COMPARING AGILE AND PMBOK® – COST MANAGEMENT*

Nikolay Todorov

The paper compares the processes and practices defined by the internationally recognized standard Project Management Body of Knowledge (PMBOK® Guide) and the agile methodologies for managing software development projects (becoming extremely popular and attractive nowadays). The goal is to show that there is a considerable mapping between the mentioned approaches for software projects management. The paper emphasizes on the knowledge area of Cost Management, following the PMBOK® defined processes and comparing them to the Agile techniques and practices.

1. Introduction. Agile methodologies are intended to be used in software projects' development. Several major methodologies exist – Extreme Programming (XP) [1], Scrum [2], Feature-Driven Development [3], Adaptive Software Development [4] and others. They are trying to reduce the risks by developing in short periods of time usually called iterations and lasting between one and four weeks. Each iteration is like a separate software project including all of the phases necessary to develop and deliver new functionality – planning, analysis, design, coding, testing and documentation.

The Guide to the Project Management Body of Knowledge [5] is a recognized standard for the project management profession. As is well known, a standard is a formal document that describes established norms, methods, processes and practices. As with other professions such as law, medicine, and accounting, the knowledge contained in this standard evolved from recognized good practices of project management practitioners who contributed to the development of this standard.

There are researches that cannot find a significant correspondence between agile methodologies and traditional project management [12]. According to them, agile cannot be considered complete from a standard project management point of view. Agile values and focuses on the final results and collaboration and is often criticized for being non-disciplined, whereas PMBOK® relies on the well documented project planning and its strict monitoring and control. In this paper we try to make a more detailed analysis and find the corresponding mapping between these two approaches.

Today's project manager in software development projects faces many challenges. Demands and pressures have increased due to competitive environments, complex solutions and changing technology—further complicated by economic conditions.

To deal with these challenges, a project manager needs to rethink traditional approaches and consider a more flexible one. Effective project management not only requires a mastery of traditional techniques but also the knowledge, wisdom, and ability to bend, throw out or rewrite the rules when the situation requires it.

Being more flexible in your mindset helps you adhere to the philosophies behind the agile approach to project management. Gartner's researchers [6] predicts that this approach will be used on 80 percent of all software development projects by the end of 2012.

It is important to state that in this paper we do not select a particular agile methodology (e.g. XP or Scrum) but consider them as a whole because of the following reasons:

• The latest trends in software development are to use the term agile in general, emphasizing on the iterative approach and agile practices we use as a natural response to the current pressing business needs and expectations.

• Many of the latest agile practices are not considered as a part of a concrete methodology but generally they refer to a general notion (e.g. planning poker, agile retrospective, continuous integration, etc.)

• Different methodologies offer different sets of practices and using a combination of them will help us to better map to the PMBOK® processes.

2. Project lifecycles. Agile software methodologies are well known with their iterative approach for delivering project's or product's valuable increments. An example of the Scrum lifecycle can be summarized using the following diagram:
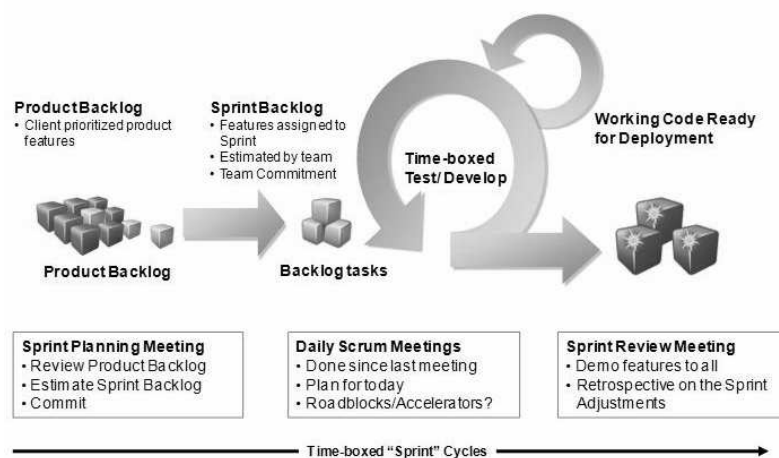

Fig. 1. Scrum lifecycle [7]

A Guide to PMBOK® [5] defines five concrete project phases – Initiation, Planning, Execution, Monitoring and Control, Closing.

