Compatibilities and impediments to the applicability of agile project management to the execution phase of construction: Introducing a theoretical approach[1]

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Introduction

Agile project management has been developed in the early 00's and has been implemented since then in the software development industry with great success. Very soon this success opened a discussion on whether agile project management can be applied to other non-IT sectors and in fact many sectors embraced such principles and continue to do so. In construction the specific subject is still debatable. There is a widespread view that agile project management can be applied to the pre-design and design phases of construction, but not to the actual execution phase, due to the unique nature of construction projects and the consequent existence of certain impediments. The existing literature has focused on the first two phases and the execution phase has only been superficially examined, if at all. It is considered a phase with traditional norms and procedures, which are very difficult to change. However, the problems observed in construction over the past years (low productivity, low profit margins for construction companies) call for a change. Since the execution phase is the core phase of construction, a possible adoption of a new, effective project management approach at this phase would be a positive step towards this direction. The specific paper analyses each agile project management principle and examines whether it is applicable to the execution phase of construction or not, identifying possible compatibilities and impediments. As far as the impediments are concerned, there are certain proposals for overcoming them in an attempt to develop a realistic approach for applying agile project management principles to the execution phase of construction. Finally, the paper analyses whether agile project management is eventually applicable to the execution phase of construction and on what conditions would this be possible. Through this analysis the approach of congile project management is introduced and explained.

Setting the scene

It seems that there is a general consensus among the researchers that applying agile project management to the execution phase of construction is particularly difficult.

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Depending on the nature of the research each researcher presents certain impediments. Owen et al. (2006) point out that while agile project management fits perfectly in pre-design and design phases, for managing the execution phase a great amount of effort would be needed, beginning with a cultural change within the sector particularly in terms of training and learning to achieve multi-skilled and self-managing teams. Straçusser (2015) focuses on the nature of construction projects stating that their sequential character make them very poor candidates for an agile approach, since changes become increasingly expensive as a project moves further down the lifecycle. Mohamed and Moselhi (2019) refer to the organisational structure of construction companies, arguing that the increased flexibility and informality associated with agile processes are not easily absorbed by larger more traditional organisations like the ones existing in the construction sector. Flexibility is also stated as an impediment by Demir et al. (2012), who claim that construction projects are not compatible with the degree of flexibility required for agile project management applicability and therefore agile project management can be implemented for managing specific phases, work packages and situations but not for managing the whole project. Ribeiro and Fernandes (2010) concentrate on cultural issues within the construction sector, which act as an impediment to agile project management applicability, such as the organisational structure of construction companies, the low degree of empowerment of people to operate at a higher level, the lack of communication and close cooperation with clients and suppliers at the development phases of the project and the emphasis that construction schedules put on contract dates allowing only minor margins for scope changes. Despite the impediments highlighted by researchers there is a general view that should these impediments be overcome, the implementation of agile project management principles would be beneficial for the construction sector. Towards this direction, a lot of researchers propose the development and implementation of hybrid models, which combine agile project management and traditional approaches. Conforto et al. (2014) call the project management research community to further investigate how to develop hybrid models in order to balance the agility needs and barriers identified. Mohamed and Moselhi (2019) suggest that agile principles should not be discarded if they can not all be incorporated in an organisation and recommend the implementation of hybrid solutions, which combine agile project management with the traditional waterfall method in order to cope with the unique nature of construction projects. The opportunity to move towards a hybrid approach is also highlighted by Archer and Kaufman (2013), who argue that when an organisation seeks the benefits agile can provide but is not well suited to adopt full-fledged agile techniques, then a hybrid method would be the better approach.

To confirm the above, Rodov and Teixidó (2016) present their hypothesis that in the future a hybrid agile/waterfall model will be the lasting approach to most projects. It is therefore evident by the existing literature review that there are certain impediments to

the applicability of agile project management to the execution phase of construction, however the development of a hybrid model can mitigate these impediments and allow the implementation of agile principles with great benefits.

Analysis

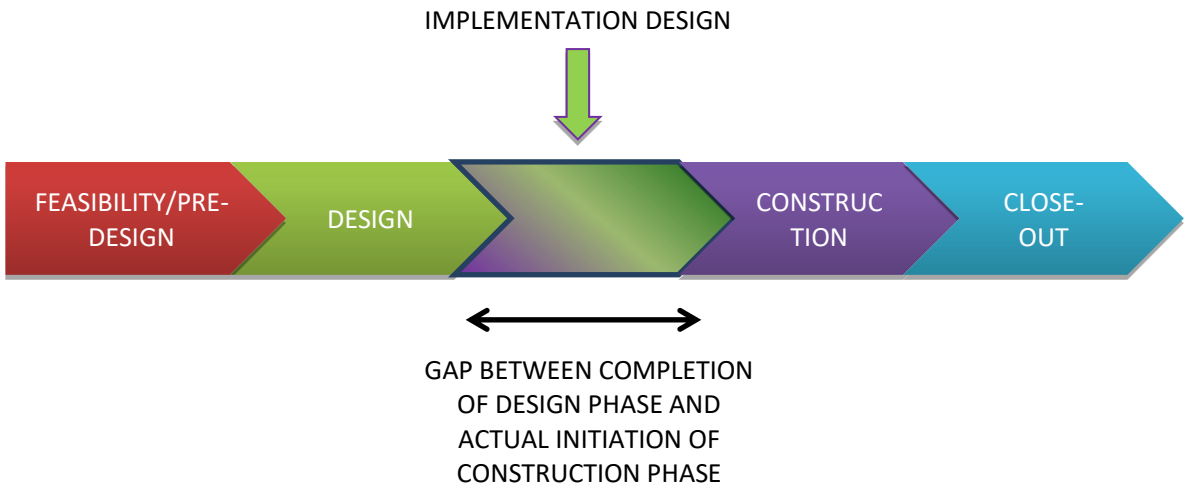
1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software

