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APPLIED INFORMATION MANAGEMENT

Implementing Earned Value Management on Agile Projects

CAPSTONE REPORT

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Abstract

This study addresses the problem of implementing and integrating earned value methodologies on Agile projects. The intended audience is program and technical managers and team members on projects that lead functional groups. In a broader sense, the audience is key project stakeholders. This study is significant because Agile has rapidly emerged, yet traditional earned value methods are still in place in many industries and organizations. This study addresses the compatibility between the two methods.

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Introduction to the Annotated Bibliography

Problem Description

Project management requires the addressing many objectives (Cioffi, 2006). The three most important objectives of project management are successful execution of schedule, accuracy of work performed, and maintaining costs within the allocated budget (Chen, H., Chen, W., & Lin, L., 2016). Many projects fail to meet one or all of these objectives (Gulla, 2011). Gulla (2011) studied historical Information Technology (IT) project success and found that at a low point in 1994, only 16% of information technology related projects were successful. Gulla (2011) also demonstrated that more recent data showed that approximately 34% of IT projects were successful in 2011.

One approach that can help ensure projects are executed on time and on budget is the use of earned value management (McMahon, 2006). Earned value management was initially adopted by the United States Department of Defense in the 1960s. As earned value management became more widely accepted in projects outside of the Department of Defense, it became more of a standard project management tool in the 1980s (McGregor, Kastelnik & Nelson, 2017). Other industries realized the benefits of earned value management established with the Department of Defense methods for the abilities for accurate forecasting, close schedule and budget monitoring, and overall program performance evaluation (McGregor, Kastelnik & Nelson, 2017).

Earned value management is defined as a technique for measuring project performance and progress through the measurement and analysis of scope, time, and cost (Browning, 2014). Earned value management integrates the areas of technical performance, schedule, work performed, and actual cost to provide metrics for actual work performed and actual cost at completion (McMahon, 2006). Essential features of any earned value management

implementation include a project plan that identifies work to be accomplished, a valuation of planned work, and metrics to quantify the accomplishment of work (McMahon, 2006).

In spite of the benefits traditional earned value management can provide, challenges in applying earned value techniques arise when applied to Agile projects (Verzuh, 2004). Hoda and Murugesan (2016) describe Agile methodologies as characterized by the division of tasks into small, rapid tempo groups. Hoda and Murugesan (2016) note that these groups are typically self-directed and use rapid and ever changing development, broken into iterations called sprints, to meet customer needs and remain flexible to requirements and test results. Agile projects involve the constant evolution of requirements and solutions based on these collaborative efforts of self-organizing, cross-functional teams and their customer(s) (Hoda & Murugesan, 2016).

Hoda and Murugesan (2016) note that there are several benefits to employing an Agile methodology. Agile allows for rapid changes if needed, improves quality by breaking down the project into manageable units, allows for predictable project costs and schedule due to the employment of sprints, provides transparency through frequent communication with the customer, and allows for early and predictable delivery through rapid feature releases and updates. Projects that employ Agile methodologies, especially software development projects, are also more likely to be considered successful than projects where waterfall methodologies are employed, especially in the areas of flexibility, rapidly changing requirements, a high level of customer engagement, and changing deadlines (Mihalache, 2017).

There are many benefits to employing an Agile methodology, but Agile projects also experience challenges and sometimes failure (Chen et al., 2016). As Hoda and Murugesan (2016) state, Agile project management can lack the focus of working towards an initial, core goal as a result of such rapid change and small group think. Agile can also present the challenge of

addressing and accepting slow changing requirements, as a slower customer does not accommodate as well to an Agile methodology.

While Agile projects do face inefficiencies and even failure, traditional views of earned value management – a method that has been shown to increase the likelihood of project success – assert that the method is too difficult to implement on Agile projects (McMahon, 2006). One challenge is the inability of earned value management methods to cope with the associated changing requirements and rapid development of Agile project tasks (Nikravan & Forman, 2010). Planning baselines and functional requirements, key elements of earned value management, traditionally do not have the flexibility needed to stay within the framework of Agile execution (Nikravan & Forman, 2010).

Agile methodologies represent a widely accepted way of executing a project (Cioffi, 2006). In order to address the problems of inefficiencies and failure that can arise on Agile projects, the processes and standard practices of earned value management must be adapted for Agile methodologies (Cioffi, 2006). According to Larson and Gray (2014), earned value management is the accepted method of program management for many industries and specialties, and project and program managers are therefore presented with the challenge of balancing traditional earned value management approaches with the newer methods of Agile project management and execution. This annotated bibliography examines the challenges of applying earned value management techniques to Agile projects and provides sources that address best practices in applying earned value management to these projects.

Purpose Statement

The purpose of this study is to examine selected literature and other scholarly sources to provide a framework for the application of earned value management to Agile methodologies.

Techniques, best practices, and lessons learned are presented for the project and program

management audience, as well as technical leaders who contribute to a project through Agile

engineering and system development.

Research Questions

Main Question. How can earned value management be modified, streamlined, and

updated for Agile projects to enable effective project tracking and management?

Sub-questions.

- What, if any, compromises need to be made to employ earned value management

    on Agile projects?

- What are current techniques for the implementation of earned value management

    for Agile project execution?

