Application of Adaptive Process in Construction Project Management

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Abstract
Construction project management issues continually change over time therefore there is need for an adaptive process. The use of this approach offers an opportunity for more proactive and collaborative approach during changes caused by construction problems (i.e. delays). The potential for adaptive management as an approach to more closely link research with construction project management is discussed. An initial framework for a collaborative approach to managing information within an adaptive management approach is outlined in this paper. Concepts utilizing active adaptive management are being gathered though a case study. Data for this paper was obtained from real data of a construction project. From the data analysis existing benefits are derived by the use of adaptive process to construction projects.

Keywords: adaptive management, project management, construction Management

JEL classifications: M2, P4

Introduction

Adaptive management, was originally developed by ecologists. Ecosystems are complex and dynamic. Therefore, understanding of ecosystems and their ability to predict how they will respond to management actions, is limited. Along with changing social values, these gaps in knowledge is the cause that leads to uncertainty about how to best manage resources. Despite these uncertainties, the resource managers must make decisions and implement plans. Adaptive management is a way for resource managers to proceed responsibly to address this uncertainty. It provides a good alternative that can eliminate the bad management options that have social, economic and ecological impacts.

Adaptive management is designed to improve understanding of how a system works, so that to achieve management objectives. Models are used to incorporate assumptions about the behavior of the system and allow managers to predict the impact of their activities. These predictions are the basis for later learning. After the activities have been performed, control of the underlying assumptions of the models against monitoring data, provides the foundation for learning and improvement of management based on the knowledge that have already been acquired.

According to Virine (2008) Agile project management and other similar methods are focused mostly on the organizational aspects of adaptation process while

Adaptive management processes originally developed by the ecologists were much broader. So, in addition to organizational principles, they include quantitative analysis methods, which would help to make better choices based on actual project performance and particularly Multi-model analysis and hypothesis testing and Actual performance measurement

Frederick Taylor as introduced the adaptive management concept in the early 1900s (Haber 1964). Kai Lee has introduced it to environmental problems but also to conservation practices, for instance the development of a common set of standards and guidelines for applying adaptive management to conservation projects and programs (Johnson et al., 1993; Nichols et al., 2007). C.S. Holling(1978) and C.J Walters (1986) have distinguished passive from active adaptive management as related to engineering practices. Bormann (1999) used the concept to build simulation models to tackle uncertainties, while more recently, Verine (2008) used adaptive project management in building design.

Table 1 shows definitions of various researchers that are given occasionally for adaptive management.

Table 1: Some definitions of adaptive management proposed in the literature

Adaptivemanagement:	**Source**
"…is an integrated, multidisciplinary approach for confronting uncertainty in natural resources issues. It is adaptive because it acknowledges that managed resources will always change as a result of human intervention, surprises are inevitable, and that new uncertainties will emerge. Active learning is the way in which the uncertainty is winnowed. Adaptive management acknowledges that policies must satisfy social objectives, but also must be continually modified and flexible for adaptation to these surprises. Adaptive management therefore views policy as hypotheses- that is, most policies are really questions masquerading as answers…and management actions become treatments in an experimental sense."	Holling 1978; Walters 1986
"…is an approach to managing complex natural systems that builds on learning - based on common sense, experience, experimenting, and monitoring - by adjusting practices based on what was learned.."	Bormann*etal.*, 1999.
"…is a formal process for continually improving management policies and practices by learning	Taylor*etal.*, 1997

