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AGILE PROJECT MANAGEMENT AS A CHANGE MANAGEMENT TOOL IN DYNAMIC CONSTRUCTION PROJECTS, A NECESSITY TO COOP WITH PROJECTS' INCREASING COMPLEXITY AND UNCERTAINTY

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Purpose: The construction industry has one of the most important roles in any countries economy, despite of that, construction projects remain under the spotlight when compared to other industries projects due to its special nature and scope, with their increase of complexity which by default increases the amount of changes occurring therefore rising the risks of low performance, which is already an issue in the sector, construction management is facing more challenges than ever, this research paper was carried out in order to provide possible alternatives for the traditional way of managing construction projects.
Design/Methodology/Approach: A literature review was carried out exploring the necessities of implementing agile management in the field in order to coop with the increasing complexity and uncertainty of construction projects therefore increasing the overall performance, alongside identifying the potentials and limitations of such an approach.
Findings: As a result it was found that a tailored approach could be the answer to improve the whole sector and bring it up to date, using an integration of various methods of lean and agile management with traditional waterfall method, the agile management tools do show promising potential for the dynamic project nature which shows the importance of such an implementation.
Originality/Value: This paper provides cognitive scientific value by adding needed knowledge in a relatively immature research area for the practical development of one of the largest industries.

Keywords: Agile Project Management, Change Management, Construction Management, Lean Management.

Category of the paper: Research Paper.

1. Introduction

The construction industry is considered a risky field with a lot of external and internal factors influencing the industries uncertainties in the construction process, making it hard to achieve its best possible performance mainly due to low productivity (Salunkhe, Patil, 2014), Actually low performance is a common issue within construction projects, more precisely cost overruns and time delays, which have triggered the interest of both researchers and practitioners' alike (Mansfield, Ugwu and Doran, 1994; Meng, 2012), a generalized statistical view on projects in the United States gathered in the Chaos report with data belonging to 2012 shows that 43% of projects carried were either late, over budget or did not meet the requirements, in which 59% were cost overruns and 74% were time overruns, while 18% were considered a complete failure, moreover only 39% were a success with respect to the project objectives (Time, Cost and Quality) (Standish Group, 2013).

One cause for projects low performance that may lead to cost overruns or even project failure is project complexity (Kaming et al., 1997), while another cause identified was changes that happen within the project due to the dynamic nature of the design-construction process, which encourages interaction between various project aspects (site conditions, site constraints, cost, stakeholders involved etc) (Lee, Peña-Mora, and Park, 2006), in the meantime other scholars pointed out that the reason behind a projects low performance is the way that these projects are being managed as it strongly affects successful delivery (Olsson, 2006; Gil, Tether, 2011).

Despite the importance of project management for successful project deliverables and performance improve, yet still research in this field remains immature (Davis, 2014), moreover that traditional project management being no longer efficient (Hertogh, Westerveld, 2010), in addition to the level of complexity in projects alongside their size shows the importance of adopting a dynamic tailored managerial approach, but the underestimation of the dynamic project environment influence remains (Priemus, Bosch-Rekveldt, and Giezen, 2013).

This article aims to point out the necessity and potential of agile management in the construction industry in a tailored approach, alongside identifying its enablers and limitations within the construction industry.

2. Literature Review

2.1. Changes in construction projects

Amendments that are made to the original contract are considered changes, these amendments are usually submitted written as a change order or a change request, and must be signed by all parties involved, these amendments can include one or more of the following changes, changes in the design, changes in the methodology, changes in the specification & requirements or even changes in materials, site, equipment and works completion, it should also be noted that these amendments are not limited to what was previously mentioned, thus they can change the provisions of the initial agreement effectively as they may also include money or time compensations (Klinger, Susong, 2006).

Despite the inevitability of changes in construction projects and the fact that these changes may occur from various sources by many different causes at any point of the project, furthermore them being considered as one of the main reasons behind projects' budget overruns and delays, yet still the decision making process in response to these changes often remains based on previous professional personal experience with them generally lacking sufficient information to base these decisions on.

