

# The Earned Value in Project Management

## Benefits in the ICT projects

Marko Häkkinen

Master's Thesis

May 2015

Master's Degree Programme in International Business Management  
School of Business



JYVÄSKYLÄN AMMATTIKORKEAKOULU  
JAMK UNIVERSITY OF APPLIED SCIENCES



Author(s) Häkkinen, Marko	Type of publication Master's thesis	Date 28.5.2015
		Language of publication: English
	Number of pages 105	Permission for web publication: x
Title of publication <b>The Earned Value in Project Management</b> Benefits in the ICT projects		
Degree programme Master's Degree Programme in International Business Management		
Tutor(s) Kiviranta, Hanna-Maija		
Assigned by The team manager of a project department of a Case Company		
Abstract <p>The companies are continuously seeking an improvement for the efficiency and customer experience. In the interest of service deliveries for the B2B customers, are often rendered via a project. The cost and schedule performance, and customer experiences are important elements over and above in a successful project.</p> <p>In what respect to improve an ICT customer delivery project management performance was the paramount issue studied in this thesis. As a more focused improvement area, the thesis's focal point was to analyze by what means an earned value will improve, the progress accuracy, the progress reporting, the cost-efficiency, and the time management in the ICT customer delivery projects.</p> <p>The research started by reflecting the tools such as, PMA, PMI, and PRINCE2 can offer the project management. It was followed by a closer look at the earned value tools and the earned schedule tools developed to use with earned value tools for more accurate schedule status. Finally it was studied how earned value can be used in a MS Project.</p> <p>The action research method adopted in this thesis was found competent in the development, ways of depicting achievements in the work community. The phases of the first cycle of the action research were encountered in the thesis.</p> <p>There was a data gathering period of April to November 2014 where all either on-going or completed projects of the project management department in the case company were put under analysis. There were improvements found for several project management practices in the case company. Major finding for improvements were more unified way of planning tasks and how to define completion percent for a task, ways to use a baseline, how to collect the progress data from the project members, and how to present the project managerial work in a project plan.</p>		
Keywords/tags ( <a href="#">subjects</a> )		
Earned value, Earned schedule, ICT project, MS Project, Action Research		
Miscellaneous Appendices are not public information. They have been removed from the public version of the thesis		



Tekijä Häkkinen, Marko	Julkaisun laji Opinnäytetyö	Päivämäärä 28.5.2015
	Sivumäärä 105	Julkaisun kieli Englanti
		Verkkojulkaisulupa myönnetty: x
Työn nimi <b>The Earned Value in Project Management</b> Benefits in the ICT projects		
Koulutusohjelma International Business Management, Liiketalouden ala, YAMK		
Työn ohjaaja(t) Kiviranta, Hanna-Maija		
Toimeksiantaja(t) Case yrityksen projektiosaston ryhmäpäällikkö		
Tiivistelmä <p>Yritykset jatkuvasti hakevat parempaa kannattavuutta ja asiakastyytyväisyyttä. Koska useat palveluiden käyttöönotot B2B-asiakkaille toteutetaan käyttöönotto- tai muutosprojekteina, ovat kannattavuus ja asiakastyytyväisyys tärkeitä elementtejä myös onnistuneessa projektissa.</p> <p>Tässä opinnäytetyössä tutkitaan kuinka ICT asiakastoimitusprojektienhallinnan tehokkuutta voidaan kehittää. Tarkemmaksi tutkinnan kohteeksi opinnäytetyössä otettiin ansaittu arvo projekteissa ja kuinka sen avulla voidaan parantaa projektin edistymisen arviointitarkkuutta, ajanhallintaa, etenemisraportointia ja kustannustehokkuutta.</p> <p>Aluksi opinnäytetyössä selvitettiin mitä työkaluja IPMA, PMI ja PRINCE2 tuovat projektinhallintaan. Tätä seurasi tarkempi tutustuminen ansaittuun arvoon ja sen rinnalle kehitettyyn ansaittuun aikatauluun. Lopuksi tutustuttiin siihen, kuinka ansaittua arvoa voidaan käyttää Microsoft Projectissa.</p> <p>Toimintatutkimus oli opinnäytetyössä käytetty tutkimusmenetelmä. Menetelmä todettiin hyväksi tavaksi kehittää toimintatapoja ja toimintaa työyhteisössä. Tässä opinnäytetyössä käytiin läpi toimintatutkimuksen ensimmäisen syklin vaiheet.</p> <p>Opinnäytetyössä tutustuttiin Case yrityksen projektiosaston huhti - marraskuun 2014 aikana etenemässä olleisiin ja valmistuneisiin projekteihin. Opinnäytetyössä löydettiin Case yritykselle uusia käytäntöjä projektin tehtävien kuvaamiseen ja valmiusasteen määrittelyyn, perusaikataulu-toiminnon hyväksikäyttöön, projektin tehtävien valmiusastetietojen keräämiseen ja projektin hallinnollisen työn kuvaamiseen.</p>		
Avainsanat (asiasanat)  Ansaittu arvo, Projekti, ICT-projekti, MS Project, Toimintatutkimus		
Muut tiedot Opinnäytetyön liitteet eivät ole julkisia, joten ne on poistettu tämän opinnäytetyön julkisesta versiosta.		

## CONTENTS

<b>1</b>	<b>THE INTRODUCTION.....</b>	<b>4</b>
1.1	Background.....	4
1.2	The relevance to the company .....	5
1.3	The broader relevance .....	5
1.4	The research questions .....	6
1.5	Conducting the thesis .....	7
1.6	The structure of the thesis .....	7
<b>2</b>	<b>THE LITERATURE REVIEW .....</b>	<b>8</b>
2.1	<b>A Project management .....</b>	<b>8</b>
2.1.1	The general information .....	8
2.1.2	International Project Management Association - IPMA.....	13
2.1.3	Project Management Institute - PMI.....	15
2.1.4	PRINCE2.....	19
2.1.5	PRINCE2 vs. PMBOK .....	25
2.1.6	The Agile methods .....	27
2.2	<b>The Earned value in project management .....</b>	<b>29</b>
2.2.1	The development of the earned value in project management .....	29
2.2.2	Closer look to Earned value technique .....	34
2.2.3	Central elements.....	35
2.2.4	Variances.....	37
2.2.5	Performance indices .....	39
2.2.6	Estimate at completion (EAC) .....	42
2.2.7	Earned value in agile project methods.....	45
2.3	<b>Earned Schedule method in project management.....</b>	<b>46</b>
2.3.1	General information.....	46
2.3.2	The ES method in use.....	47
2.3.3	The Earned Schedule in agile methods .....	51
2.4	<b>Earned value and earned schedule in MS Project .....</b>	<b>52</b>
<b>3</b>	<b>RESEARCH METHODOLOGY .....</b>	<b>55</b>
3.1	<b>Methodology used in the study.....</b>	<b>55</b>
3.2	<b>Process of empirical study.....</b>	<b>64</b>
3.2.1	The Data collection .....	64
3.2.2	The Data analysis.....	65
3.3	<b>RELIABILITY AND VALIDITY.....</b>	<b>66</b>
<b>4</b>	<b>RESEARCH RESULTS.....</b>	<b>67</b>
4.1	Case company and projects.....	67
4.2	The Discoveries of observation period projects .....	69
4.3	Getting the task durations shorter and standardized .....	75
4.4	The Early earned value experiences .....	79
4.5	Integrating the earned value into project practices .....	82

4.6	The recommendations for new project management practices .....	85
4.7	Acceptance of recommendations as first earned value tools .....	86
5	DISCUSSION .....	95
5.1	Conclusions.....	95
5.2	Limitations.....	98
5.3	Generalization .....	98
5.4	Future research avenues.....	99
	RESOURCES.....	102
	APPENDICES.....	106
	Questionnaire 1 – Earned Value .....	106
	Questionnaire 2 – Earned Value .....	110
	Project data .....	116

## TABLES

Table 1. Four levels of IPMA certification system (PMDAN 2012) .....	14
Table 2. The comparison of PMBOK® GUIDE Areas of Knowledge and PRINCE2 Themes (Siegelaub) .....	26
Table 3. Earned Value Analysis Abbreviations and Formulas .....	43
Table 4. Comparison of Earned Value and Earned Schedule. (Lipke 2006).....	48
Table 5. Measures, Indicators, and Predictors of Earned Schedule. (Lipke 2006) .....	49
Table 6. Project statuses .....	70
Table 7. Average Project Workload in Project Categories .....	70
Table 8. Project work in closer look by teams and categories .....	71
Table 9. Teams, Categories, Tasks and Durations .....	72
Table 10. The Task Averages and the Task Counts.....	73
Table 11. The Task Durations .....	74

## FIGURES

Figure 1. PMI's Body of Knowledge Structure (Association of Modern Technologies Professionals 2014, Project Management Institute 2001).....	17
Figure 2. The overview of a standard PMP Exam Application Procedure (PMstudy 2014) .....	19
Figure 3. A feasible Business Case in project's full life cycle (Hedeman and Seegers 2012) .....	22
Figure 4. PRINCE2 Process Overview (Van Haren Publishing 2012).....	23
Figure 5. All the roles in PRINCE2 project organization (Scoll Methods 2009) (Hedeman and Seegers 2012) .....	24
Figure 6. Work performance trends example .....	41
Figure 7. The Earned value analysis chart (Example) .....	53
Figure 8. Action Research cycle.....	62
Figure 9. Project model of the case company.....	68
Figure 10. The Task duration groups.....	75
Figure 11. Response rate of the first questionnaire.....	76
Figure 12. The Choices for the method by the Teams .....	77
Figure 13. The Choices for the method by respondent's age .....	78
Figure 14. The Respondents gender .....	87
Figure 15. Age groups .....	88
Figure 16. The Team-by-Team view for suitable project level for an Earned Value ...	88
Figure 17. The Interval of the earned value analysis .....	89
Figure 18. The Data collection interval vs. The Earned value analysis interval.....	90
Figure 19. The Critical path tasks vs. all tasks .....	91
Figure 20. The Managerial work in projects.....	92
Figure 21. The measurement of a task progress.....	93
Figure 22. The Tool for calculating the project management work.....	94
Figure 23. The Storing Baseline.....	95
Figure 24. The Action Research cycle of the thesis.....	99

# 1 THE INTRODUCTION

## 1.1 Background

Productive efficiency in the different facets of the project management tasks and simultaneously for the facilitation of a better customer experience is what companies are striving these days. The economy is challenged by the ongoing recession. There are many ways the project management can be improved. Main areas of improvement are in quality of planning and executing projects.

A Company can improve the quality of the project management by encouraging the project managers to study and acquire a project management certification. There are several project management associations that are offering the project management certifications based on their own project management body of knowledge. All these associations will cover the main areas of the project management certifications. Some of them concentrate on the project managers, and some channel toward the project management processes and tools.

One crucial area of the project management is monitoring an on-going project and making corrective actions based on the information available. A Project manager is required to be primed on the budget, the schedule and the scope. What makes right corrective actions difficult is to procure a timely available data. Corrective actions tend to become difficult even with timely available data. Meaning even if the data is correct but availability is not punctual, a right corrective action for the received data can actually be a wrong one.

There are several tools for monitoring the progress of an on-going project. In this thesis, the main focus is on studying the earned value and the earned schedule as a monitoring tool to keep a project on the right track. They will give an accurate view of a project and its current stage and how long it will take to end the project if continuing in the same pace.

The theory will be put into action by studying customer delivery projects in an ICT company via real life examples. Different methods to measure work performance were put to a test and some pros and cons were discovered.

## **1.2 The relevance to the company**

The motive of the thesis is to assist the project management team's tasks in a company, and at the same time find ways to ease the workload, make the project's actual schedule forecasting furthermore accurate, and make reporting automatic.

By testing different methods to measure work performance, a right method among all methods was found and steps were taken in integrating a method into use.

Various areas of a project management and a project management model used in customer projects have been under rigorous updating and development. A main theme in upgrading has been to optimize the project management to better suit various levels of customer projects and keep the customer satisfaction levels as good as earlier or impel to more necessary levels of the consumer contentment. The Introduction of an Earned value and an Earned schedule is one area of project model improvement.

The aim of this thesis is to study the Earned value and the Earned schedule and to acquire a substantial understanding of both methods and via empirical tests find the right way to take them into consideration in the project model of the company. The final aim is to implement an Earned value and an Earned schedule as part of basic project management practices of the company in customer ICT-projects.

The Development of an Earned value and an Earned schedule in the project model will continue even after the conclusion of the thesis or outcome. The research method used in the thesis will be taken into use in the continuous development of the project model. Since an action research gives proficient empirical tools for studying and refining predicaments under a loop.

## **1.3 The broader relevance**

The economic recession is in no doubt the driving force. Being rather systematic in various features of the project activities and the constant development and a better customer experience is of utmost importance to the companies these days.



The Earned value has been used and studied for decades but the Earned schedule is just a decade old method that still has dimensions and sections that can be analyzed and assessed further more. One incentive of this thesis is to evaluate the earned schedule and comprehend whether this thesis contributes, even just in a small way, in fields of an earned schedule. The particular driving momentum of this thesis is to analyze the earned schedule and weigh its contribution, even so in a small manner, in the area of an earned schedule.

The overall relevance and primary incentive is to find clear management tools and practices for the project management that facilitates project management activities and tasks that can assist the project manager to be in charge in projects. A deeper view of the current status gives more time for the project manager to take corrective actions, when the project needs them.

Essentially and minimally this thesis will be a source of knowledge insight for the earned value and the earned schedule methods in the project work. By means of references the reader is able to develop his or her perspective and understanding of the intentional subjects of the thesis.

#### **1.4 The research questions**

The research is focused on learning:

-How to improve an ICT customer delivery project management performance?

-How an earned value improves the progress accuracy, the progress reporting, the cost-efficiency, and the time management in the ICT customer delivery projects?

In a wider extent the objective of the thesis is to educate, since the earned value has some familiar and recognized known flaws and the earned schedule can fix this. This thesis further focuses how an earned schedule along with an earned value can accommodate and help the project manager in the progress accuracy, the progress reporting, the cost-efficiency, and the time management in the ICT customer delivery projects.

### **1.5 Conducting the thesis**

The action research method is applied in concluding the answers to the research questions. The action research method renders tools for a researcher with hands-on study accompanied by the project managers working in a company that operate in the field of the studied industry from the viewpoint of the project management as a whole.

Extensively collected theory entrusts a good foundation to start a cycle of Action research process. The process starts with planning of desired action before laying it in motion. While actions are in motion capturing details and taking in observations are important. As a result of detailed observation it is possible to reflect findings and detect and pinpoint further predicaments to study and improve the project management tools all the more so for the company at hand.

Only one cycle of the action research process is to be applied in this thesis in order to find answers for the research questions. Improvement of the project model in the company will continue with follow up cycles either in the area of study or an area around it based on the results and finding of the thesis.

### **1.6 The structure of the thesis**

This thesis includes five main chapters. The introduction chapter followed by the literature review, the research method, the research results, and lastly concluded by the discussion chapters. All chapters have smaller sub-chapters covering more specific issues relevant to the thesis.

The literature review chapter initiates the earned value and the earned schedule concepts in a project management. Different main project management models are presented and lightly compared prior to quarrying deeper into the theory of the earned value and the earned schedule methods. The theories of these methods are further scrutinized from different perspectives.

The research method segment acquaints an action research method used in this thesis. A participatory action research method is used in empirical part of the thesis. The participatory action research method renders a fitting possibility for the

researcher to participate and partake empirically in learning the earned value and the earned schedule while functioning along with the employees of the company working with the ICT customer delivery projects.

The research findings can be found in the research results section. The examples and instances give an easy understanding to acquaint the reader with the research findings. The research presentments convey an insight as to how the earned value and earned schedule transpires into the thesis and the kind of support and assistance they present for the project management. Adequately they grant and entrust the tools onto the project manager to manage the projects accurately, efficiently and logically. Additionally the guidance is equally important for the project manager to reciprocate timely when the projects require so.

The discussion chapter involves conclusions of the research with comparability to the earlier studies. Besides the above it incrusts limitations faced during the disquisition and the generalizability of the study analysis. There is more to evaluate and interpret especially in the field of the earned schedule method. The last topic, the future research avenues grants some views and issues which need to be studied further. Moreover an evaluation and an interpretation is required especially in the field of the earned schedule method and the future research avenues that imparts viewpoints for topics that require supplementary exploration.

## **2 THE LITERATURE REVIEW**

### **2.1 A Project management**

#### **2.1.1 The general information**

Projects and a project management are now widely perceived by institutions and companies as being crucial to obtaining their strategic objectives (Turner 2007). Their adopted robust project management methods have a competitive advantage over others in the present day apace world. A competition among companies is swiftly becoming both time-based and cost based. (Lewis 2002, xi). That is why a project management is critical for every enterprise. New products and organizational

changes that strengthen and assist keeping business profitability must be able to reliably but promptly be implemented by businesses. The key to a success in these projects lies in competent and responsible project managers. The project management concepts and practices must be well understood by the IT governance and assurance professionals. (Wysocki 2007)

A project has a clearly defined scope of the tasks done in a specific set of time and a budget. It has clear starting and ending dates. A project manager is in charge of the planning, the scheduling, and the controlling of all the actions that must be taken into consideration to meet the project objectives. Changes in one variable, performance, time or scope will affect the project cost. Changes in the project scope are often a reason for a project to fail. (Lewis 2002, 2),(Fleming and Koppelman 2002, 91).