Agile project management values customer satisfaction through the delivery of functional systems rather than the delivery of simple contract requirements. Two words constitute a problem in this case for construction applicability: early and valuable. Because of the nature of construction projects, it is not easy to divide a project into parts that can provide an early and valuable outcome for the client. Of course a project can always be divided into smaller parts; however two conditions should be met here. The first condition is that each part should provide to the client/end user some kind of utility or else value added. There is no point in delivering a part of the project with no practical use. This will not add any value and will not make the client/end user any happier. A bridge for example can be divided into spans, but can it operate with only one span constructed? Will the delivery of the first span add any value to the client/end user? The second condition is that each part should have functional autonomy, meaning that it should be able to operate independently of the rest of the project. A hospital building, for example, can be divided into floors and each floor would definitely be a valuable delivery for the client/end user, but can the first floor operate, while the second one is under construction? Hence the division of the project into smaller parts (sprints) should be made wisely and each part should be able to provide utility to the client/end user and be functionally autonomous. This is not always feasible in construction and that is what makes the specific principle quite problematic for construction applicability. On the other hand, there are construction projects in which the specific principle can more easily be applied. A section of a highway, for example, can be put into use if connected properly to the existing road network and it can be compatible with what the principle requires (see case study). If these two conditions cannot be met in a construction project, this inability would make the applicability of agile project management to that specific project extremely problematic, if not impossible.

2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.

A construction project is a sequence of works, or else a linear process, which requires specific people to be at a specific place with specific materials and equipment and specific instructions at a specific time. When this mechanism has been put in place, it is extremely difficult to welcome any changes, especially during a late stage since the cost and the time delay would be significant. Imagine for example a change in client requirements after all the materials and equipment have arrived on site and the subcontractors have started working. This would definitely be a major setback for the project in terms of time and budget. It is therefore evident that whereas in software development a change in requirements would require some decoding and recoding, in construction things are much different. The specific principle, however, is one that provides agility to the whole process to a great extent. So, can this impediment be overcome? What can definitely be done is the prolongation of the time period during which requirement changes are feasible and additionally the elimination of the necessity of such changes. The instrument for doing so is the undertaking of implementation designs. An implementation design is a short, relatively cheap design, usually carried out by the Contractor in parts during the construction phase, which revises and confirms the design of the project. The reason for carrying out these designs is because usually there is a long time period between the design phase and the initiation of the construction phase of a project. In the meantime, the local conditions and hence the project requirements can significantly be altered. An implementation design takes all these changes under consideration and adjusts the project to the new reality bridging the gap between the two phases.

Figure 1 Bridging the gap between the design and the construction phase



Because of the fact that these designs are carried out at the beginning of the construction phase, the time period during which requirement changes are feasible is significantly prolonged. The client should be involved in the whole process and express his/her views, requests and concerns on every aspect under examination. The engagement of the client in the undertaking of the implementation designs ensures to a great extent that beyond this point there will be no other undesired requirement changes.

However, unforeseen factors can always necessitate changes even at a late stage during the execution phase and it would be naïve not to expect so at some point. This kind of changes should be managed in order not to jeopardise the completion of the project. At the same time the whole process should be as quick as possible and allow for flexibility and adaptability, concepts which are related to agile project management. An action plan is proposed below:

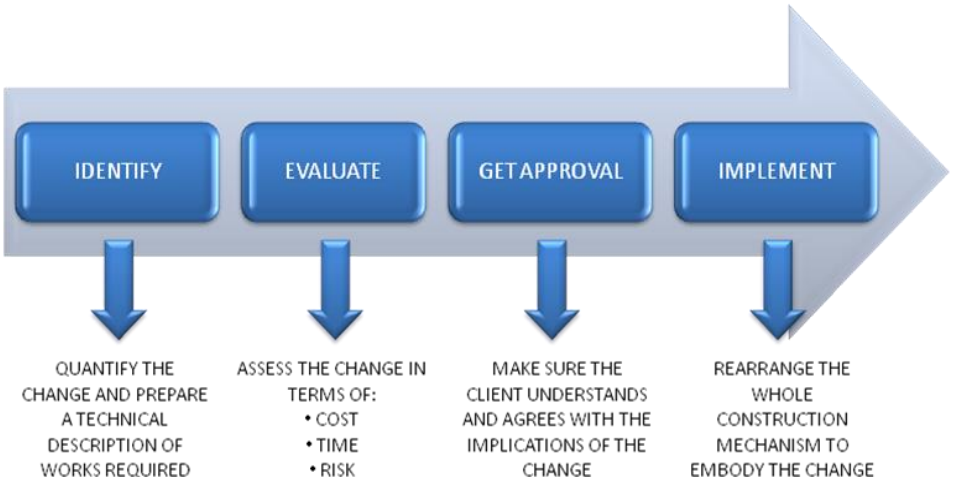
Identify – The later a change is required, the more serious the implications in terms of cost, time and risk. Therefore it is important to identify the need for a change as soon as possible and act decisively. The change should be quantified and a technical description of the works required should be prepared. The technical experience of the participants plays an important role in this process. The project should be checked at all times for potential changes. For this purpose, an open communication channel should be maintained among the client, the contractor and the designer.