Changes can be divided into different phases, the first one is specification related in which the architect or the client/owner is the stakeholder at this phase, amendments that occur during this phase include changes that are applied to project requirements, more precisely specification, scope or the design of a project, moving on to the second phase, changes at this phase tend to occur the design stage, at this phase of this stage the engineering consultant or the designer is considered to be the stakeholder, amendments at this phase usually include but also not limited to defects or errors in the design, changes in the design, buildability or site conditions omissions, the incompletion or inconsistency of drawings and codes or regulation changes, as for the third phase which happens during the construction stage of the project, at this phase the contractor is considered the stakeholder, as these changes are influenced/requested by the contractor, the amendments at this phase include modifications to the as-built drawings as they do not comply with the as-design drawings, quality defects, unanticipated site conditions, inclement weather conditions, value engineering and the unavailability of certain materials or equipment (Hao et al., 2008).

Although the previously mentioned changes are differentiated into phases, it should also be noted that these phases usually integrate in a way or another during the projects' lifecycle, in other words they can move back and forth within the project, which focuses the importance of improving the communication process by increasing its frequency in order to increase the flexibility and overall project performance.

The main objective of change management is to be able to foresee changes that might happen during the lifecycle of a project and since changes tend to go through a formal process, despite of them having a major impact on the project or not, nor them being variation orders or reworks, therefore a process model was created or rather say identified by reviewing synthesis models of change processes and their computational environment characteristics, which can be sequenced as follows (Hao et al., 2008):

1. Identification of Changes: In order to be able to implement changes while building an effective relationship between various possible outcomes and requirements, an effective managerial system forms a necessity rather than an accessory.
2. Purpose & Evaluation of Changes: a PCO (proposed change order) that has an impact assessment report of the possible outcomes of applying the changes requested on the project as a whole, this report must include but not be limited to the changes impact on the individuals and processes in both terms of time and cost, furthermore an analysis optimizing processes within the change with other projects' processes if possible, and whether a further investigation is needed or that it is alright to proceed.
3. Approval of Changes: a formal sequel of approvals takes a place right after the PCO identifying the changes has been submitted, this sequel varies from one contract to another depending on the type of the contract, moreover on the change type itself. After establishing a change review process all parties involved must agree on the submitted PCO, afterwards the final approval is the clients to make so the PCO can be finalized, this step may also include further improvements or modifications to these changes, after approving these changes, the contract is modified directly, otherwise it's either forced throughout a CCD (construction change derivative) or it is permanently rejected.
4. Implementation of Changes: this process step is more about documentation rather than decision making, all parties involved must record all relevant information of any change case that happens on their established database for future reference, the database should be kept up to date and all parties involved should be notified, to guarantee a smooth coordination between all activities and well executed in order to be able to produce a change analysis report at a later stage.
5. Analysis of Changes: after the implementation process is due, the data collected and recorded as a result is obtained for analysis and performance assessment.

The construction phase forms a challenge facing the efficient implementation of a change management process module as it requires an integrated coordination system where everyone and everything are involved in the process of changes, furthermore the change management modules that are available in the market are more of a document approval and information recording, rather than change order traceability, post-change or impact analysis and not even estimation (Hao et al., 2008).

A change management system that integrates many project aspects from a collaborative workflow with the system to the collaborative technologies including modelling, online documentation management tools in addition to web-based project management tools in a cooperative way is required (Hao et al., 2008).

2.2. Agile management necessity in construction projects

APM (Agile Project Management) can be defined as a broad managerial approach built on specific principles that aims to render the project management processes into a more straightforward, iterative and flexible type, so performance improvements can be achieved with a higher innovation levels and value adding to the customer, all while maintaining a lower effort in terms of management (Conforto, Amaral, 2010).

Tools and equipment are highly valued in the construction field in comparison with other fields, as the common belief states that the requirements of these kind of projects and work scope can't be achieved without machinery, more or less on the truthfulness of the previous statement, the construction industry did show promising managerial improvements in previous recent years, as it transacted to location based management system instead of traditional management system alongside an increase in reliance on personnel (Iqbal, 2015).