Projects deal with both negative and positive types of problems. The Main challenges for a project achieving its objectives are an over spent budget, reduced performance requirements, or delays in its schedule. Additionally a project can be cancelled prior to meeting its original target. All these, challenges are mainly caused by insufficient project planning. In order to solve a problem, the problem must be defined correctly. Otherwise the project will produce a right solution but to a wrong problem. Therefore, another way to define a project is to call it a problem scheduled for a solution. (Lewis 2002, 2).

The primary project manager is a leader who willingly makes others to do something that must be done in a project. Another role of a project manager is to be an enabler. His or her work is to help the project members get the project tasks done by securing the necessary resources for the project and by protecting them from the outside forces disrupting their work. To a large extent a project manager's timetable progresses in planning, scheduling and controlling a project work. (Lewis 2002, 4).

A good Work Breakdown Structure (WBS) is a key to identify all the tasks to be done in a project. When a project manager plans a WBS with those people that are actually doing the project work, a more profound common understanding of the project and what it is supposed to achieve will be obtained. Only properly detailed

plans will make it possible to have control over the project work. So allocate enough time to get plans well done. A project plan consists of a mission statement, a problem statement, a list of all deliverables, the milestones and the exit criteria, the needed resources, the major contributors, the control system and the risks. (Lewis 2002, 27).

After the project plan is ready and approved, a project group can start working and a project manager will monitor that a project stays on track as planned. If a deviation occurs, the project manager must take corrective actions in getting the project back on course. Sometimes corrective actions are not possible, and the project plan must be revised and approved. The new changed project plan becomes a new baseline for the project, and progress is tracked against it. A review of the project at the end of the project will produce lessons-learned information that can be applied to future projects. (Lewis 2002, 13-27).

Lessons-learned reviews at the closeout phase of the projects are important. Otherwise coming projects will easily repeat the mistakes made in previous projects. Additionally, it is good to remember that not all the lessons-learned are mistakes. Some lessons-learned can be taken advantage of in the forth coming projects. When a lessons-learned review has been conducted in a non-blame-and-punishment mode, a project manager can expect to get good and fruitful results. (Lewis 2002, 13).

Managing a project is a straightforward set of steps but it is not necessarily easy to take them since a project starts with the identification of a problem. The first step is to find a right solution for the project. It will take some brainstorming to develop a right solution option from among the alternative ones and put it into a project plan form. A project plan must answer questions such as – what must be done and by whom, how much, when, how, and so on. (Lewis 2002, 14-16).

The Implementation phase will follow the planning phase. One important task for a project manager is to monitor the progress of the project work. Without it the project manager cannot be sure if he or she will succeed or not. At the end of the implementation phase, before closing the project, there are some evaluating questions the project manager should ask: What was done well and what should be

improved? What did the project group learn during the project? The Answers to these questions and all the knowledge gathered during the project will be helpful in the future projects. (Lewis 2002, 14-16).

Even if the general principles of the project management are largely universal to all the Information Systems (IS) projects there are ways in which the different types of IS project deviate from each other. Cadle and Yeates have grouped IS projects into nine broad types (Cadle and Yeates 2008, 3):

- Software development
- Package implementation
- System enhancement
- Consultancy and business analysis assignments
- Systems migration
- Infrastructure implementation
- Outsourcing (and in-sourcing)
- Disaster recovery
- Smaller information systems projects.

Cadle and Yeates claim that the IS projects are often one time affairs since they usually achieve some unique business objective that periodically secures some competitive advantage with some extent of innovation involved. A Challenge in an IS project is to keep it within the budget and in schedule. Even though the IS projects use similar components of familiar standards and methods to those used, the established programming languages or a proven hardware or their combinations, those components are often used in a unique way. (Cadle and Yeates 2008, 139)

Estimating the project progress is often difficult especially in the IS projects. Original estimates have often been too optimistic causing many projects to exceed their original schedule or the budget. A project manager must base his or her estimates around the identified known components rather than the innovative ones. To achieve a degree of specialization in an IS estimation a project manager should be active in gathering metrics on his or her project. A project manager must remember that firm estimates are offered only on the basis of firm specifications. The data

gathered will help in improving the project progress estimation accuracy. (Cadle and Yeates 2008, 139-141).

There are several methods for estimation. All of them are prone to some level of error and have some amount of subjectivity on the estimation of the size and complexity of the tasks ahead. A “right” result is practically unachievable.

Estimations will help a project manager to make important decisions on how to proceed with emerged issues of a project and give an understanding of the scope and scale of the project. (Cadle and Yeates 2008, 141).

Making estimations is actually the easier part of project management. The actual running of the project on a daily bases, monitoring project’s progress and steering project towards its final objectives with necessary changes are much more difficult. (Cadle and Yeates 2008, 191).

Project management is a complex practice. It usually involves the task planning and the scheduling, the project scoping, the budgeting and the cost control, the resource planning and the personnel management, the change management, the risk and an uncertainty management, and at the end the project closeout. It needs skills in maintaining the quality, the avoiding of project scope creep, and the managing of wide-ranging and sensitive communication with the diverse stakeholders in a number of sites. (Levine 2003)

Project management is becoming as part of the business practices for firms, globally. A proof of this is shown by the growth of membership in project management associations, such as the Project Management Institute (PMI) or International Project Management Association (IPMA) as well as vast amount of capital being invested in projects. The project management associations have created bodies or knowledge to guide the project specialists. A categorized knowledge and a view of the project management tools and the techniques are rationalistically presented in the guides. They supply precise standards on the practices in the areas of the time, the scope, the cost, the quality, the risk, the human resources, the procurement, the communications, and the integration. (Dinsmore and Cabanis-Brewin 2006, 271-274).

### 2.1.2 International Project Management Association - IPMA

International Project Management Association, IPMA is a worldwide federation with project management associations operating in 57 countries. It actively promotes competence in a project management for the individuals, the project teams, the businesses, the organizations and the government agencies all over the world. It certifies over 16 000 project management candidates worldwide annually (PRY - Projektiyhdistys ry 2014), and by the end of 2012 there were over 170 000 IPMA certified project management professionals worldwide (IPMA 2014).

IPMA is working with increasing the recognition and effectiveness of the project management profession in areas of (IPMA 2014):

- Certifying the project managers in a vast range of specific roles in a project management,
- As a key precondition to initiative success, seeking to highlight, improve and increase the competences of all project and the program stakeholders,
- Recognizing and Awarding a project excellence of project teams, the research projects, and the individuals,
- The assessing and certifying the PM experience of the entire organizations,
- Supporting both the basic and the advanced PM education and learning,
- The acknowledging and the further developing the project management skills of young professionals, and
- Offering special and practical project management publications.

IPMA, instead of defining its own methods for project management, it focuses mainly on testing the project management professionals and certifying those professionals with enough skills for one of four IPMA's project management certification program levels (Järveläinen 2014). A project manager can prove his or her project management skills with the certification, and the companies and the organizations with certified project managers will have a competitive edge over other companies or organizations, because a customer will have more assurance of quality of the project management services and skills when working with a certified project manager (PRY - Projektiyhdistys ry 2014).



Table 1. Four levels of IPMA certification system (PMDAN 2012)

Title	Capabilities	Certification Process			Validity
		Stage 1	Stage2	Stage3	
Certified Projects Director (IPMA Level A)	Competence =Knowledge, Experience	Application, Curriculum vitalie, project list, references, self-assessment	Projects director Report	Interview	5 years
Certified Senior Project Manager (IPMA Level B)	Competence =Knowledge, Experience	Application, Curriculum vitalie, project list, references, self-assessment	Project report		
Certified Project Manager (IPMA Level C)	Competence =Knowledge, Experience	Application, Curriculum vitalie, project list, references, self-assessment	Written exam, Options: Workshop, short project report		
Certified Project Management Associate (IPMA Level D)	Knowledge	Application, Curriculum vitalie, self-assessment	Written exam		Not limited Option: 10 years

The IPMA certification program has four levels (See Table 1). The certification programs are world leading and professionally demanding. The four levels of IPMA certification programs are IPMA Level A® (Certified Projects Director), IPMA Level B® (Certified Senior Project Manager), IPMA Level C® (Certified Project Manager), and IPMA Level D® (Certified Project Management Associate). From these four levels, top three certification levels are notable, as the demand from the executives, the strategic leaders, the managers and the stakeholders for individuals with the demonstrated Project, the Program and the Portfolio Management know-how spreads worldwide. 65percent of certified individuals are IPMA Level D® project management professionals. (IPMA 2014)

IPMA level D certified project management associate has the knowledge in all required competence elements and can apply it in project management. Level C certified project manager has skills to manage projects with limited complexity and/or to assist Level B project manager in a complex project in all expertise aspects of project management. Level B certified senior project manager has proven skills to

be able to manage the complex projects and level A certified projects director to be able to manage the complex portfolios or the programs. (PMDAN 2012)

IPMA's classification system is similar to the exam-oriented, knowledge-based certifications of other major Project Management associations. Emphasis in the IPMA approach of certification is to demonstrate candidate's personal ability to understand the basic of project management in an adequate level. (IPMA 2014)

### 2.1.3 Project Management Institute - PMI

The Project Management Institute (PMI) has compiled a minimum body of knowledge sufficient for a project management demand (See Figure 1). It comprises nine general areas of knowledge in a guide called "A Guide to the Project Management Body of Knowledge" PMBOK Guide. (Project Management Institute 2001).

1. Proper project planning, the execution and the controlling have been ensured in Project integration management (Project Management Institute 2001, 49).
2. Project scope management defines the boundaries of the project. It subdivided the work into manageable components with deliverables, and verifies that scope planned has been achieved. Additionally it implements scope change control procedures. (Project Management Institute 2001, 64)
3. Project time management amounts to developing a realistic schedule for a project, and ensuring that the schedule will be met by controlling work tools (Project Management Institute 2001, 81).
4. Project cost management contains estimating the cost of resources and after cost are tracked and budgeted, keeping them within a budget of a project. Cost of resources consists of people, equipment, materials, and items such as travel and other support detail costs. (Project Management Institute 2001, 93)
5. Both the quality assurance and the quality control are included in the Project quality management (Project Management Institute 2001, 105).
6. The people needed to do the job are identified in the project human resource management. It also defines their roles, the responsibilities, and reporting

relationships. After those people have been acquired for a project, managing them during life cycle of a project. (Project Management Institute 2001, 116)

7. A project communications management consists of the processes required to manage project information. Processes ensure timely and appropriate generation, the collection, the dissemination, the storage, and the ultimate disposition of the project information. The project communications management renders crucial connections among people, ideas, and information that are necessary for success of a project. (Project Management Institute 2001, 116)
8. A project risk management is the systematic process of identifying, analyzing, and responding to both the positive and negative project risks. The negative risks will be mitigated and the positive ones exploited if possible. (Project Management Institute 2001, 146)
9. Project procurement management pertains to determining what must be procured, issuing requests for offers, selecting vendors, administering contracts, and closing them when the project work has been accomplished (Project Management Institute 2001, 159).

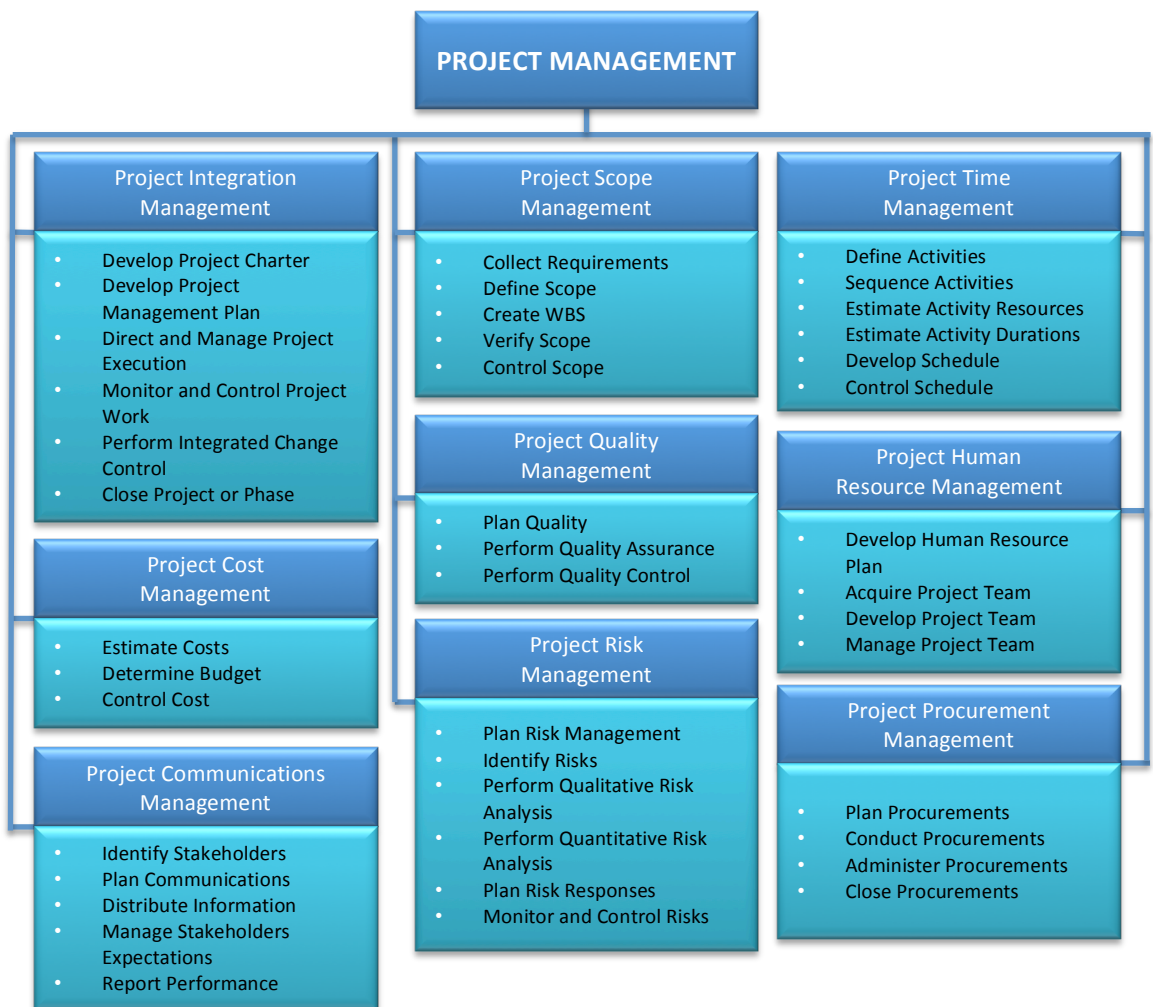


Figure 1. PMI's Body of Knowledge Structure (Association of Modern Technologies Professionals 2014, Project Management Institute 2001)

Like IPMA, PMI has several certifications matching various qualifications of certification candidate. Additional to the basic project management certifications (CAPM, PMP, PgMP, and PfMP), which more or less are matching, with IPMA certifications PMI has some specialized choices of certifications (PMI-ACP, PMI-RMP, PMI-SP, and OPM3 Professional). The knowledge and experience, as well as the future career plans are good to keep in mind when choosing right certification to obtain. (Project Management Institute PMI 2014)

PMI's Certified Associate in Project Management (CAPM) is close to IPMA-D level. It is a good entry-level certification for a new project manager or a project manager still figuring out his or her career path. (Project Management Institute PMI 2014)

PMI's the most important worldwide-recognized credential for a project manager is Project Management Professional (PMP). By PMP certification a project manager has proven his or her experience and competence in leading project teams. (Project Management Institute PMI 2014). PMP certification goes between IPMA C and B certification levels being closer to IPMA C.

PMI's Program Management Professional (PgMP) certification is close to IPMA B certification but having some elements of IPMA A. It has been intended for those who manage multiple, complex projects to achieve strategic and organizational results. (Project Management Institute PMI 2014)

The Portfolio Management Professional (PfMP) is similar level certification as IPMA A. It recognizes the advanced experience and skill of the portfolio managers and endorses proven ability in the coordinated management in the portfolios to achieve the managerial objectives. (Project Management Institute PMI 2014)

Additionally PMI has four specialized certification choices for practitioners with specific interests. One of them is for practitioners utilizing agile approaches to a project management. Certification for them is called PMI Agile Certified Practitioner (PMI-ACP). (Project Management Institute PMI 2014)

Practitioners specialized in the risk management of projects can aim for PMI Risk Management Professional (PMI-RMP) certification. It evaluates qualifications in assessing the project risks, the mitigating of threats and exploiting of opportunities. (Project Management Institute PMI 2014)

Practitioner focusing on the developing and the maintaining project schedules can accomplish the PMI Scheduling Professional (PMI-SP) certification (Project Management Institute PMI 2014).

The OPM3 Professional Certification will be the right choice for those certification candidates who are interested in practical knowledge of the project management, the organization project management and the project management maturity (Project Management Institute PMI 2014). Figure 2 explains more about actual certification procedure.