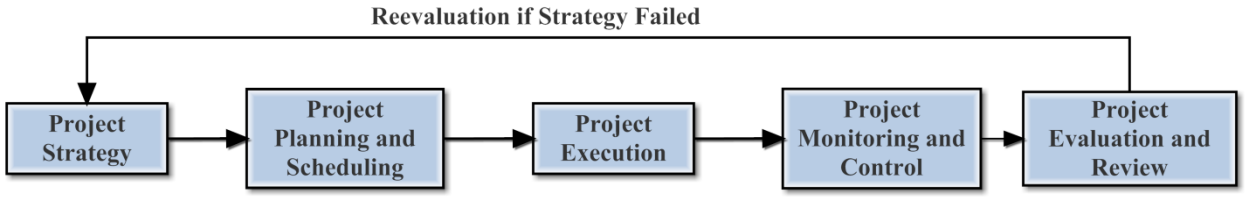
Adaptivemanagement:	**Source**
from their outcomes."	
"… a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form--"active" adaptive management--employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed. The key characteristics of adaptive management include a) acknowledgement of uncertainty about what policy is "best", b) thoughtful selection of policies or practices c) careful implementation of a plan, d) monitoring of the key response indicators, e) analysis of the outcome in consideration of the original objectives, and f) incorporation of the results into future decisions"	NybergandTaylor 1995.
"…is a structured process of learning by doing that involves more than simply better ecological monitoring and response to unexpected management impacts. It should begin with a concerted effort to integrate existing interdisciplinary experience and scientific information into dynamic models that attempt to make predictions about the impacts of alternative policies"	Walters, 1997.
"…is a systematic process for addressing the uncertainties of resource management policies by implementing the policies experimentally and documenting the results."	MacDonald *et al.*, 1999.

However there the adaptive project management has not being applied in the construction project management and especially in buildings where there is a high uncertainty involved. The aim of this work is to introduce the adaptive project management to tackle engineering problems faced in practiced caused by the projects' uncertainty.

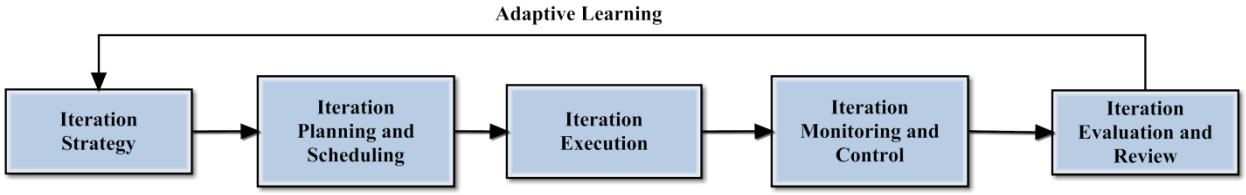
The issue addressed in this paper and the research question is a methodology approach of Project Management, called Adaptive Project Management in small construction projects. The method of adaptive management, as discussed in literature review, apply more in large scale systems , i.e in the management of systems such as ecosystems, and changes that are difficult, if not impossible to be predicted. Therefore, there was a concern whether and under what conditions could be applied to simple or complex technical projects where the occurring changes can be measured in advance. The adaptive management could be applied in the construction industry and particularly in the construction of buildings. In this case, the construction of a (detached) house is examined.

Adaptive management

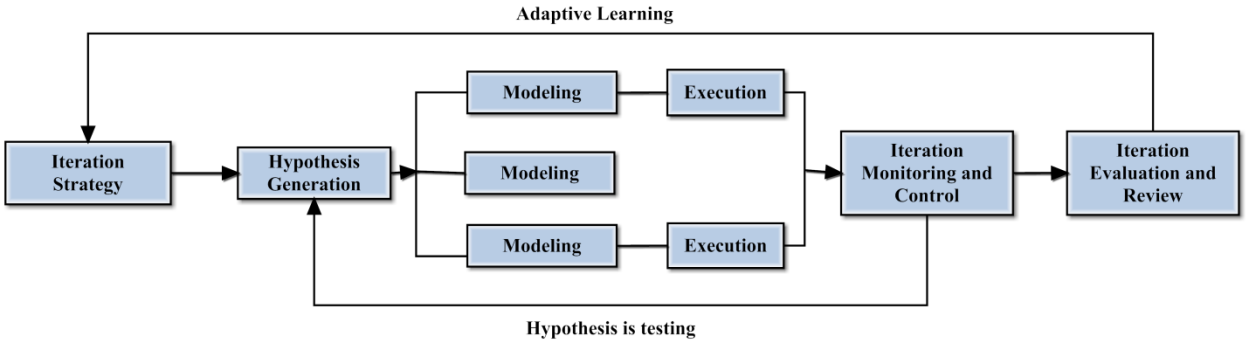
Adaptive management (AM), also known as adaptive resource management (ARM), is a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. In this way, decision making simultaneously meets one or more resource management objectives and, either passively or actively, accrues information needed to improve future management. Adaptive management is a tool which should be used not only to change a system, but also to learn about the system (Holling, 1978). Because adaptive management is based on a learning process, it improves long-run management outcomes. The challenge in using the adaptive management approach lies in finding the correct balance between gaining knowledge to improve management in the future and achieving the best short-term outcome based on current knowledge (Allan &Stankey, 2009). According to Vivere the comparison between the traditional and adaptive process is as follows(Figure 1):