Furthermore both sides of the equation (documentation and successful product delivery) are equally and excessively valued in the construction industry, therefore changes in requirements that are not forced by special circumstances nor requested by the client in order to perfectionalize end result can sometimes be proposed, these changes in requirements often results in wastes which are considered not leant, the last planner approach does show potential for these cases (Iqbal, 2015).

It is not debatable that all businesses including the construction industry value the contract and its importance, as it the most binding document, yet still revisions that contracts go through remains tremendous and changes tend to happen, and since changes are already happening at this phase, therefore an agile index prioritizing the client shows a futuristic potential and applicability (Iqbal, 2015).

Agile management provides a framework that consists of work break down structure, in addition to working on a shorter iterations, improving project's activities and team's personnel responsiveness and adaptiveness to changes that occur (Iqbal, 2015), also (Demir et al, 2012) suggest that for construction projects agile IT can have a more suitable approach in the field rather than agile manufacturing.

2.3. Agile methodologies

Despite all the variations within agile methodologies from Kanban to Scrum and more, the primary objective of considering the most recent information available remains the same, in addition to minimizing changes impact and addressing risks as early as possible (Cooke, 2012; Yllén, 2012).

SCRUM

Scrum is one of agile management tools that focuses on organizational splitting by creating self-organizing teams and dividing the work activities into smaller iterations that have clear deliverables while maintaining a prioritization list of each, in addition to breaking down the overall time structure of each activity into a relatively shorter and fixed intervals, all that while maintaining frequent optimization of processes according to the plan, in the meantime keeping customers involvement, furthermore frequent updates after each phase completion is a must (Kniberg, Skarin, 2010).

According to (Kniberg, Skarin, 2010) Scrum has three prescribed roles:

1. Product Owner (Priorities and Vision).
2. Scrum master (Leadership).
3. Team (Implementation).

Moreover Scrum also has three prescribed fixed time iterations know as (sprints), following are these iterations as identified by (Kniberg, Skarin, 2010):

1. Beginning of Iteration (Planning & Prioritizing).
2. During Iteration (Improve & Complete Within Fixed Scope).
3. End of Iteration (Deliver, Discuss).

Additional roles can be added without any limitations despite of scrums prescriptions, as long as these tasks are well identified and clear so contradictions and conflicts can be avoided between any of the added roles (Kniberg, Skarin, 2010).

A WBS (work breakdown structure) is a necessity in scrum as it simplifies processes, and since processes within scrum must completely fit in the sprint so that when the sprint is completed, all included processes within it must be finished as will, therefore the WBS process simplification is important to adapt the processes with the specified sprint, since the sprint duration iteration period is optional as long as it is kept fixed, increasing sprint duration in order for the processes to fit within also proposes another option for adapting processes to sprints, and due to construction projects activities nature the second option does look appealing (Kniberg, Skarin, 2010).

Velocity calculation is also essential in scrum as the whole method evolves around sprints, the velocity in scrum is a measure of capacity therefore each team must determine the effort (amount/size) that was done for each completed process at the end of each sprint, calculating the velocity of each sprint can provide an information and indication of how much work can be

delivered within a certain specified time duration or in the sprints case iterative interval, in order to calculate the velocity the work completed must be summed up to end up with a measure of the whole size of work that was done within a sprint and the end result would be the sprints velocity, furthermore in order to improve futuristic predictions accuracy an average of velocities can be calculated and with the right WBS the time planning process improves in terms of completion dates accuracy (Kniberg, Skarin, 2010).

Kanban

Kanban is one of the other agile management tools which also supports splitting but using a different approach, in this tool a process visualization is created in which the work to be carried out is broken into a smaller work iterations where each work process that is a result of the work breakdown is specified under the phase that is most relevant, afterwards a WIP (work in progress) is created in order to limit the number of processes in each workflow to a certain number, then a measure of the cycle time (lead time) takes a place, cycle time is defined as the average time needed to complete on cycle and afterwards lead time is to be minimized as much as possible (Kniberg, Skarin, 2010).

Kanban focuses on cycle time reduction which creates a WBS by default, therefore the user of this agile tool is not obligated to establish a certain level of WBS for it to fit within a frame/board, in other words the same board consisting a certain timeframe can have processes that takes a month or more to complete an others that can be finished within one working day (Kniberg, Skarin, 2010).