Description of Audience

Most program and project managers that utilize earned value management know its

strengths and limitations (Cioffi, 2006). Earned value holds program managers accountable to

the premise that execution must be reliable, timely, accurate, and auditable (McGregor, J.,

Kastelnik, K., & Nelson, D., 2017). Program and project managers who want to use earned value

management on Agile projects face the additional complexity of rapidly changing requirements,

a high level of customer involvement, and a higher level of collaboration with teams, which are

characteristics of Agile project execution (Hoda & Murugesan, 2016). Program and project

managers will benefit from this study through the presentation of empirical, academic research

that will aide with program and project execution.

Agile development and engineering using the Agile methodology must maintain a

balance between engineering leadership and program management (Chen et al., 2016). Agile

developers and engineers will benefit from this study because it will help to align roles and

responsibilities amongst technical and program leadership. Data will be presented that

demonstrates the ability for technical management to remain rapid and flexible, while program

and project managers can stay on budget, on schedule, and on task through earned value

management practices.

Search Report

Search Strategy. The search strategy involved using keywords related to the subject

matter. Searches with the full string of *earned value management* returned favorable results.

Google Scholar proved to be a useful engine to help narrow certain search criteria, such as

viewing common results that were returned with various search strings used. For example, key

terms such as *Agile* also returned words such as *Scrum*, *sprints*, and *cross-functional teams*.

Primarily, however, using basic search strings in the UO Library databases yielded favorable

results.

Searches on earned value management returned ample resources in the UO Library

databases, especially in the categories of Business and Economics. Using basic search strings

combining the terms *earned value management* and *Agile* also yielded positive results. Basic

searches provided returns of peer-reviewed, scholarly articles and published works. A date filter

was not used, as earned value management is an established practice that can be referenced since

inception. However, sources within ten years of publishing were primarily used due to changes

in the application of earned value management in recent history. On occasion, when a reference

was relevant to modern implementation of the subject matter, older sources were selected.

Google Scholar was also used to retrieve sources on the subject matter, yielding marginal results

due to the return of many non-scholarly sources and the requirement for payment for other

material. Many of the items returned were magazine or periodical publications, some of which were scholarly in nature and/or peer reviewed.

Key Terms. Searches utilized various keywords in order to retrieve relevant results. The keywords used are as follows:

- *Earned Value Management.*

- *Earned Value Management and Agile.*

- *Agile Project Management.*

- *Program Management and Agile Development.*

- *Scrum Management.*

- *Engineering Program Management.*

- *Agile Project Management Methodologies*

- *Earned Value Management Techniques*

- *Applying Earned Value to Agile*

Search engines and databases. The search for relevant and reputable literature mainly involved searches of UO Library databases and Google Scholar. The UO Library's databases that proved relevant for this study include the following:

- EconLit.

- Academic Search Premier.

- Business Expert Press.

- Business Source Complete.

- JSTOR.

Documentation Method

Documentation Approach. References and documentation were tracked using basic Microsoft Windows Save functions to a directory. Material was pulled from a given database, typically in Adobe Portable Document Format (PDF), and filed manually in an applicable folder. Titles of the files were modified locally to use name(s) of the author(s) and brief titles relating to the subject matter. The running annotated bibliography of this document was used for website reference when applicable; for instance, to quickly reference websites previously retrieved. A Microsoft Excel file was used to track titles, dates of retrieval, specific subject matter, and other pertinent categorization data.

Reference Evaluation

Reference evaluation criteria. References were evaluated using the list of criteria retrieved from the document *Evaluating Information Sources* (Center for Public Issues, 2014). The criteria listed in the document are defined as authority, timeliness, quality, relevancy, and (lack of) bias (Center for Public Issues, 2014). A reference was determined to be authoritative if it was peer-reviewed and if the author has professional credentials, such as advanced degrees or other published books and articles. A source was determined to be current if it was published within the last ten years to ensure that the most recent practices were reflected. The concept of earned value management has been widely employed in project management since the 1980s, and the author of this study therefore considered material of all ages, but publication dates older than 2008 were mostly excluded.

The author of this study reviewed the quality of each reference to ensure proper grammar, spelling, and punctuation, as well as the flow of the information provided to ensure it was clear and well structured. Relevancy was determined by whether the source was appropriate to the

research topic of the application of earned value management in Agile projects. Additionally,

scholarly sources were prioritized over popular sources. Each source was analyzed for bias by

looking for cited sources that supported the arguments and conclusions of the author(s). The

literature was also checked for the inclusion of multiple viewpoints. The literature was rejected if

the author or article was in the position of selling products or services.

Annotated Bibliography

Introduction to the Annotated Bibliography

This annotated bibliography addresses the research problem of implementing and integrating traditional earned value methodologies on Agile projects. The intended audience is both program-level and technical-level management, as well as team members on a project that may lead a functional group. In a broader sense, the audience consists of key stakeholders of a project. The time period analyzed for this annotated bibliography is from 2006-2018.

This study is significant due to the reality that there has been a rapid emergence of Agile methods, yet the traditional project and program management methods of earned value management are still in place in many industries and organizations. This study addresses ways to overcome incompatibility between the two methods.

Earned Value Management Techniques

Browning, T. (2014). A quantitative framework for managing project value, risk, and

opportunity. *IEEE Transactions on Engineering Management, 61*(4), 583-598.

https://doi.org/10.1109/TEM.2014.2326986

Abstract. Projects should create value. That is the desire and plan, but uncertainties

cloud the paths to this destination. All project work should add value in terms of both the

resources consumed and the benefits provided (e.g., scope, quality, technical

performance, features, and functions), yet adding value is not always straightforward.

Conventional techniques such as earned value management focus on time and cost but do

not address quality, uncertainty, risk, and opportunity. An integrated approach is needed

to account for all of these. This paper presents an integrated framework for quantifying

and monitoring project value in terms of the key attributes that matter to its stakeholders.