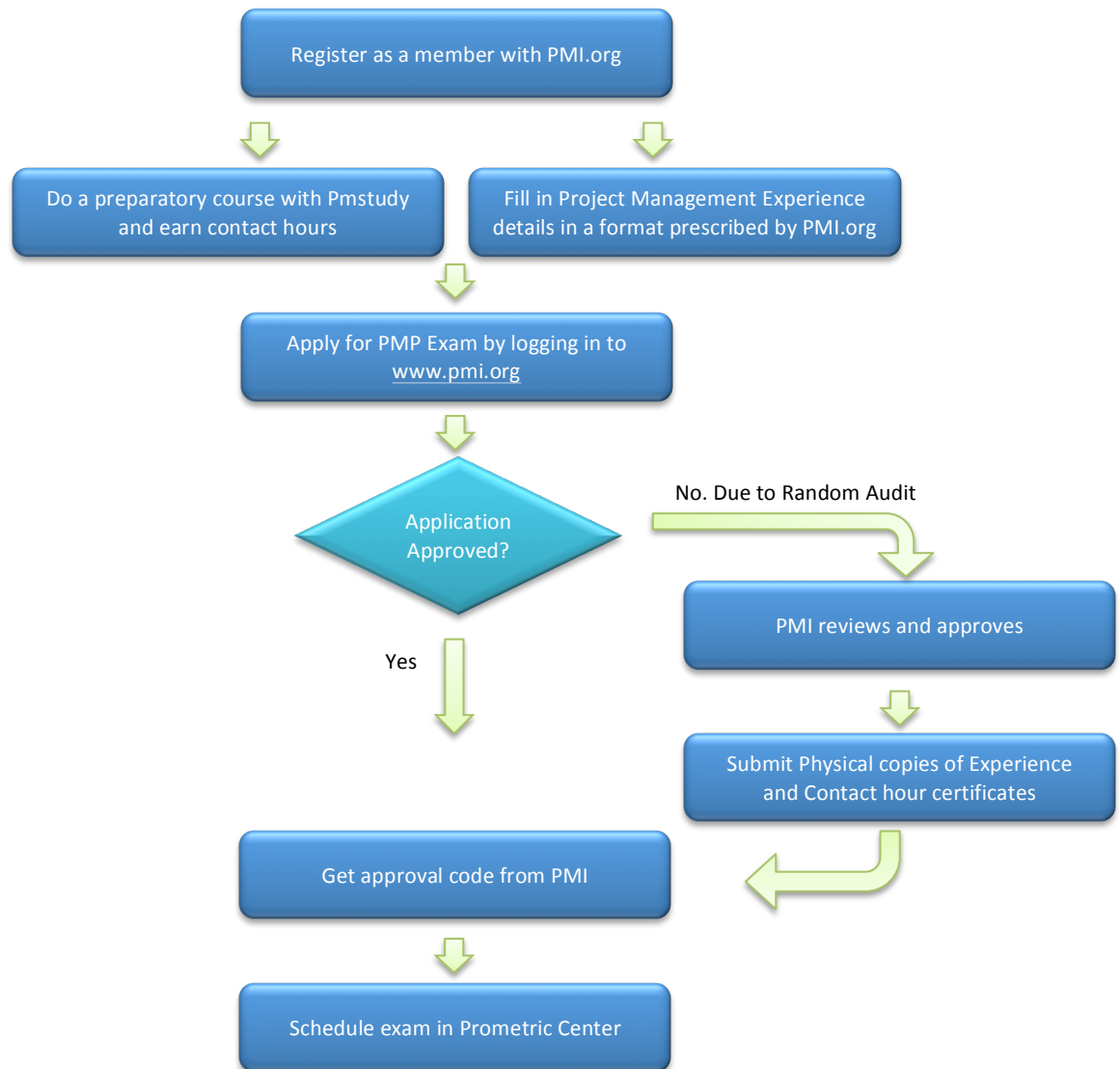


Figure 2. The overview of a standard PMP Exam Application Procedure (PMstudy 2014)

#### 2.1.1.4 PRINCE2

The name for the PRINCE2 project model comes from letters in words **P**ROjects **I**N **C**ontrolled **E**nvironments, version **2** (Axelos 2014).

PRINCE was originally based on PROMPT. PROMPT is a project management method created by Simpact Systems Ltd in 1975. The UK Central Computer and Telecommunications Agency (CCTA) adopted it in 1979. PRINCE became a standard to be used for all the Government information system projects. (ILX Group 2013)

The first version of PRINCE was released in 1989. It was renamed PRINCE2 after the revision in 1996. The revision was aimed to make it applicable to all types of projects (Siegelaub). Nowadays especially the public sector is using PRINCE2 method in the UK. The method is broadly recognized and used also in the private sector, both in the UK and rest of the world. It has become a de facto standard in a project management. (Van Haren Publishing 2012)

The research made in Queensland University of Technology shows that Prince2 gives good tools for the project managers to ensure their projects to be delivered in good quality on time and on budget. (Queensland University of Technology 2010)

Pekka Järveläinen, was a trainer at the Price2 foundation training course in Feb 2014. He marked, that developing this project model originally started when Margaret Thatcher got fed up of poorly managed and functioned governmental IT projects in the UK and ordered the problem to be solved by developing a better project model. (Järveläinen 2014)

Currently, a new company, Axelos, owns PRINCE2 and other Best Practice products. Axelos is a Joint Venture between HM Government and the UK business outsourcing organization, Capita plc. (Axelos 2014). Capita plc owns a 51 percentage share of the new company and the government of the UK kept 49 percentages of the shares to secure taxpayers benefit as the business grows (MP 2013). The main purpose of Axelos is to support and promote the international expansion of the Best Management Practice portfolio, including the ITIL® and PRINCE2® professional standards (Axelos 2014).

PRINCE2 is a structured project management methodology. It depends on processes. (Siegelaub). The current 2009 Edition of PRINCE2 model consists of 7 principles, 7 Themes, and 7 processes and 26 product descriptions (Hedeman and Seegers 2012). A project that follows PRINCE2 model comprises these principles, themes, and processes in its project management. (Järveläinen 2014). Unless all of the principles are being applied in a project, it cannot be called a PRINCE2 project (Siegelaub).

The principles of PRINCE2's latest revision (2009) are called Business Justification, Roles and Responsibilities, Manage by Stages, Management by Exception, Product Focused, Learn from Experience, and Tailored to fit (Hedeman and Seegers 2012) p19. (Siegelaub) One key element of PRINCE2 is scalability. Processes and Themes must be tailored to fit the size and essence of the project, and the uniqueness of the organization in which it functions. (Siegelaub) (Järveläinen 2014)

The exception plan is an innovative PRINCE2® concept. An Exception arises when a project is going to exceed its tolerances in time, cost, quality or product constraints. When an exception occurs the project manager must report it to the project board. The project manager will place together an updated project plan called an exception plan and present it to the project board. The exception plan will show how the stage, or even the entire project, will be concluded in the changed environment. The project board will make a decision on how to proceed with the occurred exception. The exception plan will replace the current project plan after the project board agrees with the proposed actions for the occurred exception. Or then, the project manager must come up with another version of exception plan. (Cadle and Yeates 2008, 180)

Business Justification must be kept alive throughout the entire project life (See Figure 3). In other words, a project must be ended when business justification cannot be met anymore in a project. PRINCE2 project has clear roles and responsibilities. It uses experience learned from the previous projects and the knowledge learned during the project, which will be stored for a future project use. (Hedeman and Seegers 2012)



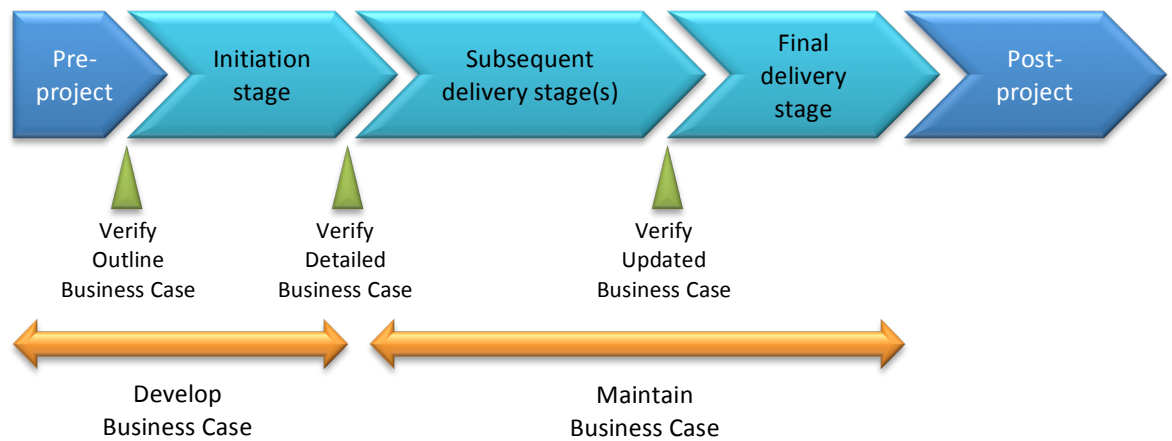


Figure 3. A feasible Business Case in project's full life cycle (Hedeman and Seegers 2012)

The Business Case, the organization, the quality, the plans, the risks, the change, and progress are themes of PRINCE2 model. A project has a business justification only if the business case of the project is feasible and agreeable. The roles and responsibilities in a temporary project organization are described in an Organization theme. The Quality criteria and how the quality will be ensured in a project will be the meaning of the Quality theme. The steps needed to design plans and suggestions of planning techniques are described in the Plans theme. The Risk theme will explain how to manage the uncertainties. The Change theme accommodates the project issues for changes in the project like the project scope. A Progress theme helps a project manager to keep plans feasible. (Hedeman and Seegers 2012, 23-24)

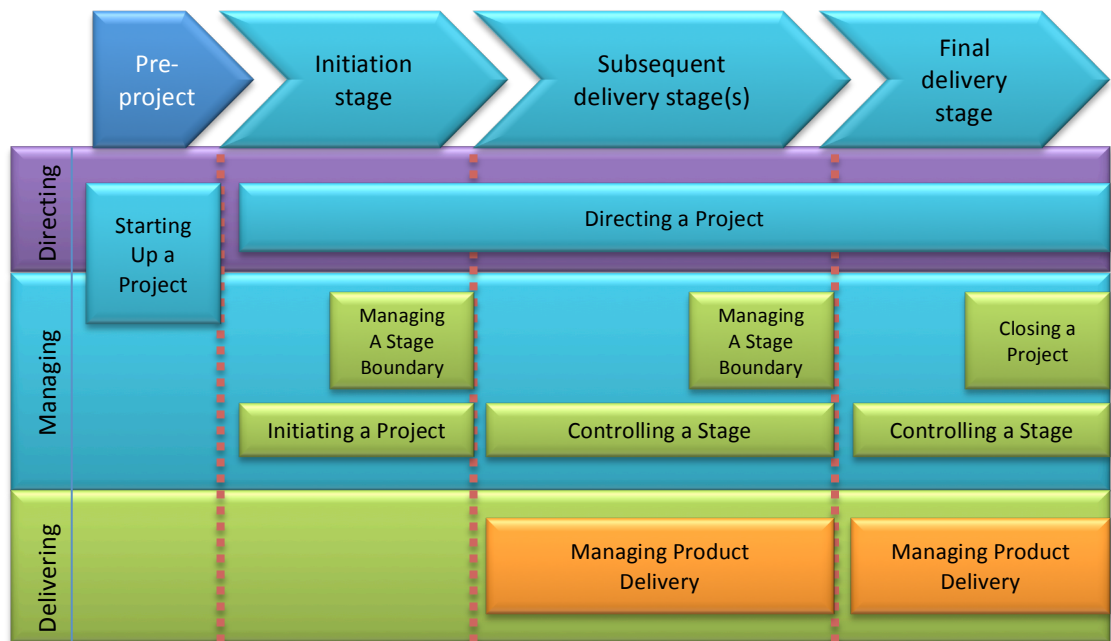


Figure 4. PRINCE2 Process Overview (Van Haren Publishing 2012)

Prince 2 processes (Turkey 2010) (Hedeman and Seegers 2012):

- Directing a Project (DP) is a Management Board's process.
- Start Up a Project (SU) is a process with an aim to give good start for a project. Project mandate ignites SU process.
- Project Board gives authorization to start Initiating a Project (IP) process. IP evaluates the justification of the project and produces the Project Initiation documents (PID). The Project Plan is one of the documents of IP.
- Controlling a Stage (CS) process explains the Project Manager's day-to-day monitoring and control activities. This is a main process for the project managers. They will spend most of their working hours with this process. When the project manager feels that the stage is about to reach its end he or she will ignite the SB process (Järveläinen 2014).
- Managing a Stage Boundary (SB) process will be carried out after each CS except the last CS, where Closing a Project (CP) process will be executed. SB depicts a controlled way to complete a stage and plan the next one.
- Managing Product Delivery (MP) process is where the actual project products will be put together. A project manager will send tasks for the Team Manager

in a form of work packages. After accepting them his or her team will execute and deliver them. Both the traditional and the agile methods can be used in MP process to execute and deliver work packages (Järveläinen 2014).

- Closing a Project (CP) process approves delivery of the products and the project Manager prepares the project for finishing it. The Project Board can start this process in case of occurred exception preventing the project to continue. In any other case exception will cause premature ignition of SB process. (Järveläinen 2014)

Besides the magnitude of the project documentation, another area where tailoring can be exercised is project organization (See Figure 5). The Executive and the Project Manager will make up the minimum project organization. The Senior User and the Senior Supplier participants are included in a project board on average. (Järveläinen 2014).

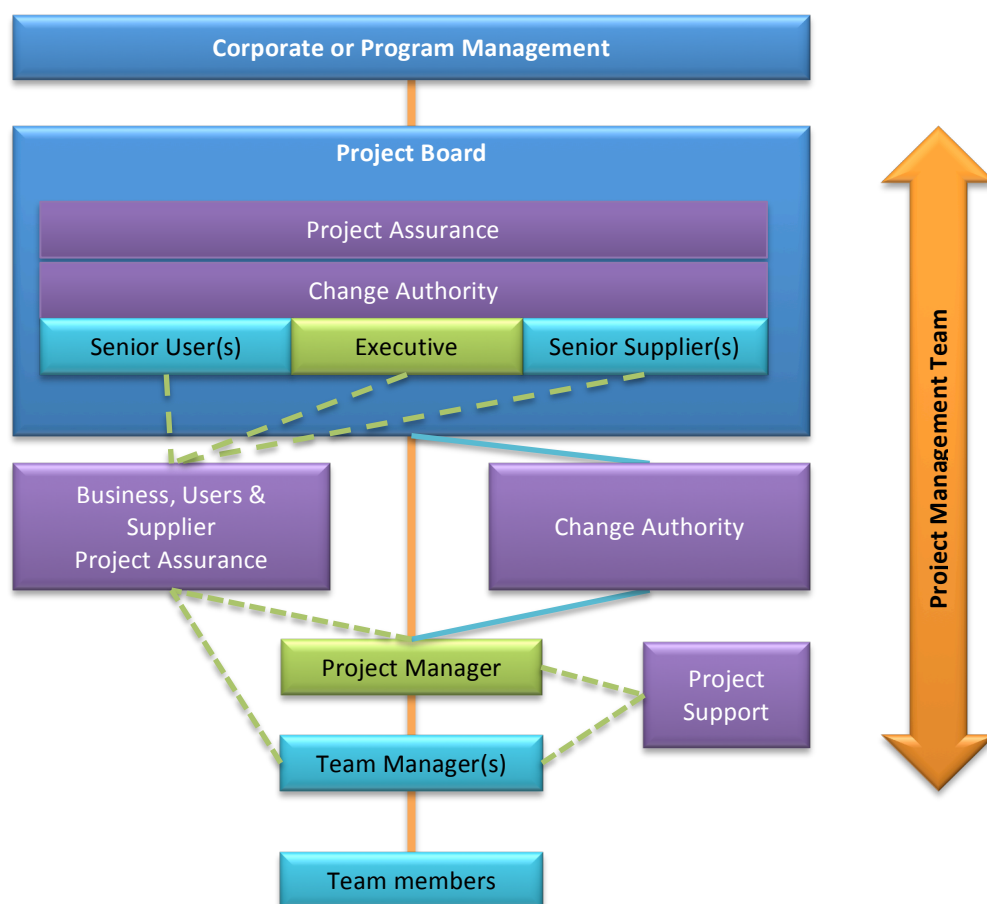


Figure 5. All the roles in PRINCE2 project organization (Scoll Methods 2009) (Hedeman and Seegers 2012)

### 2.1.5 PRINCE2 vs. PMBOK

Max Wideman has compared PRINCE2 with PMBOK of PMI. Both the methods produce processes for a project management. They formulate tools and techniques that can be used in the project. Tailoring is a way to make it suitable for different type and size of projects in both methods. Processes of PRINCE2 will make clear life cycle for a project. The project manager manages the project on everyday basis with tolerances defined at the introduction stage of PRINCE2 method. The issues past these limits will be resolved in a project board. By default PRINCE2 is prone to be heavy on documentation, but with right level of tailored documentation will match the project conditions. Instead of describing the management jobs PRINCE2 defines roles that may be allocated, combined, divided or shared matching the project requirements. PRINCE2 has product-based planning and focuses on the products to be delivered and the quality on products under delivery. (Wideman 2002).