But it does not restrict only to this sequence of phases for the whole project as it also defines an iterative relationship, where only one phase is planned at any given time and planning for the next is carried out as the work progresses on the current phase and deliverables. This approach is useful in largely undefined, uncertain or rapidly
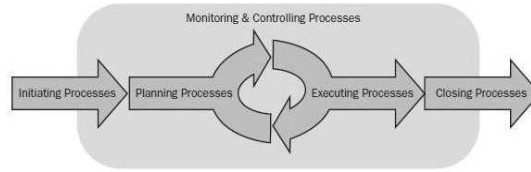
321

Fig. 2. PMBOK® Project Phases

changing environments such as research, but it can reduce the ability to provide long term planning. The scope is then managed by continuously delivering increments of the product and prioritizing requirements to minimize project risks and maximize product's business value (PMBOK® 2008).
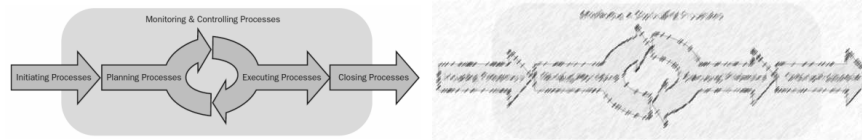

Fig. 3. PMBOK® Iterative Phase Relationship

This could be used as an initial testimony that the analyzed approaches (agile and PMBOK®) have a common base in their lifecycle ideology.

3. PMBOK® knowledge areas and processes. The PMBOK® Guide defines nine knowledge areas within the project management lifecycle. Each of them consists of several processes comprising a full set of 42 processes in the standard. As this is a huge set of processes to analyze in this paper we focus on one of the areas – Project Cost Management and other areas are a subject of further analysis. For this area we go through its underlying processes, tools, techniques and outputs and look for alternative practices in agile software development methodologies which actually implement the items defined in the PMBOK® process.

According to PMBOK®, Project Cost Management includes the processes involved in estimating, budgeting and controlling costs so that the project can be completed within the approved budget. On some projects, especially small ones or smaller scope, cost estimating and cost budgeting are tightly linked and can actually be viewed as a single process. However the tools and techniques for each are different.

In software development the main resource for project execution is the human intelligence and productivity. The cost is based on the effort necessary to implement the software solution. A rate for a manday/manhour of work is defined. It is a function based on the salary of the people involved in the project development as well as all supportive and administrative work within the organization. Therefore the cost of a project is the estimated effort of its execution (estimated in hours or months) multiplied by the rate of the organization:

$$Rate = F(Salary,\ Administration,\ Infrastructure,\ Management,\ Profit,\ \dots)$$
$$Cost = Effort\ x\ Rate$$

322

There are usually two most widely used types of contracts for a project [5]:

- **Fixed price** – the whole project is estimated before it starts and the cost is agreed based on this. These types of contracts have a huge risks and uncertainty about the correctness of the estimation, especially for larger projects.
- **Time and material** – the client pays for the completed work based on a report by the implementing team. This allows a bigger flexibility about changing scope and priority during implementation phase and is much more suitable for agile driven project execution.

In agile, the iterations are always time boxed to a certain period (could be between 1 and 4 weeks). Also the team is fully dedicated and all its effort contributes to the project. The team estimates the effort needed for every feature that goes in the iteration and this directly transfers to its actual cost based on the rate. This gives the client the opportunity to decide about the priority and scope he wants to include in this and potentially next iterations.