The framework distinguishes four types of project value: desired, goal, likely, and actual. Project management is value management. Project goals, capabilities, risks, and opportunities are evaluated with respect to each key attribute of the desired value. The project value, risk, and opportunity framework is useful for project planning, monitoring, control, and tradeoff decision support. An example project, developing a drone aircraft, demonstrates the framework's application to project planning and monitoring, including setting project goals that balance risk and opportunity. New indices for risk, opportunity, and learning are introduced to track project progress and operationalize new constructs for researchers.

Summary. Although this source did not directly address Agile and earned value management and how they interrelate, it did describe some drawbacks of earned value such as challenges in addressing uncertainty, evaluating risk, assessing opportunity, and monitoring quality. This source centers around the PVRO (Project Value, Risk, and Opportunity) framework to address these challenges. The author notes that all of these factors derive from the key attributes that matter to a project's stakeholders. Use of the PVRO framework forces project managers to define important value attributes and uncertainties at the beginning of a project. The PVRO framework produces the outputs of a project's goal value, likely value, the goal value gap, overall value at risk, and overall value at opportunity. This source is valuable to this study because it provides mathematical and statistical analyses that produce concrete numbers and trends related to project value, risk and opportunity for project managers to analyze and which to execute against.

Chen, H., Chen, W., & Lin, L. (2016). Earned value project management: Improving the

predictive power of planned value. *International Journal of Project Management, 34*(1),

22-29. https://doi.org/10.1016/j.ijproman.2015.09.008

Abstract. Earned value project management (EVPM) is an effective tool for managing

project performance. However, most studies on extensions and applications of EVPM

concentrate on improving final cost and duration estimates rather than improving upon

the use of planned value (PV) to predict earned value (EV) and actual cost value (AC).

This study proposes a straightforward modeling method for improving the predictive

power of PV before executing a project. By using this modeling method, this study

develops EV and AC forecasting models for four case projects. Out-of-sample

forecasting validation using mean absolute percentage error (MAPE) demonstrates that

the proposed method improves forecasting accuracy by an average of 23.66% and

17.39%, respectively, for EV and AC. This improvement on PV's predictive power prior

to project execution provides management with more reliable predictive information

about EV and AC performance, allowing for effective proactive action to ensure

favorable performance outcomes.

Summary. This source primarily analyzed methods of predictive analysis such as

planned value, earned value, and actual cost value. Planned value is traditionally viewed

as a time-phased representation of the performance baseline of a project. The authors

assert that planned value can actually be a predictor of earned value and actual cost at

project completion through predictive modeling. This method allows for better predictive

accuracy that can be implemented at the beginning of a project. Improving the predictive

power of planned value helps advance favorable outcomes in performance and project

completion. This source is valuable to this study because it analyzes in detail traditional

earned value methodologies, and how those methodologies can be updated through

modeling to provide better predictive analysis.

Cioffi, D. (2006). Completing projects according to plans: An earned-value improvement index.

The Journal of the Operational Research Society, 57(3), 290-295.

http://www.jstor.org/stable/i379843

Abstract. To finish in accordance with its originally planned duration or cost, a project

that is not meeting its schedule or budget requires improved performance in the work that

remains. This paper shows how to calculate the new productivity in terms of the average

earned-value performance over the first part of a project, and it shows how the new

productivity rate depends on the fraction of tasks completed. The completed task fraction

beyond which recovery is impossible is calculated, and a point beyond which recovery is

highly unlikely is suggested. Using an analytic approximation for an S-curve, these

calculations are transformed into a temporal domain.

Summary. This source broke down the calculations needed to measure the project

productivity rate as it relates to tasks completed and tasks remaining. The author began

by analyzing new productivity early on in a program or project, and then leveraged that

analysis to predict productivity rates based on tasks completed and remaining tasks.

These calculations can then be used by management to properly track work performed

and overall project progress. This source is important to this study because it addresses

how project planning and the early stages of project execution can be used to predict

project performance. This methodology shows how traditional earned value parameters

can be used in a new way to calculate fundamental pieces of information that can be used

to track work performed and overall project progress and make predictions based upon

these calculations.

McGregor, J., Kostelnik, K., & Nelson, D. (2017). All aboard! Earned value management in

DoD. *Defense AT & L.* 27-29. Retrieved from

http://link.galegroup.com/apps/doc/A497911158/PPBE?u=s8492775&sid=PPBE&xid=bf

fd8f39.

Abstract. This abstract is provided by the author of this study in the absence of a

published abstract. This article covers a broad overview of earned value management as it

relates to the Department of Defense (DoD). Topics covered include Performance

Assessments and Root Cause Analyses (PARCA) and the overall earned value policy as

it is applied in DoD. The author discusses establishing baselines through the budgeting

and planning processes of earned value management and whether or not those baselines

are achievable based on scheduled cost and work.

Summary. The authors of this source discuss the effective use of earned value

management in the DoD. The authors assert that earned value management provides a

disciplined management approach through an integrating planning and control system

that is used to track and achieve cost and schedule performance. The authors outline the

DoD's guidance on when earned value management should be used, which is established

by the use of dollar and contract-type thresholds. Contractors must also report a certain

level of detail as to the status of a project, which is dictated by CDRLs (Contract Data

Requirements Lists). At a high level, project managers must understand the baseline laid

out in the Work Breakdown Structure (WBS) and ensure the baseline is achievable. It is

then up to the project manager to make project decisions based on earned value

management data. This source is useful because it gives the perspective of the use of

earned value management from a government contractor perspective, which typically has

to adhere to strict requirements and oversight.