PRINCE2 differs from other project management qualifications - PMI (US Project Management Institute ([www.pmi.org](http://www.pmi.org)), APM (UK Association of Project Management - [www.apm.org.uk](http://www.apm.org.uk)) and IPMA (International Project Management Association - [www.ipma.ch](http://www.ipma.ch)). Unlike other qualifications, PRINCE2 method does not deal with the softer skills involved in being a project manager. It offers only a structured framework that can be tailored and scaled to match requirements of a project. The technical structure of the framework for the project of PRINCE2 is compatible with all the other project management qualifications. The softer skills learnt on other qualifications will endorse PRINCE2 method. (Axelos 2014). PRINCE2's true power lies in its common-sense approach (Siegelau).

Even if PRINCE2 is based on the same basis as the PMBOK® GUIDE, it highlights a number of areas to concretize PMBOK® GUIDE, and answers the question "how do I apply these concepts in my projects in a practical manner?" The main focus in PRINCE2 is on the critical areas. That is why a project manager may need some knowledge from the PMBOK GUIDE and other sources to complete some areas of the project management work that is not covered in PRINCE2 in the required level. (Siegelau)

The traditional project restraints that define the performance objectives of a project (identified in the PMBoK® GUIDE as time, cost, scope and quality) have been broadened in PRINCE2 to acknowledge another two factors of benefits (delivered value) and risk (the limit of the project’s risk coverage; also recognized in the PMBoK GUIDE® as “risk tolerance”). In PRINCE2 project management method all six of these, as the factors, that shape the project plan are identified (See Table 2). The variances of these factors must be monitored. A project’s progress is determined via them. They are used to determine if the project is being delivered to meet Acceptance Criteria and has it stayed under its limits of the authority set by the commissioning body or PRINCE2’s Project Board. (Siegelaub)

One of the most important features of PRINCE2 is the Project Board concept. PRINCE2 is more specific in describing features of the steering group in the projects than PMI in its PMBOK® GUIDE. Where PMBOK mentions a ‘project sponsor’ in general terms, PRINCE2 is more specific. It has a clear definition for a Project Board to provide oversight and support in a project following PRINCE2’s project management philosophy. (Siegelaub)

Table 2. The comparison of PMBOK® GUIDE Areas of Knowledge and PRINCE2 Themes (Siegelaub)

PMBOK GUIDE Knowledge Area	Comparable PRINCE2 Themes
Integration	Combined Processes and Themes, Change
Scope, Time, Cost	Plans, Business Case, Progress
Quality	Quality, Change (Configuration Management)
Risk	Risk
Communications	Progress
Human Resources	Organization (limited)
Procurement	Not Covered

The product breakdown structure of PRINCE2's Product Based Planning approach is equivalent to the PMBOK® GUIDE's Work Breakdown Structure. They both identify the fundamental components of the project deliverables. For the reason that, in PRINCE2 project goal is in deliverables instead of project activities, it continues the logic of focusing on deliverables further than PMBOK. The Product Descriptions of PRINCE2 model depicts deliverables in detail. The rigor of PRINCE2's Product Descriptions strongly reinforces the PMBOK GUIDE's manner of an approach. PRINCE2's Product Descriptions has more extensive definition of the work to be done than the PMBOK GUIDE. It provides mechanisms for ensuring expectations on all levels to be met in completed work. (Siegelaub)

PRINCE2 certification comes with more hands on knowledge in a project management than PMP. The project managers, following their PMP certification, often ask: "Where do I actually start? How do I put all of this together to actually run a project?" The project manager who have additionally completed PRINCE2 certification have answers to those questions, because with PRINCE2 methodology a project manager can shape and direct that knowledge. Due to integrated structure of PRINCE2, a project manager will get most out of it when implementing it entirely in his or her project work. Even if PRINCE2 is at its best when followed fully, there are elements in PRINCE2 that can be used independently and applied directly in any project environment. Deviation from a PMP or PMBOK® GUIDE environment is not required in neither of these approaches. (Siegelaub)

#### 2.1.6 The Agile methods

The Scrum will be used as an example for the agile methods in this thesis. Ken Schwaber and Jeff Sutherland have developed the Scrum and are maintaining the Scrum. According to them the Scrum is a project management method, which, is lightweight and simple to understand but extremely difficult to master. Due to the process framework it can be used to manage the complex product development projects. The guide for the Scrum is also pretty lightweight since it is only 16 A4 pages long PDF that can be downloaded from the Scrum's homepage for free. The framework has been available from the beginning of 1990s. (Schwaber and Sutherland 2013, 3)

The Scrum framework comprehends the Scrum Teams and their associated roles, the events, the artifacts, and the rules. The rules of Scrum combine simultaneously the events, the roles, and the artifacts, governing the relationships and interaction between them. The Scrum presents three pillars – a transparency, an inspection, and an adaptation - that sustain every implementation of empirical process control. (Schwaber and Sutherland 2013, 3-4)

The Scrum Team includes a Product Owner, the Development Team, and a Scrum Master. Scrum Teams are cross-functional and self-organizing. The self-organizing teams choose themselves how best to achieve their work, rather than being managed by others outside the team. Cross-functional teams have skills needed to allocate into the work without having to rely on outsiders. The team model in Scrum is designed to optimize productivity, creativity, and flexibility. (Schwaber and Sutherland 2013, 5).

Regularity in the Scrum has been created with prescribed events. It also minimizes the need for meetings not defined in the Scrum. The time-boxed events are used in The Scrum. Using the time-boxed events, every event has a maximum possible fixed duration. An appropriate amount of time is ensured for the planning and no waste of time is allowed for the planning process (Schwaber and Sutherland 2013, 7).

A sprint is the very soul of Scrum. It is a time-box of one month or less long event. During a sprint, a “Done”, useable, and potentially releasable product increment will be produced. The Sprints have coherent durations at full length of a development effort. A new Sprint starts promptly after the completion of the previous one. A Sprint includes following events; the Sprint Planning Meeting, the 15-minute time-boxed Daily Scrums, the development work, the Sprint Review, and the Sprint Retrospective. (Schwaber and Sutherland 2013, 8)

No changes that would affect the sprint’s goal are allowed during the sprint. The Quality goals cannot be lowered and the Development team must remain the same, but because, more is learned during a project, it is possible that the project scope can be further accurately defined and re-negotiated between the development team and the product owner. (Schwaber and Sutherland 2013, 8).

It is possible to get a sprint cancelled prior to its time-box is over. The product owner is the only one that has authority to do so, but he or she can do so only after feedback from the stakeholders, the Development Team, or the Scrum Master. (Schwaber and Sutherland 2013, 8)

The agile methods are good especially in projects where it is quite hard for the users to express their wishes clearly including the business analyst wishes precisely. This is common especially in software development projects. Even if all the parties work hard with the issue, there will be areas where the customer and the supplier have distinct view about the matter and have different ideas on specifications and what is to be done. A scrum manager with a well-developed interpersonal and stakeholder-management skills will negotiate and revisit specification with the customer and will find common understanding during sprints of the agile Scrum project. (Cadle and Yeates 2008, 4)

Traditional project management tools like the Microsoft Project (MS Project) are not flexible enough for agile methods. Tools like Jira or Polarion are more suitable for managing agile projects. (Järveläinen 2014).

## **2.2 The Earned value in project management**

### 2.2.1 The development of the earned value in project management

A Project manager must know at all times where the project is proceeding. If his or her and project group's thoroughness in reporting the progress is limited to "I think we're approximately on target," it will be too late to react to any problems during the project. The project manager and the whole project group must put special effort to measure the work performance. The most valuable information for a project manager is to know how much project work has been done. (Davidson Frame 2002, 290-291)

The Earned value concept is a useful technique for a project manager to keep a better track of how the project is proceeding. It can be used in any kinds of projects. It is an efficient utility that supports the management of the project scope, the time, and the cost. It makes possible cost and schedule variance calculations as well as



forecasting the project cost and schedule at closure. The Earned value concept gives early signs of the anticipated project results based on a project performance and will bring to light the possible need for corrective action. It will give the project manager and a project team time to react and correct the project strategy as well as to make the necessary trade-offs on the grounds of actual project performance, the project objectives, and the environment project is being operated in. (Anbari 2003, 12)

A requirement of an earned value to be functional is a fully defined project at the outset with a bottom-up plan created. It makes performance measurement possible during the total project's lifecycle. An Earned value tool starts providing accurate and reliable performance readings from 15 percentage onwards of a project completion. (Fleming and Koppelman 1998)

Earned value management is not an industry dependent technique. It can be applied if not fully but at least partly to all capital projects in any industry. Containing the cost risks associated with the project is the basic utility of the earned value. Because the projects already have much of the basic earned value data available, it is easy to implement earned value management into those projects. (Fleming and Koppelman 2002, 91)

A Usable earned value tool is the cost performance efficiency rate. It has been found to be useably stable from the 15 percentage point of a project completion. Stability gets increasingly better from the 20 percentage to 40 percentage completion points. That is why it is the single most important metric of earned value for a project manager or an executive to monitor. (Fleming and Koppelman 1998)

The cost performance efficiency rate of a project represents the relationship between the costs incurred and the earned value performed. This relationship must be periodically measured. The cost-efficiency factor is provided from the difference between the value of work performed and the costs incurred. (Fleming and Koppelman 1998, 22)

The final costs requirements based on the project's performance against the plan must to be periodically forecasted. The earned value concept's ability to automatically forecast the total required funds at the end of a project is one the

benefits of the concept. Term of this ability is commonly called the estimate at completion (EAC). (Fleming and Koppelman, Earned Value Project Management, A Powerful Tool for Software Projects 1998, 22)

Earned value (EV), or by the original name - the budgeted cost of the work performed (BCWP), is an essential performance metric on the project's progress report. An Earned value is used in calculating the schedule and cost variances as well as estimating the final cost of the contract. The final cost of the contract estimation is called the estimate at completion (EAC). (Christensen 1999, 283)

Using the earned value metrics with a solid project baseline, the project can be accurately monitored and the cost and a schedule performance measured. (Fleming and Koppelman 2002, 93). Keeping the project on the right track requires continuous monitoring and measuring. (Fleming and Koppelman 1998, 22)

The efficiency of any project rated against all the other projects in the organization can be compared with the efficiency factors converted from an earned value metric data. The Earned value data can also be used successfully in managing a portfolio of the projects. (Fleming and Koppelman 2002, 93)

The earned value schedule position can be determined after measuring the earned value and subtracting the planned value for the period. The critical path methodology can be successfully used with the earned value schedule position. The tasks being late are important, if they are on or near the critical path. Late tasks with plenty of slack or float and with the low risk are just interesting because they simply indicate that the project is running late for its original plan. (Fleming and Koppelman 2002, 93)

Measurement will occur at fixed intervals—at least monthly, but usually in weekly intervals. The project's planned value, the earned value, and the actual costs obtained can be assessed at any given point in time. The true health of a project will be reflected via the wealth of data these three dimensions provide. Besides the three dimensions, the original budget authorized to perform the completed work, and the authorized work that has been completed, are additional two elements of earned value. (Fleming and Koppelman 2002, 93)

The earned value concept was originally developed in the United States in the 1960. It was developed to help government program managers and contractors to track the progress of complex and large projects. First it was implemented in very large defense projects by the U.S. Air force. The U.S. military played a major role in the early development of the earned value. Originally this approach was only used in projects with a scope of \$100 million or beyond. Later, it was discovered that the earned value concept is as useful in small project as it has been with large ones. That discovery has made its popularity to grow rapidly. With the earned value approach, a project manager can get the valuable understanding of the project progress even in small-scale projects. (Davidson Frame 2002, 288-289)

There are two key limitations to using the earned value approach. The availability of accurate and timely cost data is one of two key limitations and the other limitation is purely educational. Organizations have not set up proper systems for collecting that kind of data or people working with the project management do not fully understand its mechanisms. Additionally much of the impact of the earned value approach is lost if the top management does not have enough understanding of the earned value approach in project performance. (Davidson Frame 2002, 288-289)

It is a challenging task for many organizations to determine the completion percentage of an activity, work package or project. It is even more challenging in a new, an emerging or the softer technology projects such as the software development, the telecommunications, the research and development, and an architectural or an engineering design. (Anbari 2003, 21)

Typical categorizations of work efforts at the beginning of a project are categorizing them either into near-term or far-term efforts. Of the project work only the near-term effort will be planned in detail by dividing near-term effort into manageable pieces called work packages. Far-term work is called planning packages. Planning packages will be divided into work packages and planned in detail as the project goes forward. (Christensen 1999, 285)

A continuous analysis is required for a baseline of a project because proposed changes in a project have impact on the baseline. All new proposed changes for

project work must be analyzed and based on analysis either approved or rejected by management board or steering group of the project. The performance measurement baseline of a project placed at the beginning of the project is only as good as all proposed changes to the baselines that have been managed during the lifespan of a project. (Fleming and Koppelman 1998, 21-22)

The decisions in project management are mainly concerns about how they are affecting the future. The earned value management (EVM) method is at any given point of the project an effective tool in forecasting the time and cost of the project at its completion (Anbari 2003, 5). Both the current project statuses and performances can be assessed and the future projects performances can be predicted and forecasted by using a variance and the performance indices from the values provided by The EVM method. (Cable, et al. 2004, 3)

Due to the complexity of collecting work performed data in really complex and vast projects, companies are hiring cost account managers (CAMs) for being responsible of gathering the required data. In smaller projects CAMs are not cost-effective way to track work performance of a project. There are ways to track work performance without causing major administrative costs. A simple 50-50 or 0-100 task-by-task rule can be applied for a project when beginning and ending of each task has been tracked. Additionally a smart usage of milestones can ease the measurement of the work performance. (Davidson Frame 2002, 286-287).

The 50-50 rule is pretty easy to use. Half of the task's value has been earned when the task starts and full value has been earned after actual completion of the task (Anbari 2003, 21) (Davidson Frame 2002, 277-279). Even in projects with large number of tasks the distortion from the 50-50 rule will be minimal. The tasks are just in varied stages of completion. (Anbari 2003, 21)

The 0-100 rule is another way to measure the work performance. In this rule it is assumed that nothing has been accomplished at the beginning of a task. Full 100 percentage value will be given for the task after it has been completed (Davidson Frame 2002, 279). The 0-100 rule is often used in the work packages with short durations (Anbari 2003, 21).

For the reason the value is earned only when a task is physically completed the 0-100 rule can be also called the weighted milestone method. The tasks can be understood as milestones. Each performance-reporting period contains one or more milestones. (Anbari 2003, 21)

The 0-100 rule can be used with an external contractor for paying contractors efforts towards the project. This guides the contractor to plan its own project work into a very detailed work breakdown structure (WBS) to ensure authorization for regular payments of the completed task(s) during the each performance-reporting period. (Anbari 2003, 21)

In some moments costs will exceed benefits of the earned value management process and because of this reason both costs and benefits of the earned value have to be evaluated. EVM criteria come to the picture in evaluating the costs and benefits of the earned value. Quality for a management control systems using the earned value is achieved via EVM criteria. (Christensen 1998, 373)

The budgeted cost is used for measuring value of the task. The earned value approach gives tools for estimating a progress of the project tasks. Furthermore consumption ("burn rate") of the project's funds and its impact to a performance of the project can be calculated. The earned value estimations can be executed at any level of WBS. (Davidson Frame 2002)

### 2.2.2 Closer look to Earned value technique

For the earned value to be a useful technique in a management of any project it requires the project first to be fully defined and then a bottom-up plan created. After those requirements have been met the performance measurements can be organized during the entire lifecycle of the project. (Anbari 2003, 21)

Planning, Organization, Analysis, Accounting, and Reporting are five areas in a development of consistency and management discipline in which the earned value system focuses on. (Davidson Frame 2002, 289-290)

Planned value, Earned value and Actual Costs are three dimension of the earned value. An authorized work and authorized budget within the authorized time frame

are building parts of the planned value. An authorized work and authorized budget within an authorized time frame will form the project baseline. The authorized work completed plus the original budget for the work equals the earned value. (Fleming and Koppelman 2002, 91)

Full advantage of the earned value approach can be used if the actual cost data is accurate and timely collected. Accurate measures of the work performed, the section of effort achieved, and the burn rate for the spending project funds can be done with an earned value system if the data has been maintained well. It is possible to do calculation of the EAC with the earned value system forecasting capabilities. The earned value approach is not just an overview of the project. The budget and schedule analysis can be carried out at any level of the WBS. (Davidson Frame 2002, 286-288).

Most of the projects can use both the earned value and planned value dimensions, but the actual costs are sometimes like on lump sum or fixed-price projects unknown. Both the schedule and the cost performance status of a project can be monitored at whole lifecycle of the project using all three dimensions of the earned value. (Fleming and Koppelman 2002, 91).

The earned value can be calculated using computations from the past experience. Total value of work achieved during the month can be estimated by computing a weighted average of a progress of on-going and completed tasks during the month. (Davidson Frame 2002, 279-280). But it is not always easy to get accurate information about the current amount of work completed especially from the on-going tasks in different stages. This problem rises easily in IT projects facing new kinds of problems and delays making predictions of overruns likely to be inaccurate. This is why it is recommended by an earned value analysis expert to evaluate each phase or stage of a project separately. (Cadle and Yeates 2008, 203-205).