Evaluate – The change should be assessed in terms of additional cost, time and risk and a full proposal should be composed.

Get approval – After assessing the change all the data should be communicated to the client. The client should clearly understand what the additional cost, time and risk would be if the change is to be adopted.

Implement – If the clients agrees with the change, the whole construction mechanism which was put in place (people, materials, equipment, instructions) has to be rearranged in order to embody the change. All participants should be informed about the scope of works and all activities should be coordinated.

Figure 2 Action plan for managing changes during the construction phase



3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

One of the main principles of agile project management is the continuous delivery of software (product) in small parts, which are easier to handle compared to a one-off delivery. The specific action promotes client satisfaction and improves the effectiveness of the team and the quality of the project because the team can always look back at what went wrong and fix it for the next part of work. It is a principle, which can be easily applied to software development; however when it comes to construction, particular attention needs to be paid. The restrictions of principle 1 apply here as well. The divided parts of the project have to provide some kind of utility to the client/end user and be functional autonomous. If these two criteria are met, then an effort should be made for the completion of the project parts as fast as possible. Of course it is not always feasible in construction to deliver project parts in a couple of weeks or months, since construction times are much different from software development times. If this impediment is to be overcome, there should be certain provisions during the design phase of a project. The designer should work towards highlighting systems or subsystems that can add value to the client/end user and can be constructed as stand-alone components of the project. The Contractor in turn should focus on constructing those systems first and deliver them to the client/end user as soon as technically feasible. This means that there should be a clear understanding of the needs of the client and the intended use of the project.

4. Business people and developers must work together daily throughout the project

The specific principle highlights the need of a close daily collaboration between all the parties involved in a project. In construction this translates at least to the designer, the construction team and the project client. It is a principle applicable to construction and one that should definitely be applied to every project. In construction there is usually a distance between the parties involved in a project and this contributes to the productivity problem observed in the sector. The application of this principle can not only enhance agility, but the productivity of the whole construction industry as well.

5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.

This is a principle that should be applied to every business sector and has an unambiguous place in construction, regardless of the project management principles applied to a project. It is believed that by applying the specific principle the construction sector has a lot to benefit in terms of ensuring better working conditions and thus employee engagement. It should be noted however that the implementation of the principle presupposes a cultural change in construction, which is not easy to be achieved.

6. The most efficient and effective method of conveying information to and within a development team is face-to-face information

Face-to-face communication is easier and faster compared to other more impersonal ways of communication, such as letters, emails etc. Moreover, it promotes teambuilding and creates a spirit of collaboration between the parties involved in a project. Just like principles 4 and 5, this is a principle, which has to be applied to construction in any case. When face-to-face communication is not possible, other direct means of communication should be preferred (e.g. teleconferences).

7. Working software is the primary measure of progress

In software development a project progresses through the development of working software and its delivery to the customer. Similarly, if agile project management is to be applied to construction, a project should progress through the construction of a valuable, functionally autonomous part and its delivery to the client/end user. The restrictions of the specific principle have already been mentioned in paragraphs 1 and 3.

8. Agile processes promote sustainable development. The sponsors, developers and users should be able to maintain a constant pace indefinitely

A constant pace indefinitely is not easy to be achieved in construction. Because of the nature of works there are often disruptions and delays related to the switching of subcontractors on site, the weather conditions and other unforeseen factors. The existence of many partial deadlines and milestones in a contract is also an impediment for achieving constant paces until the completion of the project. If this principle is to be applied to construction, an effort should be made to avoid unnecessary disruptions by arranging for subcontractors to arrive on site on time and by using prefabricated elements where possible in order to eliminate factors such as the weather or labour availability to the fullest extent possible. The existence of many deadlines and milestones should not be left to affect the pace of construction.

9. Continuous attention to technical excellence and good design enhances agility

This is a principle that should be absolutely compatible with construction. Technical excellence and good design should be the objective in every construction project. The application of the specific principle would be beneficial for the whole construction sector as it would contribute to the improvement of the quality of construction projects, which is directly related to higher client/end user satisfaction.

10. Simplicity – the art of maximising the amount of work not done – is essential

It is indeed very useful to embrace simplicity as a mindset, so that the amount of work is minimised. This can be achieved in construction through repetition and prefabrication. Again the role of the designer is critical if the specific principle is to be applied to construction. The design has to be as simple as possible and the designer has to work towards this direction. It is important for the design to include as much repetitive work as possible. Repetition in construction makes the whole construction phase easier and faster to execute. The work to be done is the same times and times again, so the Contractor becomes increasingly familiar with the requirements of the work, obtains a certain specialisation and achieves better execution times. The Contractor in turn should be able to employ the simplest methods of construction, minimise the required phases of the project and the amount of work to be done on site. Prefabrication should be preferred where possible. Prefabricated elements take significantly less time to construct compared to traditional construction and prefabrication makes the whole construction process simpler by reducing the materials and equipment required on site. Faster construction times can contribute to the earlier delivery of valuable parts of the project, which is the requirement of principle 1. Under these preconditions, the specific principle

can be applied to construction and constitutes no impediment for agile project management applicability.

