methodology – for projects of any size, Agile methodologies achieved a percentage of 39% successful, 52% challenged and 9% failed, while waterfall methodologies achieved 11% successful, 60% challenged and 29% failed. These advances, which are extremely relevant, are not sufficient because although the aim of AGILE is to increase the productivity of software development while increasing the quality of the product, its scope is limited - It focuses mainly on software development, often neglecting the environment as well as the business adjacent to IT. In order to achieve real optimization and reduction of waste, it is necessary to focus efforts on the entire structure and to question and challenge the environment in which software development takes place, as well as all support activities related to information technologies. Only with this broad vision will it be possible to achieve a relevant maturity on Lean IT, and it is important to question current practices as well as established practices. Based on this need, there were also evolutions from an IT service support perspective, being these major milestones in any Lean IT roadmap - Public domain libraries with best practices for IT support have emerged, with the Information Technology Infrastructure Library (ITIL) being the most well-known and used, developed in 1980 by the Central Computer and Telecommunications Agency (CCTA) for the Government of the United Kingdom. ITIL is essentially a set of best practices, synthesized in several documents, used to assist IT Service Management. Although extremely useful and of

ISSN 2256-0513, e-ISSN 2501-0263

great benefits, its implementation is also challenging. It should be noted that some studies indicate that although 60% of the companies studied are working with ITIL, only 10% consider themselves to be true practitioners (Curran et al., 2009), revealing that the process is still very much at risk. In addition to the weak indicators presented in this chapter, it should be considered that, regardless of the companies' strong investments in information technology, it is suggested that there is still a huge difference between what the business expects of IT and what IT can deliver (Raichura and Rao 2009). It is possible to track this poor performance to the poor involvement of top management in some organizations, one of the most common and at the same time more serious problems that can be found in most organizations. To be noted that as suggested by Dorgan and Dowdy (2004), companies with more powerful Information Technologies do not do better financially, but they achieve greater benefits by combining investments in IT with good Management. It is also added by the same authors that "Companies should first improve their Management practices and only then invest in Information Technologies" (Dorgan and Dowdy, 2004). It is suggested by this brief introduction to this paper that the Information Technology sector is a problematic sector, with high failure rates and a latent need for change in the processes and techniques being currently used. Even with the current efforts of outsourcing some development and maintenance activities to cheaper locations and to implement tighter project management " the costs of developing and maintaining applications now account for about half of the average IT budget and continue to rise" (Kindler et al., 2007). It is also suggested that our efforts to improve should not focus within a single scope or section, but the entire value chain should be considered. It is from this perspective that the need for the Lean philosophy for Information Technologies arises, a robust approach that can bring a new momentum to all stakeholders, "being able to increase productivity from 20% to 40%, while improving the quality and speed of execution" (Kindler et al., 2007). These indicators made clear that the use of Lean Management techniques highlighted the value of Information Technology in reducing waste and increasing productivity on organizations.

Lean concepts in the information technology sector – lean IT

Adapting Lean concepts to the Information Technologies may seem like a fuzzy concept. However, let us consider that IT processes can be mapped and, if they can be mapped, can be measured. If they can be measured, they can be managed. Finally, if they can be managed, they can be optimized. On the other hand, according to Peter Waterhouse (2008), "in a manner similar to manufacturing, service development involves demand management, prioritization of activities, resource mobilization (finite), and defect control". Having these principles been imported from manufacturing, there have been some efforts to adapt the Lean philosophy to Information Technologies all around the world, being seen for one of the first times in the work "Lean Software Development: An Agile Toolkit for Software Development Managers", by Mary and Tom Poppendieck (2003). This can be seen as the origins of Lean IT, being a set of leaner practices that "takes a broader view, preferring to focus on the entire business context in which software development is done" (Hibbs et al., 2009). Thus, the LEAN philosophy "describes the" what "- reduces waste, etc. AGILE, as an extension, is a way to get to the "how" - describing the ways to eliminate actions of little added value" (Curran et al., 2009). According to Mary Poppendieck (Abilla, 2006), the backlog problem from an AGILE point of view can be solved by having someone prioritizing the list and then having the development team select from the top of the list the amount of work it can reasonably expect to accomplish and deliver within an iteration, with the expected quality, leading to the common problem that the least

ISSN 2256-0513, e-ISSN 2501-0263

priority work will take a long time to be resolved. On the other hand, in a Lean environment the goal is to keep the work list by doing the shortest possible, treating the requests responsibly and not accepting work beyond the capacity that the team can offer or is able to deliver. Therefore, we can consider the 7 basic principles (Hibbs et al., 2009) defined for Lean Software development:

- Build Quality in - Do not allow continuity of defects, stopping production and correcting the defect immediately, as opposed to detection only in quality control. Note that this way, correcting the error as soon as detected, also corrects the problem, avoiding future errors on integration or regression impacts.
- Creation of Knowledge - Create knowledge and share it whenever there is a "lesson learned". In this way, not only does the same person not make the same mistake twice, as there is sharing of that experience for others not to make the same mistake. In this way it is possible to avoid errors and defects, as well as to contribute to a greater training of employees. In this sense, a continuous lessons learned culture, as opposed to the methodological approach of lessons learned by the end of each phase is advised.
- Defer commitment - Just adopt strategies when you have as much information as possible, avoiding wrong choices and consequent waste. This is a complicated balancing act but can be valuable for a sound and sustainable decision, avoiding fundamental problems on strategy or approach caused by impetus or emotional decisions. To be noted that Defer commitment is not synonymous of inability to act or take decisions.
- Fast Delivery - Deliver the complete work as soon as possible, even if it is not the end product. This software tranche delivery approach is valuable for the customer to closely monitor and test the functionalities developed, making it easier to get their opinion on the product and, as such, makes the requirements change process more flexible. In this way, the iterations are more dynamic and easy, making the development process more agile to respond to the extreme dynamism demanded by the function.
- Respect for People - Respect and involve employees. Motivation is a key factor in people's performance and the benefits of engaging them can be in many ways - higher productivity, greater pro activity and commitment, among others. On the other hand, the accountability of people can also be advantageous in detecting opportunities for improvement and in the quality of the product developed, as well as providing valuable inputs to management or business.
- Optimize the Whole - This is one of Lean's key ideas in any industry. Never forget the prospect of the entire value chain, avoiding independent ventures, only in one area, neglecting the surrounding and adjacent. It is very important not to focus just on IT, a holistic view of the organization is highly advised.
- Eliminate Waste - As well as in industry and other services, for a Lean change we need to focus on eliminating all types of waste in order to maximize efficiency and increase overall return on investment – in this regard, Information Technologies should be no exception.

ISSN 2256-0513, e-ISSN 2501-0263

All of these basic principles are important and, as mentioned earlier, for a successful and sustainable implementation it is necessary to channel continuous efforts in all of them. However, in the present paper a more detailed analysis will be done on the elimination of waste because it is less of an obvious adaptation to the information technologies, as well as being considered as the basic principle for a Leaner organization. Therefore, it can be considered that "IT organizations are no longer focused solely on managing technology, but on maintaining a continuous production line of services and, as on any production line, waste can arise anywhere" (Waterhouse, 2008). Thus, as in industry, "systematically eliminating these sources of waste improves the delivery time, quality, and efficiency" (Kindler et al., 2007). Based on these assumptions, and in opposition to the 7 MUDA considered in LEAN Manufacturing, eight types of wastes can be listed in IT operations that add no value to the final product or service, called DOWNTIME as suggested by Peter Waterhouse (2008) and as shown by Table 2:

Table 2

Waste factors in IT (DOWNTIME)

Waste factors	Examples	Main Risks/Issues
D - Defects	Project execution miss-aligned with the defined requirements and standards, or technical errors	Lack of customer focus (considering internal and external customers in organizations) and increase in costs
O - Overproduction	Production of applications or systems that will not be used, will only be partially used or used incorrectly	Increase in costs, increase in complexity
W - Waiting	Extensive lead-times between activities, for instance between defect fixing and re-testing	Lower productivity, lack of customer focus, increase in costs, increase in employee frustration
N - Non-Value added processing	Applications that do not deliver relevant value to the organization	Miss-communication and increase in costs
T - Transportation	Transports for problem solving, environment structure and client strategy	Increase in costs, lower productivity, increase in employee frustration
I - Inventory	Licensing that is not used, excessive sizing of IT infrastructure	Increase in costs and lack of efficiency
M - Motion	The need to work on a re-active way, deviating from the plan – also known by practitioners as "firefighting"	Increase in costs, lower productivity, increase in employee frustration
E - Employee knowledge	Inability to capture ideas and to keep and share internal knowledge, increasing the overall performance of the team	Lowers employee engagement and satisfaction, risk of losing knowledge on the organization