### 2.2.3 Central elements

Terminology traditionally used with the earned value analysis is one of the problems in the earned value, (Cadle and Yeates 2008, 203-205) which can make the earned

value management reports confusing. A terminology used has been cumbersome and off-putting and there are dozens of acronyms alone. (Christensen 1999, 284)

Over the time certain earned value elements and formulas have had more than one name. Originally three basic data elements of the earned value management were called a budgeted cost for work scheduled (BCWS), a budgeted cost for work performed (BCWP), and an actual cost of work performed (ACWP) (Christensen 1999, 284). BCWS and ACWP are now days called a planned value (PV) and an actual cost (AC), and BCWP as an earned value (EV). (Davidson Frame 2002, 283) (Cable, et al. 2004, 3). Almost all of the supplementary data items of the earned value management can be derived from these three elements (Christensen 1999, 284)p284.

The budgeted cost of work performed (EV) shows how much of the budget should have been spent in the given time of the project (Microsoft Corporation). According to a new refined meaning of EV, it is the value of the work actually completed during an examined timeframe (Cable, et al. 2004, 3). EV depicts budgeted amount for performing the work that has been achieved by a certain defined moment in the project. Besides measuring work completed for the task in currency the work can be also measured in working days, work hours, labor hours, or any other similar type of measurement of the cost and value associate with the project work (Anbari 2003, 13). "When the predefined, tangible criteria for the milestone are met, the balance of the value associated with the milestone is earned" (Anbari 2003, 21).

PV means the amount of planned work during a given time period (Cable, et al. 2004, 3). In other words it shows how much of the budget should have been spent by the time the project has reached to the certain status date. (Microsoft Corporation). PV is the authorized budget for executing the work package, activity, or the project related to the schedule. PV can be considered as the value to be earned accomplished in a given point of time of the project work. (Anbari 2003, 13).

Actual cost (AC) is the cumulative amount of money that has been spent to achieve a work package, an activity or a project in a given point of time, and to earn the associated value (Anbari 2003, 13). In other words AC shows the actual costs

incurred for the work already performed by a resource on a task, up to the project status date or current date. (Microsoft Corporation). AC must be analogous to the amount budgeted for the PV and the EV (Cable, et al. 2004, 3). It should be recorded in the same timeframe as EV for allowing relevant comparison for a given piece of the work. (Christensen 1999, 285)p285

Both PV and EV can be count either monthly or cumulative. Monthly value stands for the amount work planned for a month (PV) or the amount work completed during a month (EV). Cumulative value illustrates the amount of work planned (PV) or completed (EV) to the date. (Christensen 1999, 285)p285

To be able to make different analysis, scheduling, planning, risk assessment, estimating and authorization to proceed, a work breakdown structure (WBS) has to be determined. That is why the WBS is one of the most useful tools for any project manager. It is good to remember that no one is able to define tasks for a new project with definite exactness. (Fleming and Koppelman 1998, 21)

When a budget has been assigned to each work and planning package it is possible to define a time-phased budgetary baseline for the complete project. The budget for each work and planning package can be assigned in hours, euros or in other measurable units. This baseline is called the performance measurement baseline (PMB). Performance (EV) and the cost (AC) of the project are compared against the standard or plan it (PMB) represents. (Christensen 1999, 285)

Both direct and indirect costs are included in the PMB of a project. Additionally, due to included indirect cost in AC, all-important cost variances, including indirect cost variances must go through in-depth instigation by the project team. (Christensen 1999, 287)

#### 2.2.4 Variances

The schedule performance of a project must be regularly measured against its planned master project schedule. The schedule variance is the difference between the work scheduled and the work accomplished. Criticality of each task behind the planned schedule can be assessed. If the task on the project's critical path is delayed



or it can cause a high risk to the project, work towards getting the task back on schedule must be done. (Fleming and Koppelman 1998, 22)

The schedule variance (SV) and the cost variance (CV) are the most commonly used measures. A formula for the cost variance is  $CV=EV-AC$  and for the schedule variance  $SV=EV-PV$ . They will function as efficiency indicators for any project revealing their schedule and cost performances. (Cable, et al. 2004, 3) (Davidson Frame 2002, 280-283) (Anbari 2003, 14). Because the earned value measures the work performance, monetary units are used in measuring the schedule variance (Davidson Frame 2002, 281). "The schedule variance (SV) is a measure of the conformance of actual progress to the schedule." (Anbari 2003, 14)

Subtracting actual costs from planned costs has been the conventional technique of measuring the cost variance. Negative result of the variance implies money been used more than planned and positive variance result money been used less than planned (Davidson Frame 2002, 280-283). The cost variance measures how closely actual cost of the work performed follows the planned budget (Anbari 2003, 14).

A positive variance is a sign of a project being ahead of schedule or under its budget. A negative variance signals a project manager to take corrective actions because the project is over its budget or is behind its schedule. The project manager can reallocate money or resources from tasks with positive variance, increase the budget or accept reduced profit margins. (Microsoft Corporation)

The difference between the total budget of a project and the estimated total cost of a project is called the variance at completion (VAC). The term for the total budget of a project is the budget at completion (BAC) and the estimate at completion (EAC) is a term for the estimated total cost of the project. Same as a formula  $VAC = BAC - EAC$ . (Christensen 1999, 285)

VAC is an indicator that will forecast level of a cost overrun at the completion of a project or an estimated cost overrun. If VAC is around 0 the project is about to complete on budget. If VAC is over 0 the project will complete under its budget and if VAC is under 0 budget will be overran. (Anbari 2003, 18)

The total budget baseline for the activity, work package, or project is called as the Budget at completion (BAC). It is the last point on the cumulative PV curve that is also the highest value of the PV. (Anbari 2003, 13)

#### 2.2.5 Performance indices

The schedule performance index (SPI) signifies the section of a work completed, and its formula is  $SPI=EV/PV$  (Davidson Frame 2002, 284). SPI with value 1.0 or more means that the work has been started on a schedule and a value below means delayed work. (Cable, et al. 2004, 7)

The cost performance index (CPI) can be understood as a cost efficiency rate and called as the “burn rate” showing how much money has been used. The formula for the cost performance index is  $CPI=EV/AC$  (Davidson Frame 2002, 284). The cost performance index (CPI) is the most commonly used cost-efficiency measurement. The CPI with value 1.0 or more indicates that the project is progressing as planned and value below indicates an inefficient progress (Cable, et al. 2004, 7). The cumulative CPI, sum of the EV for all tasks divided by the sum of the AC for all tasks, can be used for predicting if a project will go over its budget. (Microsoft Corporation)

It has been empirically validated that the CPI metric will get stabilized from the 20 percentage completion point of a project. So CPI can be used to forecast the total final costs of the project from that point onwards. Stability will progressively increase from 20 percentages to 100 percentage completion point. (Fleming and Koppelman 2002, 93)

The cumulative CPI is commonly used in forecasting the project costs at completion. The SPI is occasionally used along with the CPI in forecasting the completion estimation of a project. The measurement using both indexes ( $CPI * SPI$ ) is called the Critical Ratio (CR). It depicts the overall state of a project. A project is facing problems if CR is below 1. Otherwise the project is considered proceeding without problems (Cable, et al. 2004, 7). It is essential to use same status dates for the data in CPI and SPI to calculate an accurate CPI analysis (Anbari 2003, 14). It is good, whenever possible, to compare CPI and SPI results of one project to all past projects of the workplace. (Fleming and Koppelman 2002, 94)

The total authorized project budget is called Budget at Completion (BAC). Dividing BAC with the cumulative CPI can get a forecast of the total project costs. With these tools a project manager can regularly monitor and forecast how much completing the project will cost. (Fleming and Koppelman 2002, 93)

The index for measuring a budget for remaining work ( $BAC - EV_{cum}$ ) against the estimated cost to achieve the EAC ( $EAC - AC_{cum}$ ) is called the to-complete performance index (TCPI) and the actual formula for the to-complete performance index is  $TCPI = (BAC - EC_{cum}) / (EAC - AC_{cum})$ . The schedule performance index ( $SPI = EV / PV$ ) can be use as the performance factor in EAC-formula ( $EAC = AC_{cum} + (BAC - EV_{cum}) / \text{Performance factor}$ ). (Christensen 1999, 290)

General trends in the work performance can be calculated by utilizing the earned value analysis. The AC, EV and PV trends are shown in Figure 6. All three lines will be collinear (a single line) if the project is proceeding as planned. There will be a cost variance if the AC line deviates from the earned value line and a schedule variance appears if the PV line deviates from the earned value line. (Davidson Frame 2002, 287-288). Putting effort in the cost efficiency is more important in the project than efficiency in the project schedule. The cost overruns are serious issues in projects because they are rarely fully recovered during a project life cycle. Effect of falling behind from the planned project schedule is not that serious matter than the cost overruns because at the end of the project the project schedule will ultimately be redeemed. Front-loaded scheduling, planning and budgeting in early stages of the project are the best methods to minimize problems of the cost overruns in the project. (Fleming and Koppelman 2002, 93).

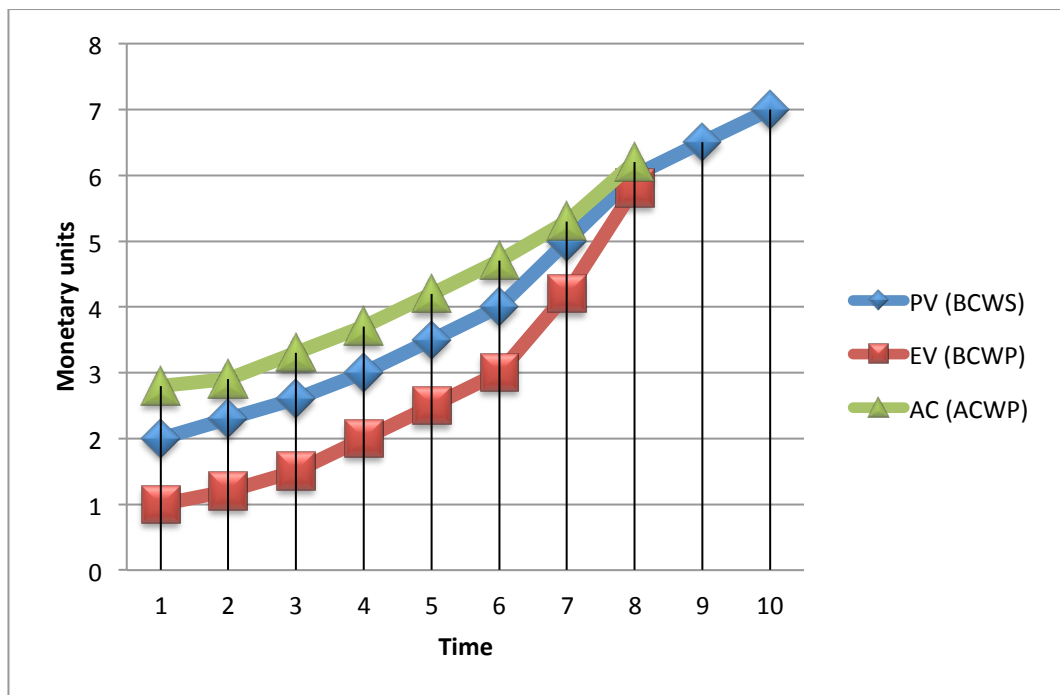


Figure 6. Work performance trends example

For the steering group of a project main interest lies in the knowledge that the project is proceeding more or less as planned. A chart like in Figure 6 will offer a quick and high-level view of project status that will satisfy the steering group members if the project is proceeding as planned. More detailed data will be needed only if the chart indicates problems (Davidson Frame 2002, 288) (Christensen 1999, 286). Small problems are typically ignored and attention of the project management is in corrective actions of substantial deviations (Anbari 2003, 22).

The Earned Value Management (EVM) guides a management of the enterprise's project portfolio to keep focus on the projects or work packages in projects by highlighting and qualifying such variations that needs the most corrective action. The EVM produces significant amount of information for a work package or a project related decision-making. "Simplification of EVM calculations, use of a graphical tools to enhance understanding of performance trends, and successful application of the EVM in the industry are important factors for the growth and effective use of this valuable project management method." (Anbari 2003, 22)

The EVM is an additional tool for managers to get important insights and to execute the comparative analysis is a database stored years of the consistent reporting data of criteria-compliant projects (Christensen 1998, 380). With early warning signals or triggers that the EVM provides for project managers, corrective actions can be taken against indicators of the poor performance or enhancing opportunities arisen for a project success (Anbari 2003, 10). EV, AC, PV and BAC are used in the EVM to evaluate performance of a project (Anbari 2003, 13).

#### 2.2.6 Estimate at completion (EAC)

The Estimate at completion (EAC) is computed as  $EAC = BAC / CPI$ . It means the estimate of a final project cost. On the basis of the efficiency that on which the work performance has been achieved for each euro actually spent, the EAC allows us to forecast the final project costs (Davidson Frame 2002, 284). The final project cost forecast based on the performance as of the status date. Another term for the EAC is the forecast at completion. (Microsoft Corporation)

Different assumptions made about the future performance will effect on value of the EAC. If the current analysis shows that an activity, work package or a project has affected of the changed conditions or the original estimation is no longer applicable, a new ETC (Estimate to Complete) must be generated. (Anbari 2003, 16)

The EAC1 is the sum of the cumulative AC and the ETC ( $EAC1 = AC + ETC$ ). This can be used where the ETC is generated for the remaining work. The EAC1 has also other names. It can be called the current working estimate (CWE), the latest revised estimate (LRE), or the revised cost estimate (RCE). Commonly a detailed bottom-up cost estimate for the remaining work will be used due to a work that already is in progress. (Anbari 2003, 16)

The past performance cannot be used in forecasting the future performance if the past problems or opportunities do not occur any more. In that case the future performance follows again the original plan. Therefore the EAC2 is the sum of the cumulative AC plus the original budget for the remaining work ( $BAC - EV$ ) and as in a formula  $EAC2 = AC + BAC - EV = BA - CV$ . (Anbari 2003, 16)

In a case where the past performance with its problems or opportunities can be used in forecasting the future performance, a performance factor, which is often the cumulative CPI, will be used in an EAC3 formula:  $EAC3 = AC + (BAC - EV) / CPI = BAC / CPI$ . This can be called either a mathematical estimate to complete (ETC<sub>math</sub>) or a statistical estimate to complete (ETC<sub>stat</sub>). (Anbari 2003, 16)

Unmanaged projects tend to fall behind their schedules, overrun their budgets or miss other quality or scope targets. It is a common human tendency to get the project back on schedule with using more resources than originally planned. Hence it is common in organizations to aim for original targets upon completion of the activity, work package or a project regardless of their prior performance ( $EAC4=BAC$ ). The EAC4 is not often achieved. The following additional formula has been made for calculating the EAC.  $EAC = BAC / CPI \times SPI$ . In rare occasions when an opportunity of the activity, work package, or the project being ahead of schedule arises, it is possible to pursue towards the significant cost savings. (Anbari 2003, 17)

Table 3. Earned Value Analysis Abbreviations and Formulas

Earned Value formulas			
Abbreviation	Name	Equation	Interpretation or result
PV (BCWS)	Planned Value (Budgeted Cost Work Scheduled)		
EV (BCWP)	Earned Value (Budgeted Cost Work Performed)	$EV = \text{Sum of the planned value of completed work}$	
AC (ACWP)	Actual Cost (Actual Cost Work Performed)		
BAC	Budget at Completion		
AT	Actual Time		
ES	Earned Schedule		
CV	Cost Variance	$CV = EV - AC$ $(CV = BCWP - ACWP)$	Positive = Under planned cost Neutral = On planned cost Negative = Over planned cost

SV	Schedule Variance	$SV=EV-PV$ $(SV=BCWP-BCWS)$ $SV=ES-AT$	Positive=Ahead of schedule Neutral = On schedule Negative = Behind schedule
VAC	Variance at Competition	$VAC=BAC-EAC$	Positive=Under planned cost Neutral = On planned cost Negative = Over planned cost
CPI	Cost Performance Index	$CPI=EV/AC$ $(CPI = BCWP/ACWP)$	Greater than 1.0=Under planned cost Exactly 1.0 = On planned cost Less than 1.0 = Over planned cost
SPI	Schedule Performance Index	$SPI=EV/PV$ $(SPI = BCWP / BCWS)$ $SPI = ES / AT$	Greater than 1.0=Ahead of schedule Exactly 1.0 = On schedule Less than 1.0 = Behind schedule
CR	Critical Ratio	$CR = CPI \times SPI$	Greater than 1.0= Performing well Exactly 1.0 = Performing well Less than 1.0 = In problems
EAC	Estimate At Completion	$EAC=BAC/CPI$ $EAC=AC+BAC-EV$ $EAC=AC+Bottom-up\ ETC$ $EAC=AC+[(BAC-EV)/(CPI \times SPI)]$ $EAC1 = AC + ETC$ $EAC2 = AC + BAC - EV = BA - CV$ $EAC3 = AC + (BAC - EV) / CPI = BAC / CPI$ $EAC4 = BAC$ $EAC = BAC / CPI \times SPI$	
ETC	Estimate to Complete	$ETC=EAC-AC$ ETC=Re-Estimate	
TCPI	To Completed Performance Index	$TCPI=(BAC-EV)/BAC-AC)$ $TCPI=(BAC-EV)/(EAC-AC)$	Greater than 1.0=Harder to complete Exactly 1.0 = Same to complete Less than 1.0 = Easier to complete
PMB	Performance Measurement Baseline		
SAC	Schedule at Completion		
TVAC	Time Variance at Completion	$TVAC = SAC - TEAC$	