We will go through each of the PMBOK®'s processes defined in the knowledge area of Cost Management and for each of their inputs, tools and techniques and outputs will try to identify equivalent agile artifacts of practices. For these purposes we will use the main agile definitions in The Scrum Guide [8], XP [1] and other. The mapping will be categorized by the following three levels:

- Yes – there is a complete correspondence between the item defined by PMBOK and practices provided by agile methodologies
- Partially – not all aspects of the PMBOK definition are covered by agile methodologies. This will be further explained in the corresponding section
- No – there is no corresponding agile process that addresses the PMBOK definition

3.1. Estimate Costs. Estimate Costs in PMBOK® is the process of developing an approximation of the monetary resources needed to complete the project activities. Cost estimates are predictions based on the information known at a given point in time. It includes the identification and consideration of costing alternatives to initiate and complete the project.

In software development the scope of the features to be included in the project is estimated and this reflects in cost calculation. In agile methodologies usually features are described as user stories and estimated in story points. User stories provide us with a way of having just enough written down that we do not forget and that we can estimate and plan while also encouraging communicating them [9].

Based on this analysis we see that we have 12 full, 3 partial and 3 items with no mapping between Estimate Costs process area and agile methodologies.

3.2. Determine Budget. Determine Budget in PMBOK® is the process of aggregating the estimated costs of individual activities or work packages to establish an authorized cost baseline. This baseline includes all authorized budgets, but excludes management reserves. Project budge constitute the fund authorized to execute the project. Project cost performance will be measured against the authorized budget.

In agile the estimations and cost affect the prioritization of the product backlog and release/iteration planning. Based on their acceptance an authorization is given to implement them during the next sprint(s). A velocity is measured in order to track performance.

Table 1. Estimate Costs

PMBOK®	Agile	Mapping
Inputs		
Scope baseline	Product Backlog	Yes
Project schedule	Release/Iteration roadmap	Yes
Human resource plan	The team is considered cross-functional	Partially
Risk register	Risks are implicitly identified and addressed as part of the process (daily, retrospectives, etc.)	Partially
Enterprise environmental factors	Company/competitor rates but they are not covered by agile methodologies	No
Organizational process assets	User stories definition and estimation process	Yes
Tools and techniques		
Expert judgment	It is expected that agile team members are skilled enough and it is their responsibility to estimate the effort/cost	Yes
Analogous estimating	Story points estimations rely on analogous comparison between features	Yes
Parametric estimating	Metrics like number of methods to be implemented can be used as a base	Yes
Bottom-up estimating	Task based estimations are bottom-up as they sum to the whole story estimation	Yes
Three-point estimate	This is actually replaced by the planning poker's all team estimations [11]	Yes
Reserve analysis	Ideal hours are the main reserve concept. Other than this the goal is to eliminate all wastes and inefficiencies	Partially
Cost of quality	"Definition of Done" is used in order to assure all aspects of the cost of quality are addressed	Yes
Project management estimating software	Estimates are based on team discussions and consensus	No
Vendor bid analysis	Agile does not define outsourcing of the work to vendors	No
Output		
Activity cost estimates	Estimates in story points or hours directly reflect in cost based on the rate	Yes
Basis of estimates	Story and tasks are documented with their estimations including any risks and constraints	Yes
Project document updates	Effort (and therefore cost) estimating may result in an update of the product backlog and its priorities	Yes

Based on this analysis we see that we have 12 full, 1 partial and 2 items with no mapping between Determine Budget process area and agile methodologies.