ISSN 2256-0513, e-ISSN 2501-0263

This table can be seen as an approach to the types of defects or waste that can be found in IT. There will surely be many other mappings, and most authors consider only 7 types of Defects, grouping Transport and Motion into one. Even so, while some aspects of this Lean Manufacturing for Lean IT adaptation may seem to be forced, it can also be extremely useful for optimizing the processes and activities involved in IT-related activities. It is added that, according to a study by McKinzey (Kindler et al., 2007), we can point out that the phases most conducive to waste are the phases of customer contact, prioritization, and testing, which can reach 50% of activity that adds no value. To be noted that identifying and analysing waste is not the only difference between Lean manufacturing and Lean IT – there are several other differences. First, the operations in the industry sector are repetitive unlike IT. This factor is important considering that in IT, with projects going through different phases many times and repeatedly, workers feel that there is no project equal to the other. In addition, teams are formed for each project, making each project really unique, making it difficult to perform continuous team-based learning. On the other hand, in the industry the definition of the product by the customer is usually very clear. This is not the case in IT, where very often, what the system should do remains vague until later stages and can be a source of many misunderstandings between customers and users. Therefore, the need to always validate the requirements in the initial phases of the project should be reinforced, and this validation must always be done with the final customer. Finally, the third and biggest difference is that in IT the work is almost invisible and very personal. Unlike the industry in which everything is visible, according to Lean concepts everything must become "even more visible" - in IT is very difficult to visualize the flows, and as such it is difficult to visualize problems related to quality. However, it may be noted that attempts to implement Lean to IT must "overcome 3 challenges that are difficult to answer: “changing behaviour, broadening the focus from specifics to general principles, and setting up the right incentives" (Kindler et al., 2007), suggesting that the difficulties would be similar to some of those felt in the industry. On the other hand, and in the opinion of the more IT-centric author, Mary Poppendieck, it is suggested that "the metrics imposed by traditional management methods are the major impediment to the implementation of Lean Software Development. In particular, instead of measuring the variation to the plan, we need to start measuring actual delivery of business value" (Abilla, 2006). Thus, we confirm that change efforts cannot be only in software development. Lean is more than that, and an approach that is capable and transversal is needed for a full business transformation. It can therefore be considered that "a lean transformation requires simultaneous changes in the technical system (changes to tools, methodologies, standards, and procedures), the behavioural system (convincing staff of the value of these changes), and the management system (new roles, metrics, and incentives to encourage the shift)" (Kindler et al., 2007). Note that these changes will only be possible if there is a strong commitment from the Top Management, being this a critical factor for the success of any transformation – and at the same time one of the most common issues, being most of the times a show-stopper for the full realization of the benefits that could derive from a lean IT transformation.

Conclusions - Lean IT maturity and further research

The application of these concepts can, as previously mentioned, bring great operational benefits to the information technologies, as well as massive savings. It can have a major impact

ISSN 2256-0513, e-ISSN 2501-0263

on an organization competitive advantage by creating a greater focus on core business and reducing overall lack of efficiency based on a continuous improvement and waste reduction mind set. Still there are not many success stories available due to the still reduced maturity level of lean IT, being the author of the opinion that this is a clear gap in the literature. Nevertheless, it can already be considered that, for example, British Airways has proposed to achieve savings of £100 million per year within two years, which it achieved and exceeded (Orlov, 2008) with an integration program called "Customer Enabled BA", with clear imports from a lean philosophy. Also on Fujitsu, according to a case study issued by the company, it is noted that "Lean is not a process, it is an attitude. It's not just tools and techniques, it's the way people think and work, culturally and philosophically. (...) What the Lean approach highlights are the peaks and gutters present in the workflow that are not always visible. It has also helped us (Fujitsu) to focus on what features are available so we can focus on more business easily since we know the flexibility to offer a wider range of services" (Cooley, 2007). These cases illustrate the importance of adopting the Lean philosophy in information technology but also stress that efforts are only just beginning - "The Information Technology world and the Lean have a lot to learn from each other" (Jones, 2013), being important for the academic and business community to continue its research on the real benefits of adapting Lean concepts to the information technology sector, gathering and sharing more comprehensive data that can assist in understanding and further developing Lean concepts. Also, a continuous review of project management methodologies and practices supported by empirical evidence and aligned with a lean philosophy would be very interesting. Additionally, the import of Lean concepts to areas related to Information Technologies such as Outsourcing, Change Management or User Training might be yet another interesting route for research since there is very limited literature available. Finally, studies on Leaner IT support organizations as well as in IT Environments and Infrastructures would also be valued by the academic and business communities, since this is also a clear gap in the literature.

References

Abilla, P. (2006) Book review: Implementing lean software development. Shmula. http://www.shmula.com/12-questions-with-mary-poppendieck/183 (Accessed 1 March 2016).

Allen, R. (1997) 'Lean and mean: workforce 2000 in America', Journal of Workplace Learning, Vol.9 No.1, pp.34 – 42.