### 2.2.7 Earned value in agile project methods

Determining the right time frame for calculating the earned value is the main difference between the agile project method and traditional one in calculating the earned value due to a nonlinear and iterative nature of the agile project method in which feedback loops will affect to the initial plan and a measuring progress relative to the original project plan will be deceptive. Time frame of the whole project is used only in a traditional project in calculating the earned value. (Cabri and Griffiths 2006, 6)

Burn chars is one of the principal agile project management tracking technique. It provides very similar status and progress information what the earned value attempts to measure. With data from the burn chars of an agile project, the earned value can be used without losing principles of accepting a change. (Cabri and Griffiths 2006, 3-6)

There are several key questions that will need to be answered in a research of validity and value of using the EVM on a scrum projects. Firstly, are the metrics valid for Scrum projects? Is the process lightweight, or do the resulting metrics add value? There have been made an analysis that the Agile EVM along with the burn down method can provide progress reports for executives' use. The progress reports are based on quantitative data in a consistent manner. A progress measuring of the Agile EVM will be done at a release level instead of using a sprint or a product levels in measuring. If compared to requirements of the traditional EVM, advantage of the Agile EVM is in work items that are integral to the Scrum process. (Barton, Blackburn and Sulaiman 2006, 2-9)

Creating detailed measures of PV starts with establishing the PV baseline at the beginning of the each iteration. AC can be captured by using a time keeping system. After the three base earned value metrics (AC, PV and EV) are available Cost Variance, Schedule Variance, Estimate at Completion (EAC), and Estimate to Completion (ETC) can be computed from these base earned value metrics. (Alleman and Henderson 2003)



## 2.3 Earned Schedule method in project management

### 2.3.1 General information

Fast and precise assessment of the schedule performance is essential in projects because time drives projects. The earned value can be successfully used for evaluating the cost performance in a project but not reliable in evaluating the schedule performance. The earned schedule has been created to correct the problem. Using both the earned value and the earned schedule elevates a project management to the next level. (Velde 2007)

Mr. Walt Lipke introduced the earned schedule (ES) during spring 2003 and ever since it has been broadly studied in a wide area of fields and programs of all sizes and on the way it has got polished to its current form. (Crumrine and Ritschel 2013) (Lipke 2009, 24)

With the earned schedule (ES) method, schedule information will be extracted from the earned value management (EVM) data. It has been shown providing a reliable schedule indicator and predictors for both late and early finish projects. The method has been successfully used as a management tool for construction, software, commercial, and defense projects in several countries. (Lipke and Henderson 2006, 26)

Core idea of the earned schedule is simple. The key issue is to identify the time at which the amount of an accumulated earned value (EV) should have been earned. The performance efficiency and schedule variance information can be provided by forming time-based indicators. (Lipke and Henderson, 1)

The idea of the earned schedule (ES) will follow the concept of the earned value. Only difference is to use time instead of cost as a unit in measuring schedule performance. The core concept of ES is to specify the time at which the accumulated EV should have occurred. In other words see the time associated with point on the Performance Measurement Baseline (PMB) where PV equals EV. The difference of the Earned Schedule concept compared to Earned Value is that the associated schedule indicators behave reliably the full life cycle of project. (Lipke 2012, 1)

Earned value tools will always have a point where the SV and SPI indicators will lose their management value. This irregular behavior of schedule indicators will bring added challenges for the project managers, because in a preceding grey area a project manager cannot be sure of whether or not he or she should believe the indicator and react to them with right corrective actions. This uncertainty will continue until end of the project. (Lipke 2003, 33-34)

Crumrine and Ritschel have studied both the Earned value and the Earned schedule and have verified Lipke's model. In their study they noticed that the SPI(t) and SPI(\$\$) values react with general consistency over the first two-thirds of the project, with the SPI values separated by only hundredths of a point. After that point the SPI values start going in different directions. The SPI(t) value starts to decrease at a faster rate, while the SPI(\$\$) value retrogress back towards a value of 1.0 in projects behind schedule. In other words after that point SPI(\$\$) becomes an unreliable measure of project schedule while ES continues to produce value to the project manager. (Crumrine and Ritschel 2013, 39-40)

The concept of the Earned Schedule (ES) was extended to include project duration forecasting a year after the publication of ES (Henderson, 2004). Henderson presented two equations for forecasting the final duration for a project. (Lipke 2009, 24)

### 2.3.2 The ES method in use

The Earned schedule cannot function without an Earned Value Management because it is an extension to The Earned Value Management. The Earned schedule method will bring tools for a project manager to analyze schedule performance. Determining the time at which the accumulated earned value (EV) should have occurred is a central element of the Earned Schedule concept. An ES is the duration of time associated with the point on PMB where the PV is equal to the EV and it provides a measure of how much has been earned of the planned duration (PD) of the project. (Lipke 2013, 15-16)

Table 4. Comparison of Earned Value and Earned Schedule. (Lipke 2006)

	Earned Value	Earned Schedule
<b>Status</b>	Earned Value (EV)	Earned Schedule (ES)
	Actual Costs (AC)	Actual Time (AT)
	CV	SV
	CPI	SPI
<b>Future Work</b>	Budgeted Cost for Work Remaining (BCWR)	Planned Duration for Work Remaining (PDWR)
	Estimate to Complete (ETC)	Estimate to Complete (time) ETC(t)
<b>Prediction</b>	Variance at Completion (VAC)	Variance at Completion (time) VAC(t)
	Estimate at Completion (EAC) (supplier)	Estimate at Completion (time) EAC(t) (supplier)
	Independent EAC (IEAC) (customer)	Independent EAC (time) IEAC(t) (customer)
	To Complete Performance Index (TCPI)	To Complete Schedule Performance Index (TSPI)

“ES is computed from the simple formula:  $ES = C + I$ , where C is the largest value of n satisfying the condition,  $EV \geq PV_n$  and I is an interpolation using the equation  $I = (EV - PVC) / (PVC_{+1} - PVC)$ ” (Lipke 2013, 16).

Schedule Variance (time) ( $= SV(t) = ES - AT$ ) and Schedule Performance Index (time) ( $= SPI(t) = ES / AT$ ) are time based schedule indicators used in the ES. The AT is the duration from the beginning of the project to the time where an EV is measured. (Lipke 2013, 16) (Henderson 2004). The Schedule Performance Index for time (SPI(t)) compares the amount of time earned to the actual time, therefor indicating how correctly or badly time is being used in the project (Velde 2014, 29). The SPI is often used to estimate the project completion date. (Microsoft Corporation)

An EVM performance data can be used in forecasting the duration. An Indicator for forecasting duration is called the SPI(t). A simple formula for this is an  $IEAC(t) = PD / SPI(t)$ . (Henderson 2004). The IEAC(t) is coming from words Independent Estimate at Completion (time-based). (Lipke 2013, 17)

The EVM schedule indicators fail in the late performing project, but these the ES indicators will perform reliably in both early and late performing projects. Additionally, the time-based indicators will always meet the actual result at the end of a project. (Lipke 2013, 16)

Table 5. Measures, Indicators, and Predictors of Earned Schedule. (Lipke 2006)

<b>Metrics</b>	Earned Schedule	$ES_{cum}$	$ES = C + I$ Number of completed periods (C) Plus an incomplete portion (I)
	Actual Time	$At_{cum}$	AT = number of periods executed
<b>Indicators</b>	Schedule Variance	$SV(t)$	$SV(t) = ES - AT$
		$SV(t)\%$	$SV(t)\% = (ES - AT) / ES$
	Schedule Performance Index	$SPI(t)$	$SPI(t) = ES / AT$
	To Complete Schedule Performance Index	TSPI	$TSPI = (PD - ES) / (PD - AT)$
$TSPI = (PD - ES) / (ED - AT)$			
<b>Predictors</b>	Independent Estimate at Completion (time)	IEAC(t)	$IEAC(t) = PD / SPI(t)$
			$IEAC(t) = AT + (PD - ES) / PF(t)$
	Variance at Completion	$VAC(t)$	$VAC(t) = PD - IEAC(t)$ or ED

Crumrine and Ritschel studied a project with SPI value below 0.9 to determine whether the Earned Value Management or the Earned Schedule is an earlier detector of problems in meeting the program schedule objectives. They discovered that in average, an EVM identified a problem at an 18 percentage completion point, while the ES identified problems in average at the 30 percentage completion point. However, the EVM failed to identify problems on 9 programs that the ES did. (Crumrine and Ritschel 2013, 40)

In their study of the optimism and accuracy of the SPI value, Crumrine and Ritschel noted that an EVM was more optimistic 59.4 percentage of the time, while an ES was more optimistic 35.1 percentage of the time (5.5 percentages of the data points had equal SPI values). Further, at the 90 percentage completion point, EVM was more optimistic in ten times of project than the ES. They were studying whichever method

is closer to the final schedule result. The closer one was determined to be the most accurate for that particular data point. They discovered that an EVM was more accurate 37.1 percentage of the time, while an ES was more accurate 57.4 percentage of the time. (Crumrine and Ritschel 2013, 40-41)

To Complete Performance Index (TCPI) is an indicator of the EVM for cost analysis. It indicates the performance efficiency needed for the rest of the project to meet a specific cost target. A similar indicator did not exist for the schedule analysis of the ES until creation of the To Complete Schedule Performance Index ( $TSPI = (PD-ES) / (ED-AT)$ ). The PD is planned duration and An ED is the desired or estimated project duration. (Lipke 2013, 17)

Both TSPI and TCPI provide the information concerning the project. Based on their results a project manager can see if project objectives are still achievable, and can a poorly performing project be recovered. With values under 1.00, the project management will have reassurance that the objectives of the project are achievable. The Project management will need to do corrective actions if values are between 1.00 and 1.10 where recovery may still be possible. The Project objectives will become unachievable when value is above 1.10. (Lipke 2013, 17)p17

A project manager can use TSPI for schedule analysis and to “look ahead” and if required, take the corrective management actions earlier enough. Two variables, the fraction completed and the performance index at a specific status point are needed in the formula  $TSPI = (1-K) / (R-K/SPI(t))$ , where  $K = ES/PD$  and  $R = ED/PD$ . (Lipke 2013, 17)

Crumrine and Ritschel discovered in their study that TSPI; between 1.01 and 1.05 will be a trigger to signal that a project is in trouble. In average situation will arise when a project reached a TSP 1.10I value at the 64 percentage completion point. If lowering TSPI threshold from 1.10 to 1.05 a problem exists at the 50,8 percentage completion point. If lowering TSPI further from 1.05 to 1.01, it is possible to detect trouble at the 24 percentage completion point. By lowering TSPI threshold from 1.10 to 1.01 will give a project manager much more time to plan corrective actions. (Crumrine and Ritschel 2013, 41-42).

The Critical Path (CP) analysis can use the Earned Schedule (ES) as an application. A CP analysis provides forecasts and information for the project managers to focus on appropriate control actions. In bigger projects a specialized person, a scheduler, will work with the CP analysis providing forecasts and information to a project manager. There is a theory that the project manager can minimize the time duration of a project if protecting progress on the CP. (Lipke 2012, 10)

ES is not complex to do and it provides useful information to the analysts and the project manager. It will only take small amount of additional work to do. A creation of a separate PMB is required from the tasks which formulate the CP followed by status the performance of the CP using EV from those same tasks. (Lipke 2012, 10)

By analyzing the CP performance and the total project jointly, the project manager can find out an imbalance in performance between critical and non-critical activities. The project is maximizing its performance when the SPI(t) from the CP analysis is equal to the SPI(t) from the total project. (Lipke 2012, 10)

### 2.3.3 The Earned Schedule in agile methods

According to Robert Van De Velde, use of an EVM for schedule management in agile projects is limited—there is no certainty that it adds value beyond what is provided by common agile tools. Another concern is with an EVM's traditional schedule performance metrics. The metrics shows without exception a schedule performance improvement as a project approaches its completion, making the performance appear to be perfect even if project delivery has been late. Due to claiming EVM to merely be just bureaucratic overhead the agile community has concerns about using EVM in any form. Mr Van De Velde claims that an Agile Earned Schedule (AgileES) applies an Earned Schedule to Agile projects and addresses all of these concerns. (Velde 2014, 29)

Earned Schedule for Agile projects (AgileES) combines the accuracy and control of an Earned Schedule with the speed and responsiveness of Agile. Common agile tools that are used for assessing schedule performance will get added value from AgileES. An Agile concern of an Earned Value's schedule performance metrics will be removed

by AgileES. “Using Earned Schedule on Agile projects is not without controversy, but there is strong, objective proof that it is valid for agile projects.” (Velde 2014, 29)

There are two phases in calculation of Earned Schedule. Firstly calculate number of complete periods in which the current Earned Value (EV) equals or exceeds the cumulative Planned Value (PV) for the period. Secondly calculate the fractional amount for the first period in which the Earned Value (EV) does not equal or exceed the cumulative Planned Value for the period (PV). (Velde 2014, 34)

Outcome of the schedule performance efficiency is shown by burn down charts. More release points consumed means greater efficiency and fewer consumed points, less efficiency. The project is either ahead or behind from its original schedule. AgileES functions differently. Instead of just focusing outcome of performance efficiency, AgileES assesses the schedule performance efficiency itself. “It shows explicitly, how time is being used and thereby adds insight to what is provided by common agile tools such as burn charts.” (Velde 2014, 30)

The Burn charts and an AgileES both point out whether or not a project is on schedule. Addition to, an AgileES assesses schedule performance efficiency; pointing out how well or poorly time is being used in the project. That provides insight into a schedule performance beyond burn charts and traditional EVM measures. (Velde 2014, 34)

#### **2.4 Earned value and earned schedule in MS Project**

The Microsoft Project program uses PV, EV, and AC in an earned value analysis for each task in a project plan. Microsoft uses old terms BCWS, BCWP, and ACWP instead of PV, EV, and AC in the MS Project program. (Microsoft Corporation)

The MS Project stores budgeted cost of each task scheduled in the project plan. The Budgeted cost of a task consists of the cost of resources assigned to the task as well as any fixed costs associated with the task. The MS Project uses baseline field in storing budgeted cost values. For storing multiple baselines during a project MS Project can store up to 10 baselines. The actual costs are correlated with actual work in the MS Project. Some portion or all of the tasks are required to complete up to the

status date. An EV is calculated for each tasks but typically analyzed in a project level. Usually the date when a project progress has been last updated, will be used as the status date for the earned value analysis. (Microsoft Corporation)

It is contingent to use either percentage completed value or physical percentage complete value for the earned value calculations of a task. A project manager makes task-by-task decisions of a right earned value calculation method used in a task. Using percentage is more common than physical percentage completed. The physical percentage completed, is often solely used when an accurate measure of real work performed or remaining cannot be drawn by using percentage completed, since percentage complete value indicates the percentage of the task duration that has been completed. Physical percentage complete is always entered directly by a project manager, but percentage completed can also be calculated by the MS Project. (Microsoft Corporation)

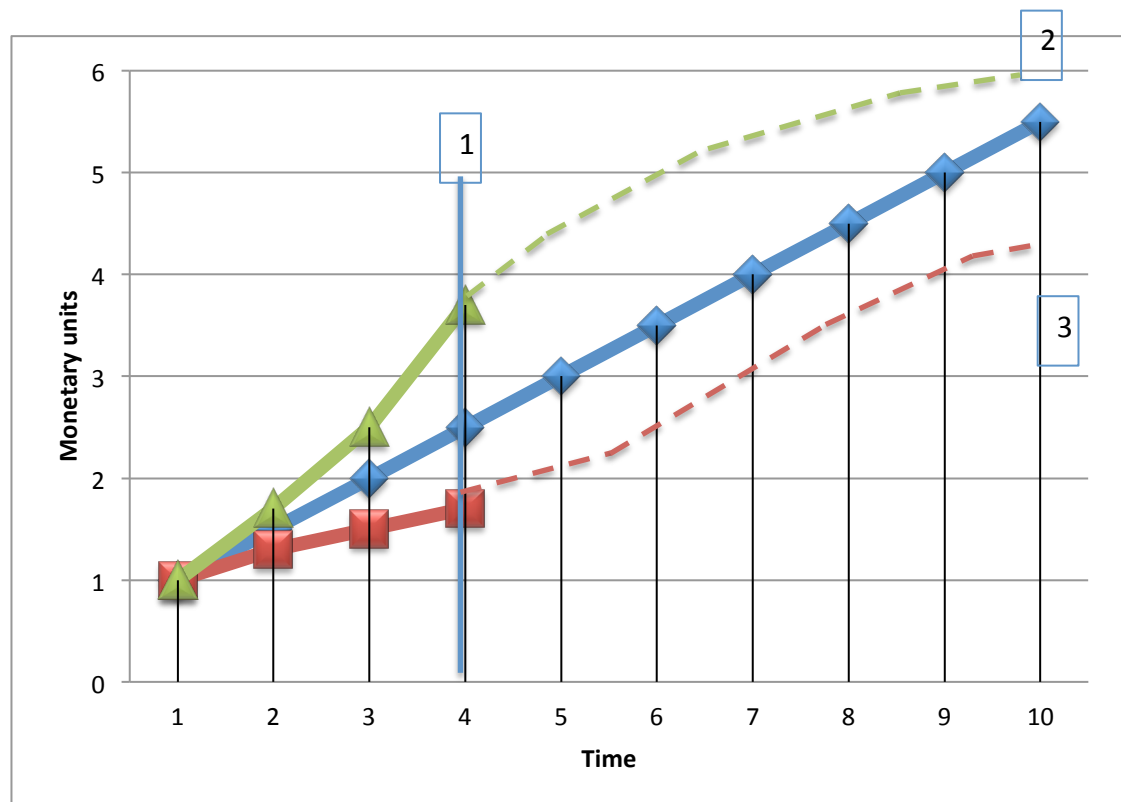


Figure 7. The Earned value analysis chart (Example)



A chart with projected cumulative cost for a project in y-axis and time in x-axis is one common way of visualizing the key values of earned value analysis (See Figure 7). The chart will show how key values of an earned value analysis have appeared on the chart from the beginning to the status date (1). In this chart an AC has exceeded the budgeted cost (2) of the project and the work performed is less than an amount spend to accomplish that work (3) (Microsoft Corporation)

Besides measuring PV, EV, and AC, the earned value analysis measures the Cost variance (CV), the Schedule variance (SV), the Cost Performance Index (CPI), the Schedule performance Index (SPI), the Budget at completion (BAC), and the Complete Performance Index (TCPI) in the MS Project (Microsoft Corporation).