4. Control Costs Control Costs in PMBOK® is the process of monitoring the status of the project budget and managing changes to the cost baseline. Updating the budget involves recording actual cost spent to date. Monitoring the expenditure of funds

Table 2. Determine Budget

PMBOK®	Agile	Mapping
Inputs		
Activity cost estimates	As described in the previous section	Yes
Basis of estimates		Yes
Scope baseline		Yes
Project schedule		Yes
Resource calendars	People availability (e.g. vacations) is considered while calculating the available ideal hours	Yes
Contract	Any contract information that affects the budget is considered in the rate	No
Organizational process assets	Issue tracking system where stories, tasks and roadmaps are defined	Yes
Tools and techniques		
Cost aggregation	Story points and iteration scope are two levels of cost aggregation	Yes
Reserve analysis	Ideal hours are the main reserve concept. Other than this the goal is to eliminate all wastes and inefficiencies	Partially
Expert judgment	It is expected that agile team members are skilled enough and it is their responsibility to estimate the effort/cost	Yes
Historical relationships	Velocity is tracked each iteration in order to measure progress and process improvement	Yes
Funding limit reconciliation	Team and iteration are fixed therefore it is a limit for the scope that can fit within it	Yes
Output		
Cost performance baseline	Estimated and agreed scope for the release/iteration authorizes the cost for the implementation and is used as a baseline	Yes
Project funding requirements	This is based on the contract type and not on the process execution	No
Project document updates	Project budget determination may result in an update of the product backlog and its priorities	Yes

without regard to the value of work being accomplished for such expenditures has little value to the project other than to allow the project team to stay within the authorized budget.

Agile methodologies use velocity to measure the actual amount of story points accomplished during the sprint in Scrum. This is compared to the initial release plan and also it is an indicator for a constant improvement within the team. In Scrum also an artifact called burndown chart is used. It shows on a daily basis the sum of the remaining effort to finish all tasks within the sprint. Therefore burndown charts are used to track sprint progress. Agile focuses extremely on the actual value provided to the customer after each iteration. This is an important and visible factor how the team performs in compliance with the budget.

Table 3. Control Costs

PMBOK®	Agile	Mapping
Inputs		
Project management plan	Cost baseline is covered as described in the previous section but cost management plan is not addressed in agile	Partially
Project funding requirements	This is based on the contract type and not on the process execution	No
Work performance information	Burndown charts and Kanban [10] boards are used to measure progress	Yes
Organizational process assets	Velocity tracking and burndown charts as defined in the organization	Yes
Tools and techniques		
Earned value management	Burndown charts have ideal line that measures deviations. Also story points implemented in sprint is the earned value for the customer	Yes
Forecasting	Burndown charts may also estimate at completion based on current progress	Yes
To-complete performance index	It can be calculated from burndowns but as the team is fixed it is not always possible to affect it	Partially
Performance review	Daily standups and sprint reviews are tools to see the actual progress	Yes
Variance analysis	Variance analysis in agile results in adding/removing items from the sprint/release	Yes
Project management software	Issue tracking systems like Jira and Trac are used to track and visualize the progress and spent cost	Yes
Output		
Work performance measurements	Metrics are shown by the burndown charts and Kanban [10] boards	Yes
Budget forecast	Tracked and visualized all the time within the issue tracking system	Yes
Organizational process assets	Average team velocity is updated based on actual information after each iteration	Yes
Change request	No changes are allowed during iteration but as a result of it the product backlog may be changed	Partially
Project management plan updates	Release plan (cost baseline) may be updated as a result of cost measurements	Yes
Project document updates	Story points basis may be updated after a review of an iteration	Yes

Based on this analysis we see that we have 12 full, 3 partial and 1 items with no mapping between Control Costs process area and agile methodologies.

5. Results. Based on the before mentioned comparison of the processes defined in PMBOK®'s knowledge area of Cost Management and their corresponding practices in agile software methodologies we can summarize the mapping between them in the following figure:
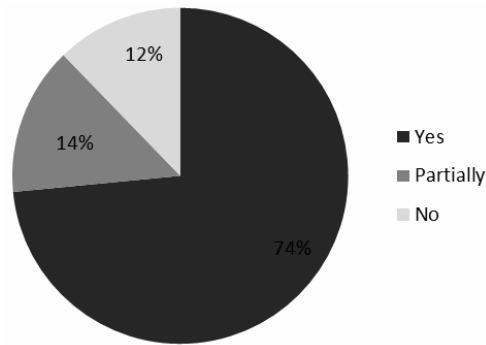
326

Fig. 4. PMBOK® and Agile – Cost management

It is visible that most of the PMBOK® inputs/tools and techniques/outputs in the processes of Cost Management have their corresponding practices and artifacts in agile methodologies. The majority of incompatibilities are based on the fact that PMBOK® takes in mind also contract aspects of cost management where agile focuses on the process of project execution.