Narbaev, T., & De Marco, A. (2017). Earned value and cost contingency management: A

framework model for risk adjusted cost forecasting. *Journal of Modern Project

Management*, *4*(3), 12-19. https://doi.org/10.19225/JMPM01202

Abstract. This paper proposes a novel framework model that considers different

behaviors of cost contingency (CC) consumption in forecasting risk adjusted final cost

during the project execution. The model integrates the dynamics of how project managers

can spend their contingencies into three S-shaped cost growth profiles to compute risk

adjusted cost estimates at completion (CEAC). The three cost curves are modeled by the

Gompertz growth model using nonlinear regression. Respectively, the framework embeds

three different CC consumption rates to represent three main categories of aggressive,

neutral or passive managerial attitudes in responding to project risk. The usage and

viability of the model is demonstrated via an earned value management (EVM) dataset.

The paper contributes to the body of knowledge by bridging the gap between the theories

of EVM and CC management and provides project managers with a model to estimate the

range of possible cost estimates at completion depending on the managerial policies that

can be activated driven by different risk attitudes.

Summary. This source focused primarily on cost contingency and how managers can

develop S-curves to compute risk and cost at completion. The method of calculating cost

contingency was then demonstrated using an earned value management dataset, which

helps to bridge the gap of cost contingency and earned value theories. The relationship of

risk to calculated earned value metrics was also presented and analyzed, which showed

correlations of risk and opportunity to project schedule and cost variances. This source is

useful to this study because cost contingency is an important aspect of project

management, both with Agile and more traditional project management methods. This

sources helps to address the use of cost contingency from an earned value dataset

perspective.

Verzuh, E. (2004). Project status reporting using earned value analysis. *CHIPS, 22*(2), 31-32.

Retrieved from

http://link.galegroup.com/apps/doc/A119508273/PPBE?u=s8492775&sid=PPBE&xid=d

266c2a8

Abstract. This abstract is provided by the author of this study in the absence of a

published abstract. The author of this document discusses a broad array of earned value

status reporting techniques. He describes the steps of analysis including the development

of a detailed plan, capturing actual project progress, calculating progress, assessing cost

performance, and analyzing schedule progress. Verzuh includes example calculations and

common mistakes.

Summary. This source uses a basic earned value example to demonstrate the earned

value management steps of beginning a project with a detailed plan, capturing progress

during the project, calculating progress, assessing cost performance, and assessing

schedule performance. The author asserts that earned value analysis and calculations

enable project managers and stakeholders to have an accurate view of project

performance and status early and often. Verzuh asserts that in order for earned value to

work properly, a Work Breakdown Structure (WBS) must be created properly by

defining specific project tasks that can be measured. He also notes that a WBS must be

trackable by defining an accurate scope to allow the accurate analysis of the tasks

identified in the WBS. This source is useful because it describes, at a high level, the

application of earned value management on projects and the purpose of this

methodology.

Agile Project Management Methodologies

Hoda, R., & Murugesan, L. K. (2016). Multi-level Agile project management challenges: A self-

organizing team perspective. *Journal of Systems and Software, 117*, 245-257.

doi:10.1016/j.jss.2016.02.049

Abstract. Agile software development advocates self-organizing teams that display high

levels of autonomy. Self-organizing agile teams are meant to share project management

activities such as estimation, planning, and requirements elicitation with managers and

customers. While prior literature has explored some individual management-related

issues, little is known about how the high involvement of self-organizing agile teams

influences everyday project management activities. Through a Grounded Theory study

involving 21 agile practitioners across six software companies implementing Scrum and

XP, we identified a set of eight project management challenges as experienced by and as

a result of self-organizing agile teams at multiple levels. These include delayed/changing

requirements and eliciting senior management sponsorship at the project level; achieving

cross-functionality and effective estimations at the team level; asserting autonomy and

self-assignment at the individual level, and lack of acceptance criteria and dependencies

at the task level. A mapping between the emergent challenges and standard project

management activities is also presented. The article also shares practical implications

and guidelines for agile teams, their managers, and customers for overcoming some of

these challenges.

Summary. This source covers the topics of self-managing groups and how they relate to

program and project management hierarchies. This article brings together the

dependencies and guidelines for agile teams and their managers, relating back to

traditional project management methods as well as newer Agile methodologies. One

finding is the assertion that self-organizing teams are now much more closely involved

with project management on Agile projects as opposed to more traditional project

management techniques such as Waterfall that stressed a distinct role for the project

manager. High team involvement leads to new challenges such as rapidly changing

requirements, a high level of involvement of functional team leaders with customers and

project management, and scope creep. The higher level of involvement of functional team

leaders with customers and project management presents challenges due to the fact that

technical leaders do not necessarily have the skill sets for customer interaction. This

source is relevant for this study because it addresses the challenges of Agile project

execution as it relates to project management.

Larson, E., Gray, C. (2014). *Project management: The managerial process* (6th ed.). New York,

NY. McGraw-Hill Education.

Abstract. This abstract is provided by the author of this study in the absence of a

published abstract. This textbook presents a balanced treatment of both the technical and

behavioral issue in project management. The authors also cover a broad range of

industries to which program management principles can be applied. Both Agile and

Earned Value Management strategies and theory can be utilized from this source.