Normally a project correlates the actual costs (AC) with the actual work. Only if the actual costs independent of the actual work has been entered or the resource pay rates has been changed, will actual cost be out of sync with scheduled cost. The MS Project includes two types of pay rates: the standard rates and the overtime rates. (Microsoft Corporation).

EV is calculated differently in the task level than at the assignment level in an MS Project. For best results, use the task-level BCWP (EV) values, which are the values MS Project rolls up to summary task and the project summary task EV values. This value is calculated for each individual task but analyzed typically at the project level. (Microsoft Corporation).

The PV is calculated as the cumulative time phased baseline costs up to the status date or current date. The Budgeted cost values are stored in the baseline fields, or if they have been saved in multiple baselines, in fields Baseline1 through Baseline10. (Microsoft Corporation).

The Cost variance (CV) is a variance that shows the difference between the budgeted cost of work performed (EV) on a task and its actual cost AC, and Schedule variance (SV) shows difference between the budgeted cost of work performed (EV) and the budgeted cost of work scheduled (PV). When cost is currently under the budgeted amount or a baseline the CV is positive, and when the task is currently over budget, CV is negative. A Positive SV means that project is ahead of schedule and in case of

Negative SV; the project has fallen behind schedule in cost terms. (Microsoft Corporation).

The Estimate at completion (EAC) is the total cost field and the Budget At Completion (BAC) is the Baseline Cost field from the baseline in question. The Variance that shows difference between the BAC and the EAC is called Variance at Completion (VAC). (Microsoft Corporation).

Using the Earned Value Cost Indicators table or the Earned Value table, the earned value information can be seen in any sheet view of the MS Project. PV, EV, AC, EAC, BAC, VAC, SV, and the CV information can be found from the earned value table. CV%, CPI, BAC, EAC, VAC, and TCPI addition to PV, EV, and CV can be found from the earned value cost indicators table. (Microsoft Corporation).

The Earned Value table is good for evaluating the difference between your scheduled and budgeted costs from indicators of EAC, BAC, and VAC. Additionally, the CV shows the difference between budgeted and actual cost of work, and the SV shows the difference between the budgeted cost of work and the actual cost of work. (Microsoft Corporation).

The Earned Value Cost Indicators table can be used to analyze cost variances. The CPI and TCPI will tell how the project is progressing against its budget and how the rate of work compares with the expected rate. The CPI with values less than 1 will reveal that the project getting less work per dollar than planned and with TCPI it is possible to follow up how much of an increase in performance is needed on the remaining tasks of the project in order to keep the project within budget. (Microsoft Corporation).

### **3 RESEARCH METHODOLOGY**

#### **3.1 Methodology used in the study**

Reason and Bradbury summarizes Action research to be as a participatory, democratic process concerned with developing practical knowledge in the pursuit of worthwhile human purposes, grounded in a participatory worldview, which we

believe is emerging at this historical moment. Action research seeks to combine action and reflection, practice and theory, working with others, in search of practical solutions to important issues for the people involved. (Reason and Bradbury)

Action research is one kind of continuous improvement and development of operations that naturally happens in working life. It gives a new, democratic approach for a research method aimed at needs of working life. (Kananen 2009, 7)

Coughlan and Coughlan define an Action research as research in action, instead of research about action. The researcher participates in problem solving that includes a series of events that requires action. A scientific approach will be used in studying the resolution of important social or organizational issues by action research. The researcher will work closely together with those who experience these issues directly in action research. While building up a body of scientific knowledge, the researcher's goal is to make that action further more effective. An Action research contains four-step iterative cycles of gathering data, feeding them back to parties concerned, analyzing the data, and planning action, taking action and evaluating, leading to further data collection and so on. (Coughlan and Coughlan 2002, 222).

The Action research combines theory and practice (and researchers and practitioners) through change and reflection in an immediate problematic situation within a mutually acceptable ethical framework. The Action research is an iterative process involving researchers and practitioners acting together on a particular cycle of activities, including problem diagnosis, action intervention, and reflective learning. (Kananen 2009, 10-11)

Avison and others point out people to be the biggest challenges in Action research since people are having individual objectives, perceptions and attitudes that are easily conflicting to each other. That makes organizations so different and complex. That is why researchers will need to understand the ill-structured, vague world of complex organizations. This encourages action research researchers to experiment via intervention and to reflect on the result of their intervention and implication of their theories. (Avison, et al. 1999, 95)

Action research can be seen as a process of professional learning and development. It essentially pertains to working life in practice and its problems, identifying them, and eliminating them. (Kananen 2009, 9)

Brydon-Miller defines the Action research as a work in progress where the research must remain objective and value-free. Action researchers must share a common value. They must have respect for people's knowledge and the ability to understand and address the issues confronting them and their communities. An action researcher will work collaboratively with others that will lead not only to organizational and/or community changes, but also to personal changes in the action researchers themselves. It is essential for action researchers to understand that the social world can only be understood by trying to change it. (Brydon-Miller, Greenwood and Maguire 2003, 14).

Coughlan and Coughlan reminds us of the action research being an application of the scientific method of finding facts and experimentation to practical problems, calling for action solutions and involving co-operation and the collaboration of the members of the organizational system and the action researchers. It is important for an action researcher to learn from both the intended and unintended outcomes, and to make a contribution to the scientific knowledge and theory, instead of just finding solutions to the immediate problems. (Coughlan and Coughlan 2002, 223)

Avison and others categorize the action research into four different types: "Action research focusing on the change and the reflection; The Action science trying to resolve conflicts between espoused and the applied theories; Participatory action research emphasizing participant collaboration; and Action learning for the programmed instruction and an experiential learning." (Avison, et al. 1999, 95).

Avison and others instructs the action researcher to be explicit about their approach. The Research aims and the supporting theory need to be clarified as well as method at the outset. The emphasis is more on what practitioner are doing than on what they say they are doing. When clarity continues all the way through the application of the research as well as at the time of its publication, the Action researcher will have a large and complicated story to tell. (Avison, et al. 1999, 96)

Action research is power and action originated from actors, not from given instructions, orders or development activity. The Power of the action research lies on the fact that people that are having a problem will find the solution for it and at the same time will commit the required change. (Kananen 2009, 9)

Action researchers are actively working at making it happen instead of merely observing something to happen. Two objectives, solving a problem and contributing to science, are always present in an action research. The Action research does not premise a difference between action and theory, but the challenge is to engage both at the same time. The Action researcher should be able to take part in making the action happen and in same time stand back from the action and reflect on it as it happens so that he or she will contribute theory to the body of knowledge. (Coughlan and Coughlan 2002, 224)

Besides continuous adjustment to new information and new events, an action research calls for co-operation between the client personnel and the researcher. Due to nature of the action research being series of unpredictable and unfolding events collaboration between actors is needed to be able to adapt to the contingencies of the unfolding story. (Coughlan and Coughlan 2002, 225)

Both the researcher and the practitioner are both owners of the problem under investigation. The Action researchers are outside agents or external helpers to the client system who act as facilitators of the action and reflection for practitioners in an organization. The Action researcher has two main models to use. One is the expert model that can be understood as the doctor-patient model. Patient goes to a doctor for diagnosis and prescriptive direction. Another model is called the consultation model. The Action researcher will work as a facilitator helping the clients enquire into their own issues and creating and implementing the solutions. (Coughlan and Coughlan 2002, 227)

Change is one constant element of an action research. The Action research is constant improvement of operations. A Collaborative work is an essential element of an action research. The Co-operation requires common target that is also an essential part of an action research. (Kananen 2009, 9)

The Action research is basically only about change. It focuses on the understanding, the planning and the implementing, changes in business firms and other organizations and it requires an understanding of the ethical framework, the values and the norms used in a distinct context. Authentic relationships between the action researcher and the members of the client organization are required in the Action research. The ethics as well as how process is understood and significant action have been taken based on mutual understanding and how the action researcher works with the members of the organization. (Coughlan and Coughlan 2002, 225).

A mutually acceptable ethical framework is what both the practitioners and the researchers need to share while working together. Avison and others have proposed four dimensions for the framework; the style of presentation adopted the tradition and beliefs implied by its assumptions, the category of action research used and its focus, and the research process, including the theme, level of the organization involved, the extent of change, and the role of the researcher. (Avison, et al. 1999, 97)

An Action research does not aim for generalization like the traditional research methods do. The Action research focuses on a single case and the research outcomes will be valid only for the case researched. (Kananen 2009, 10)

A range of pre-understanding of the organization environment, the conditions of business, the dynamics and structure of operating systems and the theoretical support of such systems is required for an action research to be productive. The Action researchers must have broader knowledge of the organizational systems as a part of pre-understanding. (Coughlan and Coughlan 2002, 226)

The Action research projects do not aim to create universal knowledge. Even though they are situation specific, it is important to generalize this knowledge to other situations too. This can be done by building a theory in small steps from moving from the particular to the general and identifying how the knowledge collected in action research project could be used in similar issues in other organizations. The theory builds up from a synthesis of an emerged data and use of the body of theory in practice that informed the intervention and research intention. A precise concern

with theory that is formed from the conceptualization of the particular experience in ways that are intended to be meaningful to others is in demand in an action research. (Coughlan and Coughlan 2002, 236)

The Action research is a process with several cycles. An average action research cycle includes planning, implementation, observation, and reflection phases. The most simplified cycle includes only planning, action, and monitoring (Kananen 2009, 10). The cycle starts with a pre-step to understand context and purpose to make sure this action project is worth studying. Furthermore an appropriate methodology has to be adopted and have an idea what are expected contributions to make knowledge. Six main steps of action research will follow the pre-step: data gathering, data feedback, analysing data, planning, implementing and evaluating actions. (Coughlan and Coughlan 2002, 231)

The Action research is a “live” case study that is being studied as it unfolds, so the action research should be executed in real time. An Action research can also take the form of a traditional case study done in retrospect (Coughlan and Coughlan 2002, 226). It is possible to predict achievements of the cycles; the planning, taking action and the evaluation but planning or designing detailed achievements in advance cannot be done. (Coughlan and Coughlan 2002, 229)

Framing and selecting an issue is often a complex process in an action research. Who selects the scope of the project, who provides access, and who is involved in it are critical questions for the action researcher because they are present in any research project. A project steering group is common part of action research since members of a steering group is responsible of the resources used in a project and the scope determination. The steering group will name a team for an action research working with the planning, the implementing and the evaluating action research cycles. This group of people will be part of the inside knowledge building process for the organization. They will learn and reflect on the emergent learning from the project while it unfolds via series of events of the designated issues studied in the action research. They will confront the designated issue and attempt to find the resolution for the issue with the help of the action researcher. (Coughlan and Coughlan 2002, 229)

Action research starts with the data gathering and the feedback followed by the data analysis and the action planning for the matter under researching (See Figure 8). Planned actions will be implemented and the implementation results will be evaluated. All this might cause changes to the theory and corrective actions are needed. In other words action research will enter to the next cycle. (Kananen 2009, 12)

The action research has its own quality criteria. It is required in ideology of the action research. The Action research should rather be judged by within the criteria of its own terms than the criteria of positivist science. (Coughlan and Coughlan 2002, 226).

Action research is relevant when a given group, a community or an organization have been working with an unfolding series of actions defined by the research question over a certain period of time, and understanding why or how some aspects of a system can be changed or improved by their actions, and learn from the conception of change or an improvement process. (Coughlan and Coughlan 2002, 227).

The Practitioners of an action research must continually monitor each of the six main steps of an action research, and inquire in what is taking place, how the steps are being managed, and which fundamental presumptions are usable. (Coughlan and Coughlan 2002, 233)

Action researcher wants to test a theory with participants of the action research in real situations, obtain feedback based on their experiences, and adjust the theory as an outcome of the feedback, and start it over with testing an adjusted theory. Each cycle of the action research process will give some new adjustment to the theory making it more likely to be suitable also for a variety of situations. (Avison, et al. 1999, 95)





Figure 8. Action Research cycle

Engaging with others with process of inquiry and action are core skills for an action researcher. A Pure inquiry, an exploratory diagnostic inquiry, and a confrontive inquiry are three types of inquiry. The action researcher acts the most neutral without participating into an actual action in pure inquiry. He or she will just observe carefully and neutrally the story of what is taking place. The Action researcher is more involved in an exploratory diagnostic inquiry. He or she begins to manage the process of how the content is analyzed by the other, by exploring emotional processes, reasoning, and actions. A Confrontive inquiry is the form of inquiry where the action researcher contributes the most in an action research, by sharing his or her own ideas and challenging others to think from a different viewpoint. These ideas may refer to content and/or process. (Coughlan and Coughlan 2002, 234)

The clear criteria should be defined before performing the research in order to later come to the conclusion of its outcome, as should ways to control variations in these

criteria as part of the process of a problem diagnosis, an action intervention, and a reflective learning. (Avison, et al. 1999, 96)

A new action research cycle will follow a previous one and research will continue from results of previous cycle, or it will have a new problem as a target (See Figure 8). The change can be made only via action. A verbal description or an order will not be enough. The innermost process cannot be revealed only with an observation, interviews or surveys. Only via an action process and the information related to it can be reached. There are often hidden knowledge that cannot be made visible without a process and participating in it. (Kananen 2009, 10)

Developing a holistic understanding during a project and recognizing complexity is an aim of an action research. The Action researchers need to have a vast understanding of how the system works, and have a possibility to move between the formal structural and the technical and informal people subsystems, since the organizations are dynamic technical-socio systems. An ability to work with a dynamic complexity is required for an action researcher in working with the organizational systems. The organizational systems are mainly complex because of the multiple causes and effects over time instead of a lot of details. (Coughlan and Coughlan 2002, 225)

It is not easy to give an accurate and an unambiguous definition for the action research, because the research method in question is not just one but a group of research methods. The Action research does not exclude the data acquisition methods or the data analysis methods of other research methods. The Development of operations (change), cooperation and a research are essential elements in an action research. (Kananen 2009, 11)

Mainly a real issue is needed of both a managerial significance and a research upon which a group or organization is initiating to study. The researched issue has an uncertain outcome at the beginning of the study. On the contrary a group or the organization is willing to divulge this issue under rigorous inquiry, particularly the analysis and an implementation of action. Recognizing the different stakeholders, their inter-relationships and different expectations is the key element of the pre-step of an action research. Additional to improved management practices the Action

Research also improves the managerial competences for those involved in the research. (Coughlan and Coughlan 2002, 228)

## **3.2 Process of empirical study**

### **3.2.1 The Data collection**

The research questions are typically affiliated with the governance or the management. An Actor participates both in the research and in the action. The Action research and the change will actualize concurrently. (Kananen 2009)

The Action researchers act as tools in the data generation. They must have self-awareness and sensitivity to what they observe as one of their core skills as well as a skill to base their observations and the interpretations to conceptual analytic frameworks. The Action researchers will get basics for skill development from the typology of inquiry. During the inquiry process an action researcher works at engaging participants of the research in identifying issues, diagnosing things they are causing to these issues as well as the planning, the implementing and the evaluation action including learning from the experience. (Coughlan and Coughlan 2002, 234)

The Action researcher can develop his or her reflective skills significantly by keeping a journal. It helps the action researcher over time in learning to differentiate between experiences and find remedies of dealing with them as well as helping them reflect on experiences and anticipate future experiences before they undertake them. Keeping a journal regularly will lead to discipline. It also captures an action researcher's experience of key events to moments when they happened, helping an action researcher avoiding changes in their perception to those moments over time. (Coughlan and Coughlan 2002, 235)