Traditional project management process (Vivere 2008)



Passive adaptive management (Vivere 2008)



Active adaptive management (Vivere 2008)

Figure 1: Traditional and Adaptive process (Vivere 2008)

Application to construction IPMA project management

Below are concisely described the basic processes of Management of Work at IPMA. Initially, at the process start up, are determined and clarified the objectives and the object of work. The timetable of individual work is drawn, as long as the program of fluctuation of needs in resources and the program of fluctuation of revenues and expenses. The planning of organizational structure and the frame of operation (project organization)is fulfilled , the constitution configuration of work as social system is decided and the configuration of "culture of" work and the processes of management of dangers as for the objective, the timetable, the expenses, the income, etc.are being under consideration.

In the phase of Co-ordination, a plan is shaped as to who is responsible to receive information on the work, and also how to transit it. The continuous and effective communication between manager, the members of Team of Work and the members of Team of the projects' owner is being ensured. Finally, the continuous control and the adaptation of relations with the representatives of interested parts, the continuous support for the completion of each sector of work and the continuous control of availability of necessary resources is immunized.

During Control of the course of the Project the control of the progress takes place, along with the comparison with what was expected, the corrective energies for by any chance divergences and the growth of Reports of Work on each resource, or on the whole work or for his departments. The processes of control takes place in regular time intervals. It begins with the "initiation" in the work and finishes with the deposit of final report on the completion and the record of work.

In the phase of Management of Crises / Danger we consider potential divergences from the expectance, as long as extreme situations and developments, however in one interval from the worst possible script to the best. The management of Danger involves three stages.The recognition and evaluation of danger,the planning and implementationand,finally, the control of danger.It is marked that the crises and the occasions emerge without warning. In the frames of Process of Departure and Process of Control it is possible to shape Scripts on potential Crises in the development of work, accompanied from Alternative Reactions (Responses). The confrontation of crisis begins with the definition - the recognition –of the Crisis and finishes with the briefing the ones responsible (eg. owner of project) that the crisis finished.

Finally, in the phase of Closure of Work it is initially included, the sentimental closure, as the "dissolution of" the Team of Work, the exemption by responsibilities, the recognition of offer, the finish of relations and channels of communication with the interested parts, as a by any chance social event for the closure. Then, it is the essential closure as for the content with evaluation of the record of work with a Certificate of Acceptance of work from the owner of the project, the evaluation of the total, but also the record of each involved member. The achievement of final obligations is done, and the creation and deposit of final reports (Panagiotakopoylos, 2008).

The main problems presented during a project, the ones that the team of execution has to face with effectiveness, is the overshooting of cost, of time and the working problems.

The overshooting of cost is a usual problem, specifically for the projects of Greek State (public work) and can be owed in unanticipated factors (eg. natural destructions, negative developments in the economy, etc.) or in bad planning, in insufficient control and insufficient administration. The overshooting of cost leads to reduction of profits or wastefulness of economic resources of the financing part.