11. The best architectures, requirements and designs emerge from self-organising teams

Another principle that is easy to implement in software development but not so much in construction. Because of the sequential nature of works in construction, there is a high degree of interdependence between works, which requires some kind of coordination. A possible solution would be to form self-organising teams and assign to only one member of the team the task of reporting and communicating with a superior executive, who would be responsible for coordinating all the teams. This ensures that the desired independence of the construction teams is combined with the required degree of coordination and eliminates the need of organising meetings with numerous participants, which are often counter-productive and time wasting.

12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly

A learning process should be embodied and become a norm in construction. A good way to do so is by gathering the team regularly and reflecting on what went right and wrong in order to adopt best practices and avoid omissions in the future. It is a principle with easy implementation in construction and one that should definitely be adopted, just like principles 4, 5, 6 and 9. By applying it, the construction team can improve its performance and achieve better results.

Discussion

The analysis of the agile project management principles shows that there are principles which are compatible with construction and can be applied without any problem and others that at least initially seem to be problematic for construction applicability. The ones, which are compatible with construction, would be quite beneficial for the whole sector if they are eventually applied. Below there is a table with these principles and the possible benefits that each one has to offer to the construction sector in case of adoption.

Table 1 Compatible principles for construction applicability and possible benefits

Principle	Benefit
4. Business people and developers must work together daily throughout the project.	More direct communication, improved productivity.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.	Better working conditions, employee engagement.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face information.	Easier problem solving, team bonding.
9. Continuous attention to technical excellence and good design enhances agility.	Improved quality.
10. Simplicity – the art of maximising the amount of work not done – is essential.	Faster execution times.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly.	Improved performance.

As far as the problematic principles are concerned, with the right adjustments the impediments can be mitigated and there is certainly room for construction applicability. The table below shows the problematic principles, the source of the problem, a suggested solution and the benefits obtained if the solution is to be adopted.

Table 2 Problematic principles for construction applicability, types of impediments, suggested solutions and possible benefits

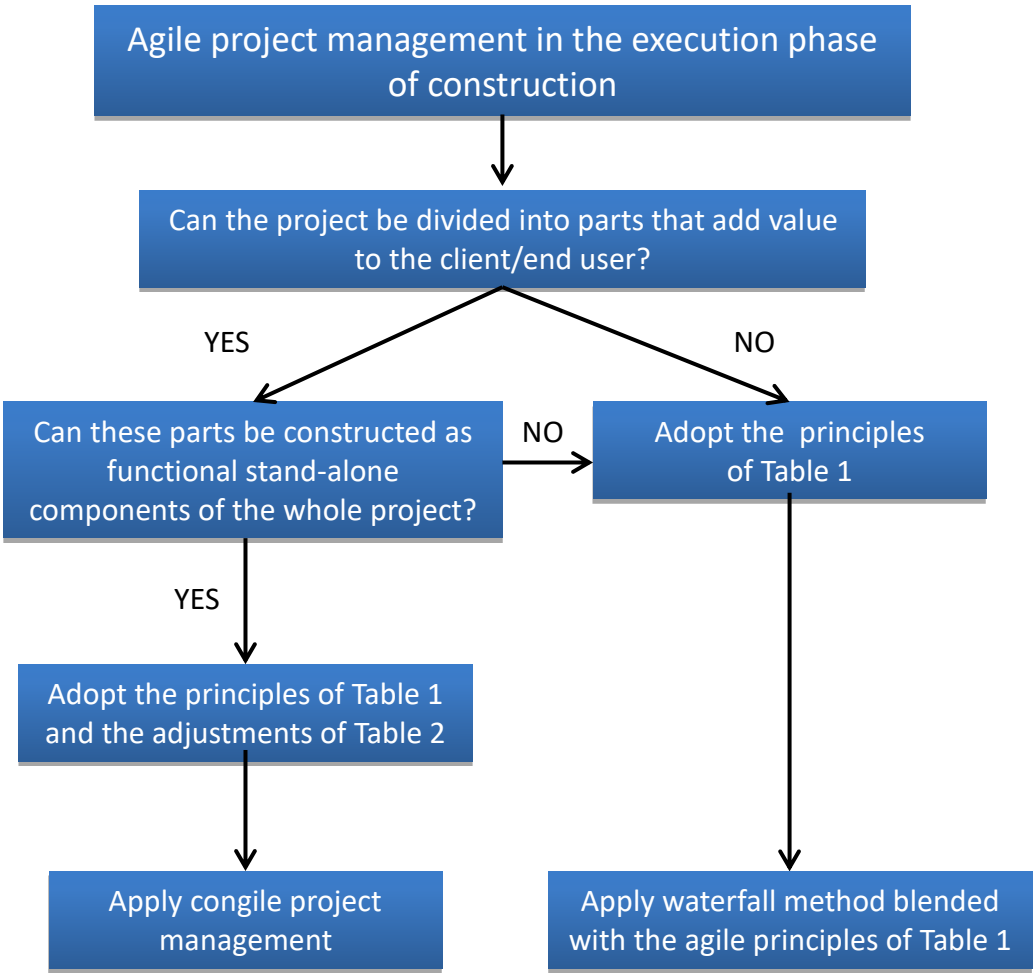
Principle	Impediment	Adjustment/Solution	Benefit
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.	The sequential nature of construction works requires certain people, materials and equipment to be on site at a certain time. After this mechanism has been put in place it is costly to make changes.	Try to deal with all the changes required before the execution phase by undertaking implementation designs prior to the initiation of works. Make sure that the client/end user is engaged in this process. In case the need for a change arises during the execution phase manage the whole process by identifying, assessing and implementing the change as fast as possible and with the maximum degree of flexibility.	The gap between the design phase and the construction phase is minimised prolonging the time period during which changes are less harmful. The engagement of the client/end user in the process ensures that there are no other change requirements after this process. Unavoidable changes during the construction phase are dealt with using a standardised change management method which embodies concepts related to agile project management.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.	It is not easy to divide a construction project into valuable parts that can be delivered early to the client/end user.	The design should highlight systems or subsystems that can be constructed as stand-alone components and the Contractor should construct them as early as technically feasible.	Higher client/end user satisfaction and maximisation of the usefulness of the project.
8. Agile processes promote sustainable development. The	There are always disruptions and delays in construction due to	Try to minimise unnecessary disruptions and	The construction pace is accelerated and