Kanban has a more adaptive approach rather than the prescriptive approach that scrum has, therefore the user is not obligated to be using any certain calculation/estimation method, so this tool user has the freedom of choosing whatever method they find best fit for their project necessities (Kniberg, Skarin, 2010).

2.4. Agile management tools comparison

When comparing agile management tools with traditional managerial methods, agile is considered to be light weighted, in other terms it is less prescriptive. As for flexibility within agile itself, if it is to be identified by the number of rules that each tool uses and has, the scrum is considered to have more than Kanban, therefore it can be said that it is more prescriptive than adaptive, yet still it remains less prescriptive than approaches that use traditional methods and tools (Kniberg, Skarin, 2010).

If it was for agile tools to be organized from the least prescriptive tool to the most ordered respectfully, Kanban tool takes the lead and SCRUM follows it, then XP (eXtreme programming) takes a place and RUP (rational unified process) is considered the most prescriptive of them all, stating the obvious scrum comes in the centre of both extremes (Kniberg, Skarin, 2010).

When comparing scrum to Kanban, three prescribed roles can be found in scrum but that doesn't mean the Kanban cannot also have prescribed roles, but this tool as previously mentioned doesn't obligate the user to implement any, as for the time iterations scrum unlike Kanban has to have a start date while in Kanban the user starts whenever they see suitable, thus it can be concluded that Kanban limits the work in process per workflow state compared to scrum that limits work in progress per iteration, since both tools are considered to be empirical, they tend to give constraints rather than providing all the answers, so the user of any or both can personalize their method in relevance to their personal experience and projects requirements (Kniberg, Skarin, 2010).

In terms of planning velocity is calculate for scrum while cycle time is used within Kanban, moreover it is necessary to establish a work break down structure in scrum as for Kanban there is no limit for the work breakdown level, furthermore work in process within Kanban is directly limited directly while using scrum is limited indirectly, unlike scrum Kanban allows the user to add more processes in an ongoing sprint as long as the capacity allows it (Kniberg, Skarin, 2010).

The two tools that were discussed earlier are considered to be both agile and lean, as they both adopt the scheduling pull method, in addition to inventory management using JIT (just in time), in addition the continuity and process optimization is considered a part of kaizen lean management, furthermore scrum and Kanban are equally change responsive, therefore the key to a successful implementation is tools integration, so rather than having sticking to one tools limitations, integrating these tools maybe the way to ease improvements (Kniberg, Skarin, 2010).

2.5. Integrated project management

Many approaches are pointing out the great possible outcome of an integration, (Hassan, Khodeir, 2019) recommended Integrating agile project management with the traditional method, furthermore (Zender, de Soto, 2020) find a great potential in combining scrum with lean management, pointing out that it can be a mid-grounds between the two approaches (Sohi et al., 2016) also suggest an integrated combination of agile and lean supported by the correlation analysis conducted and concluded that the use of agile and lean practices can help coop with projects complexity increase.

Agile Integration with Lean

In order to improve adaptation to the increase of complexity in projects now a days, an agile-lean management integration was suggested as a solution, according to a correlation analysis that was conducted between the two methodologies, a total of twenty-five correlations were tested in which eight of them were found to be significant correlations between both managerial methodologies, the correlation elements also resulted in a significant reduction in project complexity, moreover in a subsequent research that was conducted it was concluded

that an overall improvement in project performance was documented due to the reduction of project complexity (Sohi et al., 2016).

Furthermore, an illustration of an agile-lean framework integration on the showed a combination of adaptability to changes alongside an elimination of wastes on the operational level, this integrated work frame serves best the more dynamic projects, as with higher dynamicity within a project the higher the uncertainty is, leaving the door open for more change causes to happen, the research also concludes that this integrated framework can be the best approach in improving projects performance by reducing projects' complexity (Demir et al., 2012).

A research investigation was initiated by reviewing literature and followed by quantitative analysis in order to identify the CSF (critical success factors) in both approaches, the identified multiple success factors included business strategies, motivation, leadership, trust in addition to organizational capabilities, the quantitative analysis also found that for agile the foremost important CSF is identifying the knowledge of the recipient, as in lean knowledge source identification was the CSF, furthermore the article concluded that trust between construction organizations and individuals is the most important CSF (Saini, Arif, and Kulonda, 2018).