Bell, S. (2006). Lean Enterprise Systems: Using IT for Continuous Improvements, John Wiley & Sons, Inc., New Jersey.

Bhasin S. and Burcher, P. (2006) 'Lean viewed as a philosophy', Journal of Manufacturing Technology Management, Vol.17 No.1, pp.56-72.

Bhatia, N. and Drew J. (2006) Applying lean production to the public sector: governments at all levels must deliver more for less. The principles of lean manufacturing offer surprisingly apt solutions. http://www.mckinsey.com (Accessed 1 March 2016).

Cohen, D. and Ware, B. (2001), 'Improving Software Investments through Requirements Validation' in Software Engineering Workshop: Proceedings. 26th Annual NASA Goddard, Greenbelt, IEEE Computer Society, Maryland, pp. 106 – 114.

Cooley, I. (2007) Lean creates a solid platform for growth, Fujitsu Services Limited.

Curran, C., Legnine, S. and Boudrow, R. (2009) The skinny on Lean IT. http://www.ciodashboard.com/it-management/the-skinny-on-lean-it/#. (Accessed 1 March 2016).

ISSN 2256-0513, e-ISSN 2501-0263

Dorgan, S. and Dowdy, J. (2004) When IT lifts productivity: Companies should beef up their management practices before focusing on technology. http://www.mckinsey.com (Accessed 1 March 2016).

Elliot, G. (2001) Manufacturing excellence. https://www.questia.com/read/1P3-74809022/manufacturing-excellence (Accessed 1 March 2016).

Hancock, W. and Zaycko, J. (1998) 'Lean production – implementation problems', IIE Solutions, Vol.30, pp. 1 – 9.

Hastie, S. and Wojewonda, S. (2016) Standish Group 2015 Chaos Report - Q&A with Jennifer Lynch. https://www.infoq.com/articles/standish-chaos-2015 (Accessed 1 March 2016).

Hibbs, C., Jewett, S. and Sullivan, M. (2009) The Art of Lean Software Development, O'Reilly Media, Inc., Sebastopol.

Jones, D. T. (2004) Lean Beyond Manufacturing. http://www.leanuk.org. (Accessed 1 March 2016).

Jones, D. T. (2013) Lean and IT. http://pt.slideshare.net/LeanUK/lean-and-it (Accessed 1 March 2016).

Karlson, C. and Ashlstrom, P. (1996), 'Assessing changes towards lean production', International Journal of Operations & Production Management, Vol.16 No.2, pp. 24 – 41.

Katayama, H. and Bennett, D. (1996), 'Lean production in a changing competitive world: A Japanese perspective', International Journal of Operations and Production Management, Vol.16 No.2, pp. 8 – 23.

Kindler, N., Krishnakanthan, V and Tinaikar, R. (2007) Applying lean to application development and maintenance: To make application development and maintenance more productive, IT managers are getting lean. http://www.mckinsey.com. (Accessed 1 March 2016).

Kleiner, A. (2005) Leaning toward utopia. http://www.strategy-business.com (Accessed 1 March 2016).

Lathin, D. and Mitchell, R. (2001), 'Lean manufacturing: techniques, people and culture' in Quality Congress Proceedings, Milwaukee, pp. 321 – 325.

Liker, J. (1996) Becoming Lean: Inside Stories of US Manufacturers. Productivity Press, New York.

Orlov, L. (2008) British Airways: A case study in Lean IT. IT Business Edge. http://www.cioupdate.com/insights/article.php/11049_3767846_1/British-Ariways-A-Case-Study-In-Lean-IT.htm (Accessed 1 March 2016).

Overby, S. (2007) Learning to love Lean IT. http://www.cio.com/article/2439151/it-organization/learning-to-love-lean-it.html (Accessed 1 March 2016).

Poppendieck, M. and Poppendieck, T. (2003) Lean Software Development: An Agile Toolkit. Addison-Wesley, Crawfordsville.

Raichura, B.and Rao, V. (2009) Lean IT Transformation: Reduce Total Cost of Ownership, Guarantee Quality-of-Service and Achieve Business Agility, Infosys Technologies Limited.

Soriano-Meier, H. and Forrester P. L. (2002) 'A model for evaluating the degree of leanness of manufacturing firms', Integrated Manufacturing Systems, Vol.13 No.2, pp. 104-109.

The Standish Group (1995) The CHAOS Report, The Standish Group International.

Waterhouse, P. (2008) Improving IT economics: Thinking 'Lean', CA Technologies.

Womack J. P., Jones, D. and Roos, D. (1990) The machine that changed the world: Based on the Massachusetts Institute of Technology 5-million dollar 5-year study on the future of the automobile. Rawson Associates, New York.