Summary. This source is a book that covers all aspects of project management, from methodologies to organizational behavior to best practices. The book covers Agile and Earned Value in a straightforward way, providing input and insight into both methodologies as they relate to project management in general. The authors address the selection of organizational structure and project selection, based on both the technical requirements of the project and the organizational culture. Agile is typically selected in a rapid-changing, small group environment that has a large degree of customer interaction. The book contains a section specifically on Agile where the authors note that Agile is found to be highly effective in modern project management, especially relating to software development. This source is relevant for this study because it encompasses many aspects of project management, which allows for the comparison and contrast of different organizational cultures and behaviors, as well as the technical aspects of project management.

McAvoy, J., Butler, T. (2009). The role of project management in ineffective decision making within Agile software development projects. *European Journal of Information Systems, 18*(4), 372-383. https://doi.org/10.1057/ejis.2009.22

Abstract. Decision making in traditional software development lies with the project manager. In contrast, Agile software development teams are empowered to make decisions, while the role of project manager has changed from one of command and control (i.e. to make decisions and ensure they are implemented) to one of a facilitator. This article argues that decision making in software development is not characterized by a sequence of isolated or exclusive decisions; rather, decisions are inter-related, with each decision leading to further decisions, the chain of which often spans the entire duration of

a project. Over this extended period, there are several potential factors that can negatively

affect the efficacy of decision making by Agile teams. One of the findings of this

exploratory longitudinal study is that the high level of empowerment of a cohesive

software development team undertaking an Agile project may be one of these negative

factors, as empowered, cohesive teams can exhibit problems such as groupthink or the

Abilene Paradox. This article therefore argues that the role of project manager in Agile

development initiatives needs to be reassessed, with project managers taking on the role

of devil's advocate in the decision-making process.

Summary. The authors of this source analyzed the efficacy and empowerment of

traditional project management as it relates Agile teams and project execution. McAvoy

and Butler assert that non-technical project managers executing a project in traditional

earned value management with Agile techniques inhibit their teams and are anti-

development, which is a different finding than others in this study who found that earned

value management and Agile project execution can coexist. However, McAvoy and

Butler do assert that project management has a role in Agile, but it should be more of a

'devil's advocate' role that helps to eliminate group think and questionable decision

making at a team level. This source is useful for this study because it describes details of

Agile project execution while also addressing shortfalls of the exclusion of traditional

project management practices.

Mihalache, A. (2017). Project management tools for Agile teams. *Informatica Economica, 21*(4),

85-93. https://doi.org/10.12948/issn14531305/21.4.2017.07

Abstract. The 21st century started as the era of agile methods and technologies which

combine adaptable and highly flexible methods designed to help teams to develop

applications faster and safer. The challenge is to adapt just enough technology to enhance

the performance of teams which are using agile methods and to avoid going back to weak

workflow ideas of the industrial era. In this paper, I will present some relevant agile tools

that could improve every software development project and I will also mention the

features and criteria used for evaluating currently existing tools. Finally, I will propose a

classification model to the appropriate agile tool selection, but keep in mind that in order

to be successful, organizations and teams do need to deal first with the issues that

accompany product complexity and growing teams.

Summary. This source presented several Agile features and tools that help to improve

performance on most software development projects. The commercial tools featured in

the study are JIRA, VersionOne, Rally, and Visual Studio Team Services. More general

tools such as Google Suite, Microsoft Project, and Microsoft Excel are also analyzed.

Features that each of these tools contain enable Agile reporting and metrics,

communication, and project assessment. The author found that the tools required to

execute a project are dependent on the specific needs of the project stakeholders,

including customer requirements and organizational perspectives. For example, if a

customer requires a steady Gantt style chart progression, then the project might benefit

from tools such as Microsoft Project. This was a more technically detailed source than

some others in this annotated bibliography, but it is useful to this study because it helps to

bridge the knowledge gap between the principles of Agile and actual tools used to

execute a project or program under the Agile framework.

Application of Earned Value Management Techniques on Agile Projects

Goodpasture, J. C. (2010). *Project management the Agile way*. Fort Lauderdale, FL: J. Ross

Publishing.

Abstract. This abstract is provided by the author of this study in the absence of a

published abstract. This source offers practical tips and application advice for how to

bring the methods of Agile and earned value together when managing a project,

describing how earned value can work with non-traditional project management methods.

The scaling of Agile and iterative methods for enterprise projects is also explained. This

source also discusses the means to outsource and contract with Agile and iterative

methods.

Summary. The author discusses business cases for Agile and how to use value modeling

to determine a business case, especially through the use of balance sheets. Goodpasture

defines *value modeling* as a data-driven representation of the worth of what a company is

doing. He notes that a project balance sheet helps to break down numbers and

communicate a business case to key stakeholders. Goodpasture also addresses quality

issues that can arise when using Agile methods, including scope creep and lack of formal

testing. Goodpasture asserts that quality methods must be interjected by project

leadership into every aspect and stage of the project to make sure rapidly working groups

adhere to directed quality standards.

Goodpasture notes that a WBS (Work Breakdown Structure) is a tool for analyzing

scope, but it is up to project managers to adjust as needed and scale and modify a

project's course, especially from an Agile perspective. The author also discusses Agile

methodologies such as Scrum, Crystal Methodology, EVO Methodology and Extreme

Programming. Goodpasture notes that at a high level, Scrum is management centric,

while Crystal Methodology is human powered; Extreme Programming is a more

disciplined methodology, while EVO is more PDCA (plan-do-check-act) centric. PDCA

is an iterative management method used for continuous improvement of processes. This

source is valuable to this study because it addresses many aspects of project management

and brings together Agile methodologies and traditional earned value management

practices.