6. Conclusions and future work. Our goal in this paper was to show that using agile methodologies it is absolutely possible to cover almost all aspects of managing a software project. We choose the PMBOK® knowledge area of Cost Management and for each of its processes we tried to show in a systematic way the similarities between its inputs, tools, techniques and outputs and the existing and well known agile practices and artifacts.

The results showed that in most of the cases the two approaches for managing software projects have much in common and they perform the same, however using different terms and templates.

As a future work in this area we plan to combine the analysis for the cost with the aspects of scope, time and quality management. This elaboration is expected to lead us to a definition of an overall agile process for software development which addresses the major four variables in project planning and execution.

REFERENCES

[1] K. BECK. Extreme Programming Explained: Embrace Change. Reading, Mass., Addison-Wesley, ISBN 0201616416, 1999.

[2] K. SCHWABER. Agile Project Management with Scrum, Microsoft Press, ISBN 073561993, 2004.

[3] S. R. PALMER, J. M. FELSING. A Practical Guide to Feature-Driven Development. Upper Saddle River, NJ, Prentice-Hall, 2002.

[4] J. A. HIGHSMITH. Adaptive Software Development: A Collaborative Approach to Managing Complex Systems. New York, NY, Dorset House Publishing, 2000.

[5] Project Management Institute (2008), A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 4th Edition, 2008.

[6] Th. Murphy, J. Duggan, D. Norton, B. Prentice, D. Plummer, S. Landry. Predicts 2010: Agile and Cloud Impact Application Development Directions, Gartner, 2009.

[7] Focus on Agile, available at `http://www.agile-training-courses.com/agile-methodologies.html`, 27 March 2012.

[8] Scrum.org, The Scrum Guide, Available at `http://www.scrum.org/scrumguides`, 17 March 2012.

[9] M. Cohn. User Stories Applied: For Agile Software Development, Addison-Wesley, ISBN 0-321-20568-5, 2009.

[10] D. J. Anderson. Kanban: Successful Evolutionary Change for Your Technology, Blue Hole Press, ISBN 978-954-92934-1-8, 2010.

[11] N. C. Haugen. An empirical study of using planning poker for user story estimation, Agile Conference 2006, Oslo, ISBN 0-7695-2562-8, 2006.

[12] P. Fitsilis. Comparing PMBOK and Agile Project Management Software Development Processes, Advances in Computer and Information Sciences and Engineering, Springer Science+Business Media B.V., ISBN 978-1-4020-8740-0, 2008.

Nikolay Todorov
Institute of Mathematics and Informatics
Bulgarian Academy of Sciences
Acad. G. Bonchev Str., Bl. 8
1113 Sofia, Bulgaria
e-mail: `nikolay.todorov@gmail.com`

СРАВНЕНИЕ НА ГЪВКАВИ МЕТОДОЛОГИИ И PMBOK® – УПРАВЛЕНИЕ НА ЦЕНАТА

Николай Иванов Тодоров

В настоящата статия се сравняват процеси и практики, определени от международно признатия стандарт – Система от знания за управление на проекти (PMBOK® Guide) и гъвкавите (Agile) методологии за управление на софтуерни проекти (които придобиват изключителна популярност и атрактивност в наши дни). Целта е да се покаже, че е налице значително съответствие между споменатите подходи за управление. Статията акцентира върху областта от знания за управление на цената на проекта, следвайки дефинираните в PMBOK® процеси и сравнявайки ги с техники и практики от гъвкавите методологии.