sponsors, developers and users should be able to maintain a constant pace indefinitely.	weather conditions, switching of subcontractors on site and other unforeseen factors. The existence of too many partial deadlines does not help either.	intensify construction pace by arranging subcontractors to arrive on site on time. Use prefabrication which eliminates the weather factor where possible and do not let deadlines distract the construction of the project.	faster execution times are achieved.
11. The best architectures, requirements and designs emerge from self-organising teams.	The high degree of interdependence between works in construction requires some kind of coordination.	Form self-organising teams and try to keep coordination to what is absolutely necessary. Assign only to one member of the team the task of reporting to a superior coordinator and let the other members work undisturbed.	A combination of the desired independence of the working teams and the necessary degree of coordination is achieved. The reporting of only one member to a superior coordinator prevents the counter-productive meetings of numerous participants.

The main finding of analysing the agile project management principles seems to be that the key criterion for applying agile project management to construction is, first of all, whether the project can be divided into parts that can add value to the client/end user. This is the most fundamental principle of agile project management and the one that gives the required degree of agility to the whole process to a great extent. There is no point in trying to apply agile project management when the specific principle cannot be applied in practice. In case this criterion can be met, the parts of the project should be able to be constructed as functional, stand-alone components of the project and be delivered to the client/end user as soon as technically feasible. Again there is no point in constructing a part which can be valuable for the client/end user, but cannot operate independently of the rest of the project, because in that case it would simply not be valuable for the client/end user. If both criteria are satisfied, then obviously agile project management cannot be applied to construction the way it is applied to software development, but it should be adjusted to the special characteristics of the sector by adopting the principles of table 1 and the adjustments of Table 2. This “adjusted to

construction" agile project management version that arises through this process, can be called "congile project management". When the division into valuable parts is not possible or these parts cannot be constructed as functional stand-alone components of the project, then the adoption of a traditional waterfall method would be preferable. Even in this case however, a construction project has a lot to benefit by adopting the principles of Table 1. The whole proposal is presented schematically below:

Figure 3 Flowchart for applying congile project management



The principles of congile project management, derived from the analysis of the previous sections, as opposed to the original principles are shown below:

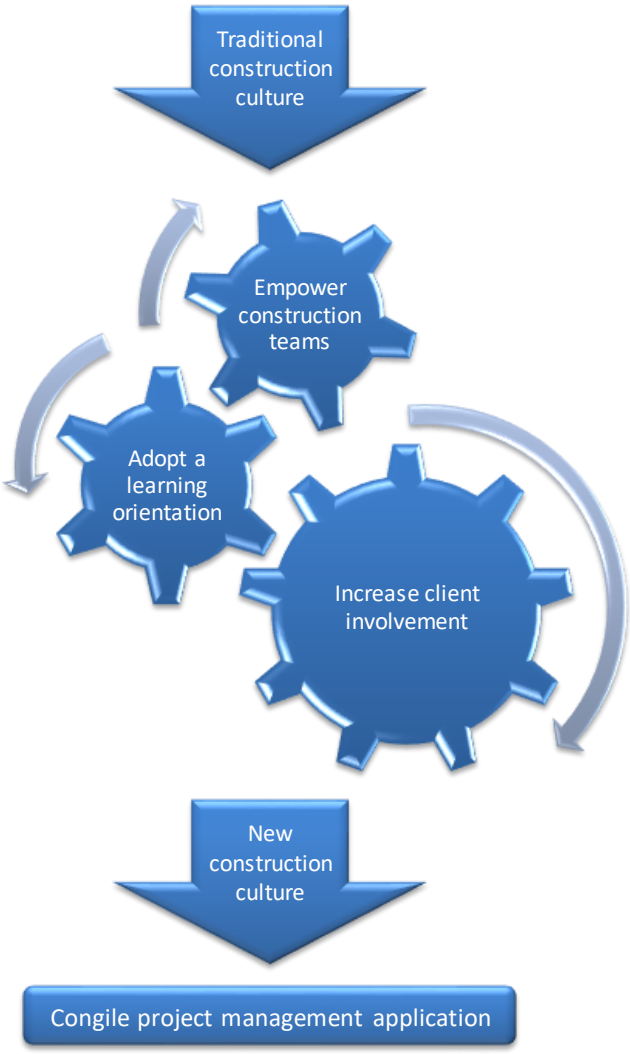
Figure 4 Proposed congile project management principles