Maruping, L., Venkatesh, V., & Agarwal, R. (2009). A control theory perspective on Agile

methodology use and changing user requirements. *Information Systems Research, 20*(3),

377-399. Retrieved from http://www.jstor.org.libproxy.uoregon.edu/stable/23015471

Abstract. In this paper, we draw on control theory to understand the conditions under

which the use of agile practices is most effective in improving software project quality.

Although agile development methodologies offer the potential of improving software

development outcomes, limited research has examined how project managers can

structure the software development environment to maximize the benefits of agile

methodology use during a project. As a result, project managers have little guidance on

how to manage teams who are using agile methodologies. Arguing that the most effective

control modes are those that provide teams with autonomy in determining the methods

for achieving project objectives, we propose hypotheses related to the interaction between

control modes, agile methodology use, and requirements change. We test the model in a

field study of 862 software developers in 110 teams. The model explains substantial

variance in four objective measures of project quality—bug severity, component

complexity, coordinative complexity, and dynamic complexity. Results largely support

our hypotheses, highlighting the interplay between project control, agile methodology

use, and requirements change. The findings contribute to extant literature by integrating

control theory into the growing literature on agile methodology use and by identifying

specific contingencies affecting the efficacy of different control modes. We discuss the

theoretical and practical implications of our results.

Summary. The authors of this source develop a model for project managers of the

relationship between project requirements change, project control modes, and Agile

methodology use and their effects on project quality. The authors used data collected near

the beginning, in the middle, and at the end of software projects in naturally occurring

conditions within organizations. Questionnaires were used at these points in time to

gather feedback about project status. Empirical data analysis was analyzed using

constructs of various types.

The authors found that under conditions of high levels of requirements change, it is

essential that Agile methodologies are used. The authors also concluded that control

modes that are implemented by management that promote autonomy contribute to

increased quality and overall project success. In addition, the authors encourage

managers to use project incentive mechanisms that focus on team performance and

corresponding successful project outcomes of good teamwork.

This source is valuable to this study because it presents empirical data in relation to the

use of Agile methodologies and project management practices and the impact on project

success.

McMahon, P. (2006). Lessons learned using Agile methods on large defense contracts.

Crosstalk: The Journal of Defense Software Engineering, 19(5), 25-30. Retrieved from

Retrieved from www.pemsystems.com/pdf/200605-McMahon.pdf

Abstract. While the agile movement began on small commercial projects, many

contractors are employing these methods today (to varying degrees) on large defense

contracts. In the process, new challenges are being faced that are not addressed by

current published agile literature. Examples of questions being asked include: How do

we treat firm requirements? How do we report earned value? How are systems

engineering, configuration management, and our test group affected? How should we

handle traditional customer deliverables? What can we do about personnel who are not

motivated to work on self-directed teams? This article employs scenarios based on actual

project situations occurring in 2005 to share the latest lessons learned on what is working

and what isn't working when applying agile software development on large government

defense projects.

Summary. This source focused on higher level analysis, as compared to more detailed

tools used for Agile and earned value management execution. The example scenarios of

actual projects and project execution are used to demonstrate what may and may not

work when using Agile development on government contracts. One example is the

application of requirements. The author recommends that the program manager write

down all of the firm requirements as soon as possible and not collaborate on them.

Program managers should expect more conflict early in projects, and it is therefore

critical to have good conflict resolution practices in place. The author also recommends

that the program manager not assume the Agile team knows how to collaborate, noting

that many Agile team members will need to be taught collaboration skills. The author

asserts that progress must reported early and often relative to the baseline, which will

allow some of the traditional flexibility of Agile under the guise of a government

contract. This source is useful for this study because it addresses many of these

aforementioned tips and lessons learned when using an Agile methodology in defense

contracting.

Nikravan, B., & Forman, J. (2010). Beyond backlogs and burndowns - Completing "Agile"

methods with EVM for improved project performance. Presented at PMI® Global

Congress 2010 – North America, Washington, D. C. Retrieved from

https://www.pmi.org/learning/library/earned-value-management-understand-agile-6567

Abstract. Earned value (EV) measurement and techniques, as methods for project

management monitoring, reporting, forecasting, and controlling have been developed and

adopted over the past few decades in software product development as well as traditional

engineering projects. The methods, relying largely on baselined task-driven plans with

fixed and well-defined scope, assume linear progression on task execution and

completion that pave the way to the devising of schedule and cost performance indices

that can be used for forecasting and making decisions on project controls. While Agile

Manifesto does not mention the words "measurements" and/or "metrics," and the

approaches do not readily lend themselves to return on investment (ROI) metrics, the

authors identified the need to complement their projects' performance monitoring,

forecasting, and control techniques by adding simplified earned value management

(EVM) methods to the burn charts and velocity calculations. Short sprint cycles are

helpful, and project risks and uncertainties get reduced by delivering regularly and

quickly; but, while the product backlogs remain dynamic, as a result of sprint spillovers

and stakeholders' fine-tuning of features and requirements, the additional performance

tools provided by EVM are still required to communicate the "bigger picture" of end-to-

end project status and forecasts to the non-agile stakeholders, as well as for input to the

project control and executive decision-making process.