Despite what was previously discussed regarding project complexity adaptation, agillean integration can cause an increase in project complexity due to the increased frequent collaboration between the small self-organizing teams increasing the complexity of these relationships, in addition to frequent changes, thus to facilitate smoother application of the agilean integration coping with the increased complexity, and in order to establish a well-coordinated system that also allows dynamicity, Interface Management is proposed (Chen, Reichard, Beliveau, 2007).

Agile Integration with Waterfall

There are three different life cycle types that are supported, the namely predicative, iterative and incremental in addition to the adaptive which is also considered as a part of the iterative type (PMBoK, 2013), a waterfall-agile integration was established using empirical analysis resulted not only in the project's success but also to the positive contribution in information accuracy alongside commitment and leadership (Conforto, Amaral, 2016).

Moreover (Singhto, Phakdee, 2016) found in another study conducted on a software development project that integrates agile with waterfall using scrum tool concluded positive outcomes, as the waterfall allowed early problem identification while scrum allowed a better adaptation to the circumstances, which also increased customers involvement.

Thus it can be reasoned that the argument has shifted from which method is more suitable, to which method is right for which project, or including an integration between both methodologies (Van Der Merwe, 2017).

2.6. Agile management potentials in construction projects

Managers that use iterative planning while maintaining an incremental repetitive process of continuous learning can improve projects responsiveness to changes, moreover improving the cooperative environment can increase agility of construction projects (Arefazar et al., 2019), furthermore the precision of the plan in addition to the continuous update of the construction projects progress is considered a primary assumption for completing the construction project successfully and according to the terms of the contract and aligned with project goals of cost, time and quality (Kozlovska, Mackova and Spisakova, 2016).

It was found possible to apply the four values of agile by all parties involved in the construction project in addition to applying eleven out of twelve agile principles by the main parties involved according to the case study conducted (Mohammed, Jasim, 2018).

One of the important advantages of agile construction is its adaptive response to changes that happen to project requirements, in addition to increasing the understanding between the teams and the client due to the increase of interaction which leads to continuity of inputs (Balaji, Murugaiyan, 2012), furthermore the impact of implementing agile management in order to optimize changes influenced by stakeholders in projects we found to be as follows, achieving project goals within budget, a lower risk of project failure, competitive growth enhancement moreover an increase in customers demand in marketplace (Hassan, Khodeir, 2019).

Scrum also shows great potential for application in the construction sector, as the result of another case study that was conducted in Peru resulted in a flexibility increase in terms of responsiveness to changes, in addition to the reduction of overall project duration which meant an earlier delivery deadline which resulted in client noticeable valuation, furthermore the case study also noted a lower risk rate in situations that included high uncertainty, therefore stakeholders overall satisfaction. The study also found that it was also feasible to apply scrum-agile in an environment that is characterized by accelerating uncertainty, also the researchers found the approach also applicable to other work areas within the same project environment such as logistics, safety and quality (Zender, de Soto, 2020), to achieve what was previously discussed it is important for the project delivery system to develop in a way that eliminates barriers between designers and contractors by promoting partnership (Arefazar et al., 2019).

2.7. Agile management limitations in construction projects

Some of the limitations that were identified in construction projects were referred to cultural problems which cause a hardship in terms of creating self-organizing (self-managing) teams (Arefazar et al, 2019; Han 2013), in other words the workforce is not prepared enough professionally nor financially (Koch, 2005), moreover agile construction management lack of codes therefore the benefits of this approach has not been solidly proven in this particular field, thus stakeholders can find it risky compromising their limited resources including initial investment, in addition to the changes in work conditions for the other parties involved in the

project, forcing then to adopt a relatively complicated coordination processes while taking into consideration other external factors (Arefazar et al., 2019; Han, 2013).