Agile Project Management	Congile Project Management
1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.	1. Our highest priority is to satisfy the client through continuous delivery of valuable, functionally autonomous parts of the project.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.	2. Welcome changing requirements up until the initiation of the construction phase of each group of works. In case changes arise during the construction phase manage fast and with maximum flexibility
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.	3. Deliver valuable, functionally autonomous parts of the project, as soon as technically feasible.
4. Business people and developers must work together daily throughout the project.	4. The project client, the designer and the contractor must work together daily throughout the project.
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.	5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face information.	6. The most efficient and effective method of conveying information to and within a construction team is face-to-face information.
7. Working software is the primary measure of progress.	7. A functionally autonomous project part that adds value to the client is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers and users should be able to maintain a constant pace indefinitely.	8. Agile processes promote sustainable development. A project should be able to maintain a constant pace as long as possible by avoiding unnecessary disruptions to the extent feasible.

9. Continuous attention to technical excellence and good design enhances agility.	9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity – the art of maximising the amount of work not done – is essential.	10. Simplicity – using prefabricated elements and employing as much repetitive work as possible – is essential.
11. The best architectures, requirements and designs emerge from self-organising teams.	11. The best architectures, requirements and designs emerge from self-organising teams, combined with the minimum required degree of coordination.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly.	12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly.

As mentioned above the application of congile project management presupposes a cultural change in construction, which is difficult to be achieved. This cultural change should be towards three basic directions and its purpose is to transform the traditional construction mentality as it stands now to a new mentality open to congile project management principles, as shown below:

Figure 5 Cultural change needed in construction for applying congile project management



- **Empower construction teams** – The construction sector is not well-known for utilising self-organising teams or making use of extensive delegation policies. It is a sector which uses a linear hierarchy with the project manager exercising his/her authority by deciding on almost everything that has to do with a project. There is a low degree of delegation and depending on the managerial style of the project manager there can be high levels of authoritarianism in some cases. This has to change if congile project management is to be applied. Self-organising construction teams play a central role in this approach. Construction teams should consist of highly motivated individuals, who should be given the means and resources to accomplish the tasks entrusted to them. Each construction team should be responsible for a specific group of works. The general direction of the

work should be given to self-organising teams by the project manager and then the teams should decide on how to get the job done. As mentioned above due to the interdependent nature of works in construction, there should be a minimum degree of coordination between the self-organising teams in order to avoid unnecessary conflicts between works. A team member of each construction team should be responsible for reporting to a superior coordinator.

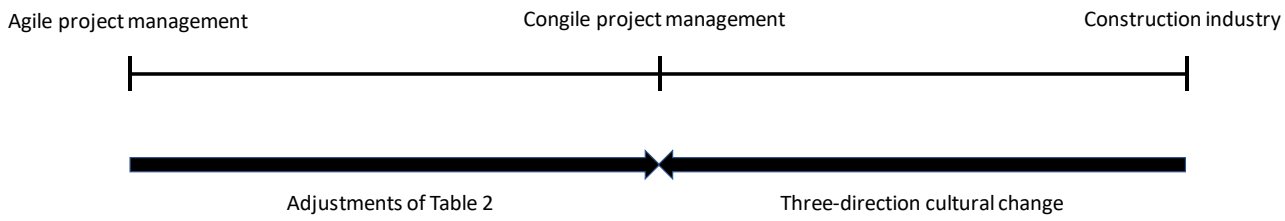
- **Adopt a learning orientation** – Learning from past experience is particularly important for successfully implementing the proposed approach. Each team should gather regularly and reflect on what went right and wrong and communicate this knowledge to a centrally formed learning committee. This learning committee should be responsible for recording the main problems of each project, the actions taken to solve them, the keys issues of each project and how they were dealt with. All these data should be analysed and the lessons learned should be codified and included in a learning database. Based on the results derived from this process, training should be provided to employees depending on their specialty.

- **Increase client involvement** – It is perhaps the most important cultural change required in construction. The client involvement in construction nowadays is very low, especially during the construction phase of public projects. This has a number of negative effects, such as misunderstandings, disputes, errors and uncertainties which eventually result in cost overruns and time delays. The client should be involved in every stage of the construction phase and should be able to check the project as it is constructed. It is believed that by doing so all the aforementioned negative effects will be minimised and there will be higher levels of client satisfaction.