Summary. This source discusses supplementing Agile methods and projects with earned

value management techniques to improve project performance. Earned Value

terminology can be modified and definitional metrics can be adjusted to be meaningful to

an Agile setting. One example is to create a granular measurement of BCWP (Budgeted

Cost of Work Performed) using testable requirements. Also, an Agile project can

establish a Budget Cost of Work Performed (BCWP), as well as a BCWS (Budgeted Cost

of Work Scheduled) at each iteration, not just at the beginning of the project. The authors

also advise the capture of ACWP (Actual Cost of Work Performed) through the use of a

timekeeping system. Burn-down and burn-up charts that are used in Agile can also be

used in earned value; the authors note that a burn-up chart closely resembles the Earned

Value (EV) and Planned Value (PV) plots of an earned value 3-lined graph. In addition,

traditional earned value SV (Schedule Variance) can be calculated at the end of each

iteration or sprint, which helps to drive project EAC (Estimate at Completion). This

source is useful for this study because it demonstrates a hybrid of Agile and earned value

management, both from a principled perspective and from a calculation perspective.

Sulaiman, T., Barton, B., & Blackburn, T. (2006). AgileEVM - Earned value management in

Scrum projects. Paper presented at *AGILE 2006 (AGILE'06),* Minneapolis, MN.

https://doi.org/10.1109/AGILE.2006.15

Abstract. Scrum is an agile project management framework. This framework specifically

focuses on maximizing return on investment (ROI). Scrum, however, does not define

how to manage and track costs to evaluate actual ROI against the vision. A reasonable

cost measurement that integrates with Scrum would help provide an additional feedback

loop. We adapted earned value management (EVM), using values defined in Scrum. The

result is called AgileEVM (agile earned value management) and is a simplified set of

earned value calculations. From the values in Scrum, we derived a release date estimate

using mean velocity and from this equation, generated an equivalent equation using

traditional EVM techniques, thus establishing the validity of using EVM with the Scrum

framework. Finally, we used this technique on two projects to further test our hypothesis.

This investigation also helped us determine the utility of AgileEVM.

Summary. This source bridged the gap of earned value management and Agile,

presenting the term AgileEVM with a Scrum framework. This method presents a more

customized set of earned value style calculations that are more compatible with Agile

projects, while still providing good metrics and forecasting for management. The

traditional Performance Measurement Baseline (PMB) is the sum of all work package

schedule estimates. In Agile, this translates to the total number of story points planned for

a release. Schedule Baseline is modified from the sum of all work packages for each time

period to the total number of planned sprints multiplied by the sprint length. Budget at

Complete (BAC) is modified to plan a budget per release, not per project. Planned

Percent Complete is traditionally an expectation of percent complete at a certain point in

the project. This measurement can be subjective or a dollar value compared to the

performance baseline. The customized Agile method for this measurement is to take the

number of the current sprint and divide it by the total number of planned sprints. Overall,

traditional earned value equations remain the same, but terms and definitions are

modified to address Agile practices. This source is useful for this study because it directly

addresses the use of earned value practices in Agile projects.

Conclusion

Introduction to the Conclusion

This study addressed the research problem of implementing and integrating traditional earned value methodologies on Agile projects. This study is significant due to the reality that there has been a rapid emergence of Agile methods, yet the traditional project and program management methods of earned value are still in place in many industries and organizations. This study addresses ways to overcome incompatibility between the two methods. Best practices and emerging methodologies, to include hybrid methodologies of Agile and traditional earned value management, were analyzed. The research for this study was approached from a project management perspective by utilizing scholarly sources addressing these topics.

Earned Value Management Techniques

Earned value management originated in Department of Defense and government contracting projects in the 1960s and 1970s, and has been adopted in many industries since that time (McGregor, Kostelnik, & Nelson, 2017). Earned value management is an effective tool for managing project performance based on schedule and cost using predictive calculations such as Planned Value (PV), Earned Value (EV), and Actual Cost value (AC) (Chen, Chen, & Lin, 2016). By comparing Earned Value and Actual Cost value to Planned Value throughout the project, project managers can determine whether their projects are in danger of exceeding cost and schedule baselines (Chen, Chen, & Lin, 2016). Verzuh (2004) notes that the first step in earned value management is to develop a detailed plan of the project.

Browning (2014) asserts that traditional earned value management is effective at managing and monitoring cost and schedule, yet it falls short of monitoring and addressing project risk, uncertainty, opportunity, and quality. The PVRO (Project Value, Risk, and

Opportunity) framework helps to address these issues in a traditional earned value environment

approach by defining important value attributes and uncertainties at the beginning of a project

that matter to key stakeholders and then monitoring project progress, which Browning (2014)

defines as reducing uncertainty by generating information through the accomplishment of project

work. In addition, the PVRO framework includes the creation of risk management and quality

management plans that lay the framework to address potential problems that may arise

throughout the project.

Productivity should also be defined and measured at the beginning and early stages of a

project in order to establish a baseline for predictive analysis of project performance that can

help track work performed and overall project progress using earned value calculations (Cioffi,

2006). Narbaev and De Marco (2017) also advocate the use of cost contingency to reduce the

overall risk on projects and maximize the opportunities. Narbaev and De Marco (2017)

developed a method for estimating project cost contingencies using a traditional earned value

dataset that includes Planned Value, Earned Value, and Actual Cost.

A key step in earned value management that is common among all of the sources in this

annotated bibliography is the identification of a project baseline to enable the calculation of

project progress (Browning, 2014; Chen, Chen, & Lin, 2016; Cioffi, 2006; McGregor, Kostelnik,

& Nelson, 2017; Narbaev & De Marco, 2017; Verzuh, 2004). While differences exist in the

frameworks used to apply earned value management on projects and the specific variables that

are tracked to gauge project progress, all of the authors employ project baselines as a key tool

(Browning, 2014; Chen, Chen, & Lin, 2016; Cioffi, 2006; McGregor, Kostelnik, & Nelson,

2017; Narbaev & De Marco, 2017; Verzuh, 2004).