The unusual sub-contracting and employment agreements that takes a place in construction projects is also identified as an obstacle facing agile management implementation in the field (Owen, Koskela, 2006; Owen et al., 2006) also cited in (Vaz-Serra, Hui, and Aye, 2019), moreover certain construction project phases cannot be flexible enough for such a methodological implementation due to these phases sequential nature (Demir et al., 2012) also the strict deadlines and scope that are ruled out by contractual and regulatory constraints (Turner, Downey, 1993; Chin, 2004), therefore agile management adoption can limited to certain project phases rather than a fully integrated implementation, moreover the special circumstances of each project should be brought into spotlight and highlighted, in addition to the high level of project complexity can lead to conflicts throughout project phases (Demir et al., 2012; Gustavsson, 2007).

3. Discussion

The growth of the construction industry in any country is considered a corner stone for measuring it's economic growth (Alzahrani, Emsley, 2013), due to the nature of projects, more precisely construction projects, it was pointed out that these projects go through many changes throughout their life cycle, of which limits the success of the end result delivery by causing delays, cost overruns and unsatisfactory quality (Lee, Peña-Mora, Park, 2006). Launching from the fact that the integration of these three project objectives (Time, Cost and Quality) is a measure of any construction projects success, and failing to maintain a consistency between all three is causing severe issues that can lead to projects failure, moreover not being able to foresee these indicators nor forecast project fails makes it a larger issue (PMI, 2010).

To address causes previously identified and according to previous studies it was concluded that projects go through external and internal factors that lead to projects low performance (Meng, 2012), the internal causes source can be traced back to the client, contractor, consultant, designer and subcontractor (material, equipment or labor) in addition to these parties interaction methods and ways, while the external causes can be referred to weather conditions, market fluctuations, regularity changes and unforeseen site conditions (Assaf, Alhejji, 2006; Hertogh, Westerveld, 2010), as for changes which are very common in the construction industry, these changes include any modifications made from revisions to addition or deletion happening to the goals or scope of a project, regardless of them increasing or decreasing any of the projects' objectives previously mentioned (time, cost and quality), therefore the continual update of the construction management documentation is an essential part for managing these changes as the construction management planning documentation is a reflection of efficient planning (Ibbs,

Wong, and Kwak, 2001), furthermore these changes are hard to predict due to the special nature of each construction project in addition to the limited resources spent on planning, executing and delivering the project which makes an impact on the projects' overall performance (Hanna et al, 2004).

Agile management can be a good tool to handle changes and uncertainties within construction projects (Han, 2013), as the increased adoption of agile within projects that are characterized by their uncertainties and unpredictability (Alleman, 2005; Cicmil et al., 2006), also with more than 80% adoption in large public sector projects and projects executed by global firms (Mah, 2008), moreover projects that used agile were found to be twenty times more productive compared to the ones that used traditional methods according to a study by (Rico, Sayani, and Sone, 2009), Furthermore 60% of agile projects were a success compared to only 47% success rate for traditional projects, 28% were challenges using agile in comparison with 36% using traditional, as for failures agile had a lower failure rate with only 12% when compared to the 17% using traditional (Scanlon-Thomas, 2011).

4. Conclusion

The construction industry has one of the most important roles in any countries economy, despite of that, construction projects remain under the spotlight when compared to other projects due to its special nature and scope, with their increase of complexity which by default increases the amount of changes occurring therefore rising the risks of low performance, which is already an issue in the sector, construction management is facing more challenges than ever, while writing this article it was found that agile management forms an answer to the low performance of construction projects, in relevance to projects complexity levels and various types of changes that occur during the projects life cycle, furthermore to the challenges that face the construction management system, moreover when looking at the tools and methods that agile management provides it shows a great potential in improving construction projects in terms of (cost, time and quality), it was also found that a tailored approach could be the answer to improve the whole sector and bring it up to date, using an integration of various methods of lean and agile management with traditional waterfall method, the agile management tools do show promising potential for the dynamic project nature which shows the importance of such an implementation, yet still due to its limited implementation within the construction industry, in addition to the fact that research in this particular field is not mature enough, worries and limitations rise still, in regards of these limitations a tailored approach can be the answer, especially when integrating different managerial approaches as agile-lean and agile-waterfall, finally addressing these limitations in future research forms necessity.

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