Conclusion

The analysis of the agile project management principles shows that under certain conditions there is room for applicability to the execution phase of construction. Of course, agile project management as applied in the software development industry and the construction industry are initially far away from each other. For a convergence to be feasible, the distance has to be mutually covered. The way to do so is by adjusting the principles of agile project management to the special characteristics of construction and at the same time by applying a cultural change to construction in order to form a mentality, which is more suitable to agile principles. The whole process is explained below:

Figure 6 Congile project management development process



Depending on the nature of construction works, there are projects that fit agile project management principles better and others that don't. The criteria that differentiate the former from the latter is whether the project can be divided into parts that provide some kind of utility to the client/end user and whether these parts can be constructed as functionally autonomous, stand-alone components of the project. If the aforementioned criteria can be fulfilled then certain actions should be taken to allow for the implementation of an agile project management approach adjusted to the special characteristics of the sector. These actions are summarised in Table 2. In addition to these actions, a three-direction cultural change is also necessary, in order for agile project management principles to be applied to a construction project: 1) construction teams empowerment, 2) learning orientation adoption and 3) client involvement increase. Should the specific adjustments and cultural change actions be taken, it is proposed that a project can make use of an agile project management approach, named congile project management. It should be noted that if a project cannot meet the criteria of utility and functional autonomy, there is still the ability of applying agile project management principles by adopting the principles of Table 1, which do not require any further corrective actions in order to be applied and provide certain benefits. In this case a waterfall method would be preferable, blended with the agile project management principles referred to Table 1. Returning to the congile project management model, it is believed that the implementation of the specific approach to the execution phase of construction will produce very positive results. However, this remains to be seen upon its implementation in practice.

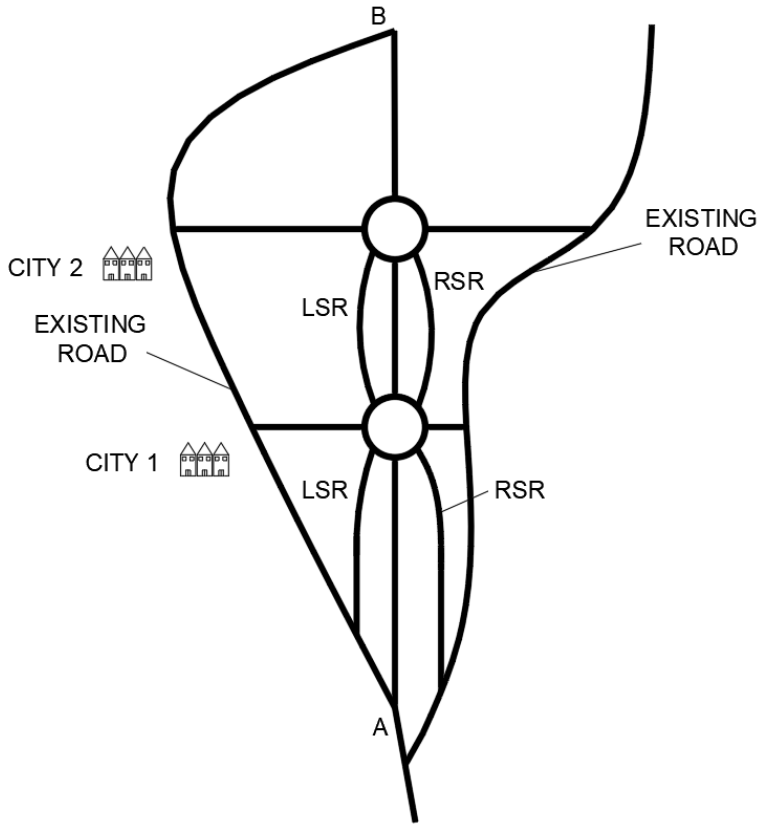
The proposed approach has undoubtedly certain weaknesses. Some may argue that it is not applicable, others that its applicability is only limited or that it is only based on theoretical foundations. The fact is that it constitutes a first solid attempt to apply agile project management to the execution phase of construction and a good base for further improvement and development.