The overshooting of time is also a usual problem and it can be owed in unverifiable causes (meteorological, natural destructions, strikes of personnel, etc.), in insufficient study of real requirements, in insufficient financing and in bad organization of the constructor.

The working problems concern problems of personnelwhich influence negatively the developmentof workanddecreasesthe productivity. In this category belong mainly retirements of personnel, escalation of requirements and oppositions of administration and workers, lack of good labor climate, contestation of hierarchy, lack of collaboration between the executives or the organizational units etc…

Methodology

As mentioned in the literature review, adaptive management, which was originally developed by environmentalists, has become an effective tool for ecological and environmental management. We observe that Environmental Management and Project Management have much in common. First of all, both deal with multiple uncertainties. Both resource managers and project managers are faced with questions like: "How do I apply the guidelines in a way that will fulfill the objectives of management;", "Which of many possible actions should I apply?".

Adaptive management provides a powerful tool for addressing these issues. It is a formal, systematic and rigorous approach to learning from the results of management actions, to changes and improvements of management. It has to do with the synthesis of existing knowledge, the exploration of alternative actions and explicit prediction for their results. The management actions and monitoring programs have been carefully designed to create reliable feedback of information and to clarify the reasons behind the results. The actions and objectives are then adjusted, based on these observations and on improvement of understanding. In addition, decisions, actions and results are carefully documented and shared with third parties, so that the knowledge gained through the experience can be transferred rather than lost when people move or leave the organization. Therefore, project managers can effectively implement adaptive management practices in their projects.

The methodology followed for the implementation of the adaptive method in Constructionprojects, is derived from the variation of the corresponding methodology followed for natural ecosystems.

Concretely, the next steps are followed at the application of adaptive method of management of a project:

Step 1st: Observation of deviations from the initial timetable and the initial budget.

Step 2nd: Estimation of consequences 9Estimate/ determination of size of divergence from the initial plan in terms of time an cost).

Step 3rd: Examination of alternative scenarios.

Step 4th: Dcision makinmaking for the best alternative scenario

Step 5th: Application of the best scenario and comparison with the traditional method.

Case Study

A case study for a typical housing project is used to demonstrate the above method as described in the previous paragraphs. More particularly, the above methodology is applied to a case study of a small building project. The GANTT diagram of this project appears in the following form (Figure 2).