Agile Project Management Methodologies

As Larson and Gray (2014) state, there are many variations in technical and behavioral management methods for project management. Agile is a method of project management that utilizes 21st century characteristics of development and team-centric strategies that addresses rapidly changing requirements and development processes, typically associated with software development (Mihalache, 2017). Iterative releases are achieved through the use of Agile sprints, which are time-boxed efforts that are restricted to a specific duration (Hoda & Murugesan, 2016). Sprints produce releases that are incremental, and multiple sprint cycles lead to iterative releases (Larson & Gray, 2014).

Larson and Gray (2014) assert that Agile project management methodologies have characteristics of traditional earned value principles, such as cost and schedule tracking, but must be adapted to the rapid pace of iterative releases and the possibility of changing requirements. Hoda and Murugesan (2016) assert that Agile development promotes self-organizing teams that are much more involved with project management than teams on projects that use traditional waterfall methods. Because of this high level of involvement, the program and project management hierarchy on Agile projects has morphed from a command and control structure to more of a facilitating entity (McAvoy & Butler, 2009).

To be successful, project managers on Agile projects must utilize the flexible and fluid techniques of Agile development, which include rapid cycles of development and testing and the acceptance of changing requirements throughout sprint cycles, as well as the life of the project (Hoda & Murugesan, 2016). In addition, project managers must use control modes to promote team autonomy and facilitate proper responses to rapidly changing requirements (Maruping, Venkatesh & Agarwal, 2009). McAvoy and Butler (2009) advise project managers to be vigilant

in combatting group-think on Agile projects, noting the risk of group-think because the illusion

of unanimity and collective rationalization come naturally with a unified, highly skilled, and

rapidly functioning team. They also note that because requirements on Agile projects are

iterative rather than developed and baselined at the start of a project, scope creep is common and

must be avoided (McAvoy & Butler, 2009). Finally, McAvoy and Butler (2009) advocate that

project managers use the "devil's advocate" posture, which consists of keeping functional team

leaders in check with regards to requirements, testing, and quality control, in order to keep the

project on track.

Application of Earned Value Techniques on Agile Projects

Despite their differences, earned value methodologies can be used with Agile

methodologies on projects to help establish a business case during project charter creation,

establish a baseline, track project progress, ensure quality control, and communicate effectively

to key stakeholders (Goodpasture, 2010). Goodpasture (2010) recommends the use of balance

sheets to communicate a business case to key stakeholders on Agile projects. He advocates for

the use of project baselines on Agile projects to enable the tracking of project progress, and

recommends that project leadership enforce the use of quality methods in every aspect and stage

of the project to ensure that rapidly working groups adhere to directed quality standards

(Goodpasture, 2010).

Nikravan and Forman (2010) note that with traditional earned value project management,

task execution and completion are measured using cost and performance indices. Agile doctrine

has no mention of "metrics", and at a sprint level, results do not typically lend themselves to a

return on investment type calculation. Sulaiman, Barton, and Blackburn (2006) also note that

Scrum, a specific agile project management framework, does not define how to manage and

track costs to evaluate project ROI. However, traditional project performance tools provided by

earned value techniques can be utilized to track progress and communicate the 'bigger picture' of

the overall project status and forecasts to key stakeholders (Nikravan & Forman, (2010). In

addition, executives who are making decisions related to the project and exercising project

control need the performance information provided through traditional earned value management

(Nikravan & Forman, 2010).

Sulaiman, Barton, and Blackburn (2006) identify Scrum as an Agile project management

framework that focuses specifically on maximizing return on investment. Earned value

methodologies can be applied to Scrum terms within the Scrum framework using a method

developed by Sulaiman, Barton, and Blackburn (2006) called AgileEVM, which modifies key

terms and definitions to fit the framework of Agile, using the traditional earned value equations.

In particular, the AgileEVM calculations can be used to estimate a schedule baseline for Agile

projects, planned percent complete at any point in the project, and planned budget per release

rather than the traditional method of calculating Budget at Complete (BAC) at the project level

(Sulaiman, Barton, & Blackburn, 2006).

The adoption of Agile methodologies on large defense contracts where earned value

management is also used demonstrates the ability for traditional earned value and Agile

approaches to be used in conjunction with each other when managing projects (McMahon,

2006). In order to ensure requirements are addressed and documented, defense contract program

managers must calculate project progress and performance early in the project, often with limited

collaboration or influence from a technical lead or other expert. Conflict management practices

also need to be in place to address conflict arising from strict requirements, a hallmark of defense

contracts, that may have a negative impact on Agile team dynamics. These practices can allow

some Agile flexibility under the guise of a traditional defense contract (McMahon, 2006).

Concluding Thoughts

These scholarly sources identified for this study indicate that the capabilities of Agile and

earned value project management techniques can by symbiotic, as long as there are compromises

made in the application of both methodologies. Agile provides a high degree of flexibility and

rapid development, but earned value management techniques can be applied to the Agile

framework in order to mitigate scope creep, ensure quality requirements are met, and provide

project status and progress to key stakeholders. As more projects outside of the specific case of

software development adopt Agile-type methodologies for project execution, opportunities will

continue to arise to apply traditional techniques such as earned value management in conjunction

with Agile approaches. A larger number of projects adopting these hybrid methodologies will

yield more data for the analysis of hybrid project management effectiveness with the morphing

of traditional techniques, providing further valuable research studies.

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