CASE STUDY: THE A TO B HIGHWAY

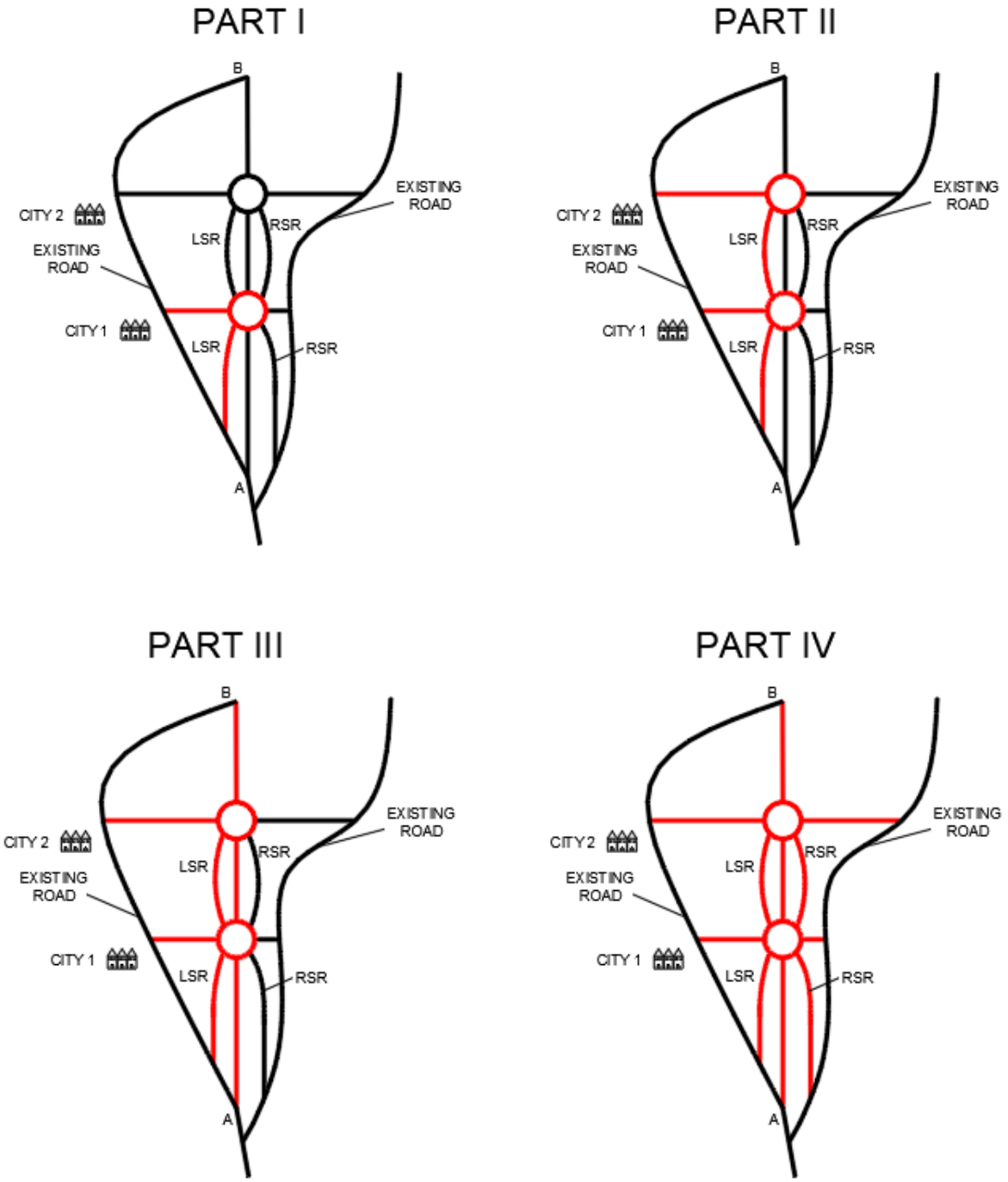
The proposed congile project management approach aspires not only to be a theoretical model, but one that can be applied in real life situations. The following is an imaginary project based however on real life technical data with the purpose of showing that the proposed approach can indeed be applied in practice.

The project

The movement of vehicles from point A to point B and vice versa is served by an existing road, which passes through cities 1 and 2. The road is old with obsolete geometric characteristics and cannot serve the growing traffic volume anymore. For this reason, a new highway with modern geometric characteristics and an increased traffic capacity is to be constructed, replacing the old road. In order to decongest cities 1 and 2, minimise traffic delays and increase travelling velocities the new highway will detour the cities, which will be served by two roundabouts. The local movements will be served by two service roads, the right service road (RSR) and the left service road (LSR). The horizontal alignment of the highway is shown below:



According to the proposal of the previous section, the two criteria which qualify a project for congile project management applicability are: a) the project should be able to be divided into parts that provide some kind of utility to the client/end user and b) each part should be able to operate autonomously. Bearing the above in mind, the parts are shown below:



When attempting to divide a project into parts in order to apply congile project management, one has to take under consideration the purpose and requirements of the project. In the specific case study the purpose of the project is to allow vehicles to move from point A to point B and vice versa at increased travelling velocities by detouring cities 1 and 2. The divided parts have to be compatible with the specific purpose. The fastest way to do so is by constructing the Left Service Road (LSR), which is easier to construct compared to the highway. By constructing parts I and II the main purpose of the project (detour cities 1 and 2 and increase travelling velocities) has already been served to a great extend, providing a great utility to the client/end user. Parts III and IV complete the project and maximise the offered utility (increase travelling velocities further, provide easier and safer movements). The offered utility of each part and whether it is functionally autonomous or not is shown on the table below:

Table 3 Division of A to B highway into parts

Part	Utility	Functional autonomy
I	Detours city 1 and decreases transition times	Yes
II	Detours city 2 and decreases transition times further.	Yes
III	Increases travelling velocities and makes movements safer	Yes
IV	Completes the whole highway network and maximises the usefulness of the project	Yes

Note that each part serves a specific purpose, providing a certain utility to the client/end user. The project continuously upgrades and each part provides an increasingly important utility, until the completion of the project when the usefulness is maximised. Due to the fact that each part is connected with the existing road network, functional autonomy is achieved meaning that after the completion of each part the project remains functional, since it can serve its purpose of allowing vehicles to move from point A to point B and vice versa. One may claim that this is an oversimplified example which fits perfectly to the congile project management principles. It is exhibited however to show the way of thinking when dividing a project into parts with the purpose of exercising agile project management at the execution phase of construction.

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