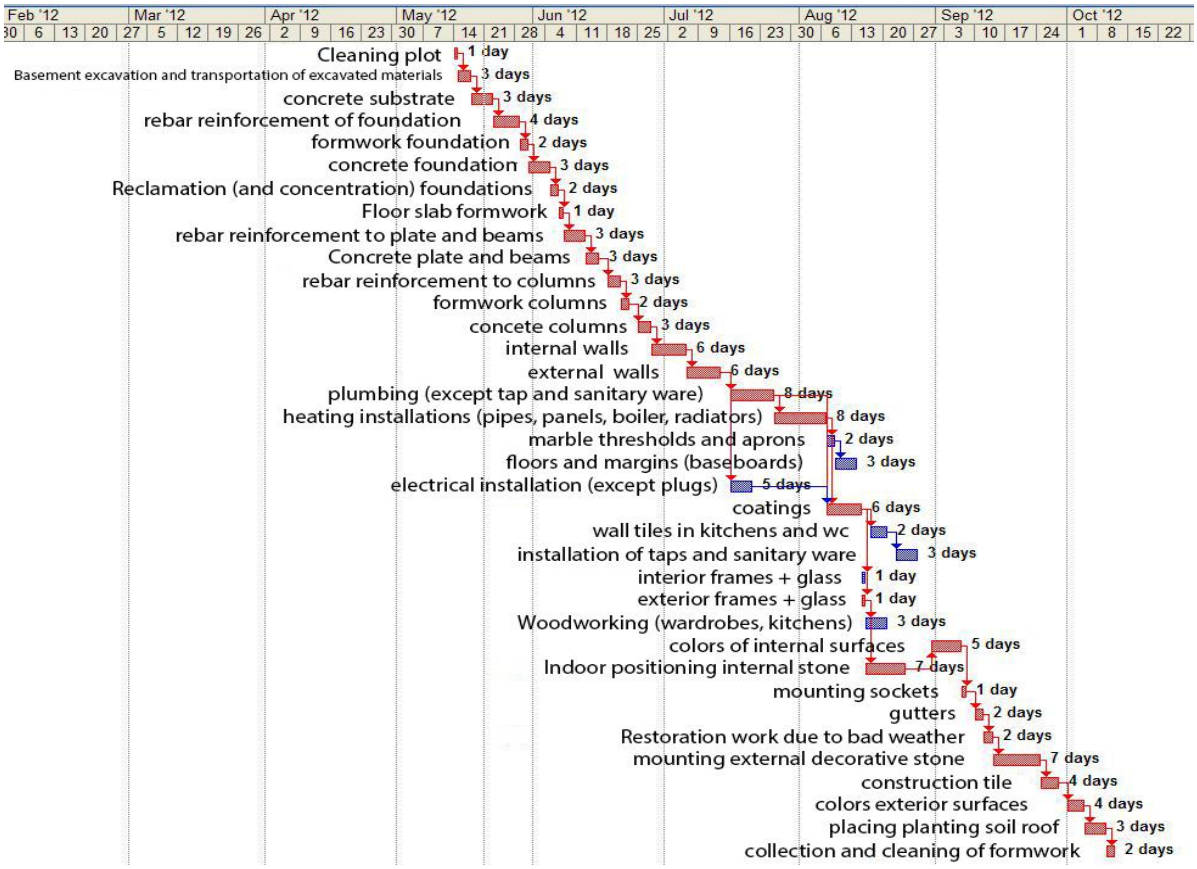


Figure 2: GANTT diagram

Observations:

1 There is an unimportant 2 days delay receiving the water closets' materials which does not influence the flow of work since the particular activity is not yet on the critical path of the project. Thus, this activity presents elasticity as for the time of implementation.
2 The delay receiving the tiles for kitchen and WC for 2 days also does not influence the flow of work since the particular activity is not found on the critical path of the project.
3 At the completion of placement of gutters and before the placement of exterior decorative Stone were met extreme weather situations, that delayed the work for 2 days. The consequence was the use of 2 workers at the duration of these two days (increase of cost at 100 €) and a repercussion in initial timetable at 2 weekday days, because the particular activity was found on the critical path.
4 Because of a change of cost of materials for the manufacture of the ceramic roof (increase at 20%/+96€) the total cost of work wasincreased at 96 €. The timetablewas not influenced at all.
5 The painters delayed at least 4 weekdays, fact that influenced only the time planning of work, since the particular activity is found on the critical path.
6 Finally, at the duration of work various extra expenses occurred, a sum of 3.000euros

All the above factors changed the timetable and the cost of the project. To be accurate these changes raised the cost to 73185 € and the timetable to 109 days, as for the previous calculations where 69989 € and 103 working days.

Application of the method

- The method of adaptive management of work can be applied: the contractor is adapted in the situation (the timetable delay due to the un received materials for the water closets and the tiles) and - using the method of adaptive management of work - avoids by any chance other delaysordering the materials faster (at least at 2 weekdays) from that initially programmed.
- As for the delay of the painter for 4 days, that influenced the critical path of work and in consequence the work as total, the contractor also applying the adaptive method, ensured for the rest of work that the workers of each specialty will be reliable as for the observation of timetable pressing him further. In this way the adaptive method of management of work helps the constructor to economize time and money for the remainder piece of the project.
- The methodology that is followed for the application of adaptive method in technical systems emanates from the variation of corresponding methodology that is followed for the natural ecosystems.
- The application of adaptive method of management of work is issued in a small building project and lies in the fact that the process of learning by the unexpected/dangers that are observed at the course ofwork,are applied in itself, in the befalling processes. In this way, as it was mentioned before were observed the following delays/unexpectedly and they were faced with the following ways:

- During the delay of the reception of the WC material and tiles for at least two (2) weekdays, the administrator of work applying the process of learning and observing the adaptive method of management of work ordered the materials from the befalling processes of work two days earlier from that initially budgeted. Concretely, the orders that were influenced by this delay are the following:
    - Order internal and exterior frames
    - Orderofglasses
    - Order of decorative Stone and relative building materials
    - Orderofgutters
    - Order of colours for exterior walls
    - Order of materials for planting of roof
- At the delay of implementation of work for three (3) weekdays because of bad meteorological circumstances before the placement of exterior Stone, the administrator of the project , observing again the process of learning by the adaptive method of management of work, commanded overdraft material and more general things which are frail in ugly meteorological not to be left unattended. In this way, leaving the worksite they will cover the frail materials will be protected.
- The change of cost of materials for the manufacture of the ceramicroof aswas mentioned before, the administrator is again called to apply the adaptive method of management of work. Via the process of learning by the deviations by the initial timetable, the administrator of work is called to agree the prices at the order and prepay for each order, so that similar incidents will be avoided in the befalling activities up to the completion of work. Concretely, the activities that will be influenced by the particular unexpected are below:
    - Down payment at the order of colours for the dye of exterior surfaces of residence
    - Down payment at the order of materials for the placement of earth and the planting in the roof of residence
- The delay of the painters, for the coloration of internal spaces, for four (4) weekdays helped the administrator revise tactics and contracts with the workers, applying thepractices thatfixesthe adaptive management of work. This has as consequence the briefing of workers at least four (4) days earlier from that initially calculated, so that future similar delays will be avoided. The specialists to be earlier informed are the following:
    - electricians for the placement of sockets
    - roof workers for the placement of gutters
    - workers for the placement of exterior Stone
    - roof workers
    - workers for the dying of exterior surfaces
    - workers for planting the roof
    - Workers for the collection and the cleaning
- Finally, with regard to the extra expenses,the administrator cannot apply the adaptive method of management of work, since these are of small scale and are not estimated as essential so nothing is to be done to avoid them.

In Table 2 the divergences that resulted at the completion of work are presented. In the column "Contracting divergence" the usual contractors' tactics to submerge a budget for extra expenses, of 20% is presented. In the third column are the real divergences of the project.

Table 2: divergences during the implementation of a project

A/A	Estimates during planning	Implementation according to the adaptive management method	Implementation on a traditional basis	Divergence according to the adaptive management method	Divergence on a traditional basis
Cost of project	**69.989€**	73.185€ / +4,6%	83.986€	+3.196€	+13.997€
timetable	**103 workdays**	109 workdays / +5,8%	124 workdays	+6 workdays	+21 workdays

The above table, according to the used method of implementation, adaptive project management, the real cost of work is +4,6% on budgeted at the phase of study, while the real time of implementation is increased at only 5,8%. Thus, the owner of the project economizes roughly 10.000 € sum that corresponds roughly to the 15% of the total investment. Also, the timetable of work shrinks at 15 weekdays from that regularly calculated.

Conclusions

This study presented the possibility of implementation of a special project according the methodology/technique of adaptive management. The particular methodology is followed in systems which present big complexity and in which any intervention does not have measurable indicators as for the forecast of repercussions. Such systems are as an example the ecosystems.

The challenge as for the fulfillment of this job was the investigation of the possibility to apply this method in small scale technical systems, where each change is beforehand measurable.

The results of this project show that though the international practice lies in extremely complex systems with unpredictable changes, such as the ecosystemsthis method can also be used this method in small scale technical systems

Therefore the particular method is advisable for small technical systems, occurred, since saving of money and time –an essential issue- is done.

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