Research methods are needed in different phases of the research. The Research material will be collected with a chosen method. The Research method will be needed in processing and analyzing research materials. Several different research methods can be used in analyzing same research materials. A thumb rule is that less information there is available about the phenomenon most likely only qualitative method can be used. (Kananen 2009, 17)

All type of data gathering methods is available in an action research. It is possible to use methods from the traditional research for data gathering and quantitative and qualitative tools like surveys and interviews are usually used. These tools should be well thought out with the action research participants and clarity must be used in integrating them into the action research process. Action researcher should keep in mind that the data collection tools like survey or interview are themselves interventions and generate a data because they can generate suspicion, anxiety, hostility and apathy or create expectations between members of the organization. Significant data that may be critical to the success of the project can be missed if an action researcher purely focuses only on the collection of data. (Coughlan and Coughlan 2002, 225)

Depending on the context data can be collected in different ways. Often action researcher will gather data by active involvement in the daily processes of the organization. Directly perceivable behavior is a principle source of data for the action researcher either gathered in formal settings like in meetings or interviews or informal settings like over lunch, coffee or other more recreational settings. It is also possible that instead of the action researcher, the organization itself has gathered the data for the action researcher. The action researcher only participates or facilitates in the feedback meetings. (Coughlan and Coughlan 2002, 231)

### 3.2.2 The Data analysis

An action research being collaborative, where both members of the client system and the researcher are making data analysis together, is the critical aspect of data analysis in action research. After collaborative data analysis is done, the action researcher and members of the client system will do further action planning as a joint activity. When further action has been planned senior management and the action research steering group set an appropriate time schedule and name participants to do tasks of planned actions, because it is the client system that implements the planned action. Relevant key members of the client system must join action researcher and compose together the desired changes and follow through in the plans. An experience from reflecting both intended and unintended outcomes of the action and reviewing of the process will help in planning next cycle of action

research. This evaluation process is the key to learning. An absence of learning action research can go on and on aimlessly making participants more frustrated and action research more ineffective due to missing realization of success or failure that could be learned from the evaluation process. (Coughlan and Coughlan 2002, 233)

Processes are mainly studied in a qualitative research. The aim of a qualitative research is to describe a phenomenon, comprehend it and present a meaningful interpretation. Endeavor in deeper understanding of the phenomenon under magnifying glass as well as profound and rich portrayal and interpretation of the phenomenon. Aim is to absorb as much as possible from a perception of the phenomenon, in other words the case will have in-depth study. Analysis will not be a last stage of the study but an action that is present in all stages of a research process. It self-guides both research process and data gathering. There is a direct contact between examinee and researcher in qualitative research. (Kananen 2009, 18-19)

Action research can consist of several data gathering and analysis methods of the qualitative research. Action research does not have own methods for data gathering or data analysis. The Action research, in addition comprises of some quantitative research methods. (Kananen 2009, 20)

### **3.3 RELIABILITY AND VALIDITY**

An action researcher must maintain validity by accepting and using action research cycles, testing the assumptions and exposing them to public testing. An action research result is a story that the researcher is telling. An action researcher must avoid telling a biased version of the story but take into consideration the scale on which the story is a valid presentation of things that has taken place and how the story is understood. (Coughlan and Coughlan 2002, 237) Suggest four "parts of speech" as helpful to the Action research role: Framing, Advocating, Illustrating, and Inquiring.

Framing occurs when an action researcher is disclosing the dilemma to be solved, stating the purpose of speaking for the present incident, and sharing assumptions about the situation. Advocating takes place when an action researcher is disclosing the goal to be accomplished, perception, asserting the option, and feeling or

proposal for action. In the illustration role, the action researcher is exposing a bit of the solid story making the advocacy concrete and orienting the other more distinctly. Inquiring occurs when an action researcher is getting to know the perspectives and views of the participants by questioning them.

## **4 RESEARCH RESULTS**

### **4.1 Case company and projects**

The case company functions in the ICT field, provides ICT services for both domestic and international B2B and B2C customers. B2C solutions are normally one or several product bulk deliveries for domestic customer but service deliveries for B2B customers often consist of several services and/or customer demands are unique requiring customization and/or customer based solutions. A successful outcome can often be reached only by a detailed project planning in delivering complex or otherwise demanding B2B customer services or solutions.

There are three main project focus areas in the case company. The first focuses on customer deliveries mainly for B2B customer, the second for R&D of new solutions and services for customers and the third for development of internal production systems and processes. This thesis focuses on project management in B2B customer delivery projects

Despite the different natures of the project types, the case company has a common project model for all of them. The unified project model of the company has remained almost unchanged for years. The most recent substantial developments of the model were completed at the beginning of the previous decade soon after a merger of two competitors combining their best practices into one project model. In the past few years project development has mainly focused on composing and refining supporting documents but the experiences and lessons learned in a variety of project have been used in the refinement of the project model.

The common project model helps project managers to keep the essential project issues in focus during a project in all of its stages from the beginning to the end. Furthermore it provides tools to keep the quality higher if followed attentively.

The project model of the case company consists of four phases and five to seven decision points (See Figure 9). Project starts with a pre-study phase. The pre-study phase ignites with a first decision point giving permission to start the phase. During the pre-study phase an initial project plan draft and business case will be formulated and evaluated. The decision of the viability of the project will be made in the second decision point. If the project seems viable, the actual project can start with the planning phase. The project resources are appointed and project plan will reach version 1.0 during the planning phase even though technical design and delivery planning will continue in the project execution phase.

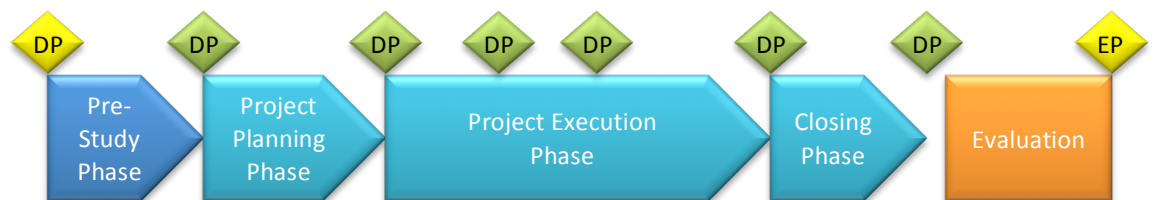


Figure 9. Project model of the case company

Earned value and Earned schedule tools are not included in the project model but can be used parallel to the project model to enhance it. All phases start after getting an approval at a decision point (DP) prior to the phase. A project can only end after an approval in the last decision point. Since the project execution phase can be long and consist of several sub projects and service deliveries it can have a required number of decision points, often up to two.

After the project has ended and some time has passed, the sales manager or service manager can kindle revive spark to activate the evaluation phase. It is possible to proceed with the evaluation phase only after enough time has passed to be able to verify how well the business case has been met with in the project. The evaluation phase ends at the Evaluation Point (EP). The evaluation phase is not part of the actual project

For several years, project management organization for B2B customers have been part of various forms of departments connecting delivery, service management and production in with varied approaches aiming to meet the constantly evolving customer needs. The latest organizational structural change took place on April 1<sup>st</sup> 2014 when the managerial project management group merged with the more technical project management teams to become a department of three project teams. Consequently, project management for B2B customer has grown from a few specialized teams into an independent department focusing on the unifying project management of previously different teams and fine tuning the common model suitable to B2B customer delivery projects of various sizes and lengths. The development of the project management model has been rendered to meet the demands of smaller and simpler projects, to find the core and remove the nonessential layers and procedures around it without altering the fundamentals of the common project model.

Earned value and earned schedule have not been part of the project model previously and there is interest in identifying how they can improve the project management in the department. Deducing the above tools for an improved accuracy of both the value and schedule were in demand.

#### **4.2 The Discoveries of observation period projects**

The Empirical part of the thesis started from comprehension of the project work, and the projects the project department of the case company is working with. All on-going projects that had reached at least planning phase and completed projects in the timeframe of April 1<sup>st</sup> 2014 to November 30<sup>th</sup> 2014 were included into the study (See Table 6).



Table 6. Project statuses

Phase	Number of projects				% of projects			
	Team A	Team B	Team C	Total	Team A	Team B	Team C	Total
Planning	4	4	8	16	9%	5%	15%	9%
Executing	25	41	23	89	53%	56%	43%	51%
Closing	1	1	2	4	2%	1%	4%	2%
Completed	17	27	21	65	36%	37%	39%	37%
<b>Grand total</b>	<b>47</b>	<b>73</b>	<b>54</b>	<b>174</b>	<b>27%</b>	<b>42%</b>	<b>31%</b>	<b>100%</b>

There were altogether 174, either on-going projects or a project that had completed, during the observation period. 37 percentages of the observed projects were completed at the end of the observation period and rest of the projects were on-going projects in different project phases, mainly in an execution phase. More detailed situation at the end of the observation period can be seen from table 6.

Table 7. Average Project Workload in Project Categories

Project Category	Average h/week	Average-%	Average Duration
A	14,3	38,1%	415,6
B	6,4	17,1%	173,9
C	5,9	15,8%	194,4
D	8,7	23,3%	267,6
INTERNAL	9,4	25,0%	283,8
<b>Average</b>	<b>7,1</b>	<b>19,0%</b>	<b>215,0</b>

Taking into account the nature of B2B customer delivery projects can vary a lot, four level categories is in use to help finding an appropriate level project management approach for all size customer projects (See Table 7). The right project management approach depends on complexity of a project, its length and customer demands for a project.

The Category A has been planned for complex, multi product delivery projects that will take long time to complete. It uses all the managerial tools and functions designed into the project management model shown in Figure 9. Sometimes less complex project is a Category A project because of customer requirements for the project management.

The Category B was introduced at April 1<sup>st</sup> 2014 structural change of a project management. It was aimed for shorter or less complex projects previously managed with Category A method. There were some areas in project management that did not need so much managerial effort.

Both the A and B project can consist of several sub projects. The sub projects are considered as D Category projects. The D Category was introduced some months after introductions of A, B and C categories introduced at April 1<sup>st</sup> 2014. Some of the projects counted into the C category should have been in D category count in the following tree tables.

The Category C projects have least managerial work included. This project model suited for simple and short projects. Additionally the Category C project could have been sub project prior to introduction of Category D projects.

An average workload was following the project category levels as designed. A project manager can manage two simultaneous categories A project and he or she also has time for one B or C project. The Project manager working majorly with a B project can manage up to 6 B category project and project manager working only with a C category project has time to manage up to 6-7 projects similar duration according to results of observation time period. There were minor differences between teams.

The Table 8 shows that the project department works mainly with the B2B customer delivery projects. During the observation period 95 percentage projects were B2B customer delivery projects, and 5 percentage internal projects. The Table also shows that majority of the B2B customer deliveries have been the C category projects during the observation time period.

Table 8. Project work in closer look by teams and categories

Team	Project Category (project count)						Project Category (%)					
	A	B	C	D	Internal	Total	A	B	C	D	Internal	Total
Team A	5	6	21	8	7	47	56%	27%	18%	47%	78%	27%
Team B	3	8	57	5	0	73	33%	36%	49%	29%	0%	42%
Team C	1	8	39	4	2	54	11%	36%	33%	24%	22%	31%
<b>Total</b>	<b>9</b>	<b>22</b>	<b>117</b>	<b>17</b>	<b>9</b>	<b>174</b>	<b>5%</b>	<b>13%</b>	<b>67%</b>	<b>10%</b>	<b>5%</b>	<b>100%</b>

The Team B has been working with almost half of the C Category projects with 57 out of 117 C Category projects count. The Team B was most productive if looking at results also by number of all projects. It had been working with 73 projects out of the total of 174 projects. The reason for it became clearer after studying projects by their categories from the table 8 and an average project duration and task count from the table 9. Most of the projects Team B was working with were a category C project with shortest average project duration making them faster to complete them and giving the possibility for Team B to process more projects than other teams.

Another assumption can be seen from the tables 8 and 9 are results of Team A. Since Team A was formed from the managerial project managers working mainly with complex projects, the team had 56 percentages of A category projects in average of 506 working days during the observation timeframe. Due to their complex nature, the projects were also 164 percentages longer than with the Team B or 182 percentages more than with the Team C.

Table 9. Teams, Categories, Tasks and Durations

Teams and Project Categories	Average Duration (days)	Average task count	Average 5 or less days task %	Average 10 or less days task-%	Max task duration (days)
<b>Team A</b>	<b>268,6</b>	<b>29,6</b>	<b>57,3 %</b>	<b>67,8 %</b>	<b>694</b>
A	506,4	55,8	48,0 %	55,6 %	600
B	185,2	21,2	51,2 %	55,1 %	235
C	198,9	24,9	54,4 %	65,7 %	281
D	371,5	45,9	71,9 %	85,3 %	694
Internal	261,4	13,6	52,6 %	65,3 %	442
<b>Team B</b>	<b>189,5</b>	<b>19,4</b>	<b>60,1 %</b>	<b>71,8 %</b>	<b>554</b>
A	309,7	19,3	56,9 %	60,3 %	292
B	202,6	35,3	48,6 %	60,3 %	180
C	186,1	17,2	63,3 %	75,5 %	554
D	136,0	18,8	62,8 %	75,5 %	100
<b>Team C</b>	<b>202,9</b>	<b>16,9</b>	<b>62,1 %</b>	<b>70,7 %</b>	<b>300</b>
A	279,0	3,0	66,7 %	66,7 %	267
B	136,8	36,1	61,6 %	67,1 %	176
C	204,1	11,5	65,8 %	75,9 %	300
D	224,5	32,3	49,6 %	63,6 %	198
Internal	362,0	23,0	63,0 %	63,0 %	294
<b>Average</b>	<b>215,0</b>	<b>21,4</b>	<b>59,5 %</b>	<b>70,1 %</b>	<b>694</b>

The Team C was formed mainly from the project managers with both the technical and the managerial backgrounds and it is kind of a mixture of Team A and B in nature. The Team C worked with more projects (31 percentage) than the Team A (27 percentage), but less than the Team B (42 percentage) during the observation time period. Otherwise all the teams functioned in similar manner.

Department manager of the case company had his first review of the thesis in its early stages after majority of theory was gathered together from various sources. He recommended giving a closer look for 0-100 rules as Davidson Fame and Anbari have introduced in their articles (Davidson Frame 2002, 279) (Anbari 2003, 21) in the first cycle of action research. He saw that this method could be introduced if tasks can be broken into a weeklong work package in maximum. Another method to test during the first cycle of action research was the model in which 0 percentage = not started, 25 percentage = just started, 50 percentage = half way through, 75 percentage = almost done, and 100 percentage = done. He saw that this model was usable in the projects with tasks maximum two weeks long.

According to the observation time period data it was possible to progress with both options the department manager had suggested for studying in the first cycle of the action research. The 0-100 rule is often used in project tasks with short durations and it is a simple way to introduce basics of earned value for the project department. Moreover department manager's 0-25-50-75-100 model looked as a good first step towards the usage of earned value.

Table 10. The Task Averages and the Task Counts

	Average				Average %		Max task duration
	Task Count	Task Duration	Max 5 Day Tasks	Max 10 Day Tasks	Max 5 Day Tasks	Max 10 Day Tasks	
A	37,8	51,6	18,8	21,3	49,7%	56,5%	600
B	31,7	18,3	17,3	19,7	54,4%	62,2%	235
C	16,7	16,7	10,2	12,2	61,5%	73,0%	554
D	34,7	14,6	22,8	27,4	65,6%	79,0%	694
Internal	15,7	38,9	8,8	10,1	56,0%	64,5%	442
<b>Average</b>	<b>21,4</b>	<b>19,7</b>	<b>12,7</b>	<b>15,0</b>	<b>59,5%</b>	<b>70,1%</b>	<b>505</b>

The Projects had tasks with duration maximum of two working weeks in average of 70 percentages from all the tasks, and almost 60 percentages of the tasks had duration maximum of one working week (See Table 10). The situation was best in the categories C and D, and worst in the category A. There were also projects with duration of the tasks up to 700 working days long (See Table 10). This was the case not in one but in three category projects (A, C, and D category). Overly long tasks were not a big problem because only little more than 3 percentages of tasks with durations more than 100 working days (See Table 11) were found. The biggest issue was to uncover means to reduce tasks from duration of 10 day to 100 days group into the targeted task durations, since this group comprised about 27 percentages of all the tasks.

Table 11. The Task Durations

Task durations	Task count	Task %	Cumulative Task %
0-5	2214	59,5%	59,5%
5,01-10	391	10,5%	70,1%
10,01-25	464	12,5%	82,5%
25,01-50	308	8,3%	90,8%
50,01-100	213	5,7%	96,6%
100,01-250	101	2,7%	99,3%
250,01-500	23	0,6%	99,9%
Over 500	4	0,1%	100,0%
<b>Total</b>	<b>3718</b>	<b>100,0%</b>	<b>100,0%</b>

Since about 70 percentage of the tasks have durations of two weeks or less, the tasks over two working week up to duration of 20 working weeks with their 26 percentage of all the tasks (See Figure 19) has main focus in finding solutions to present them differently in projects. It became clear that this was the first issue to study further in the case company.

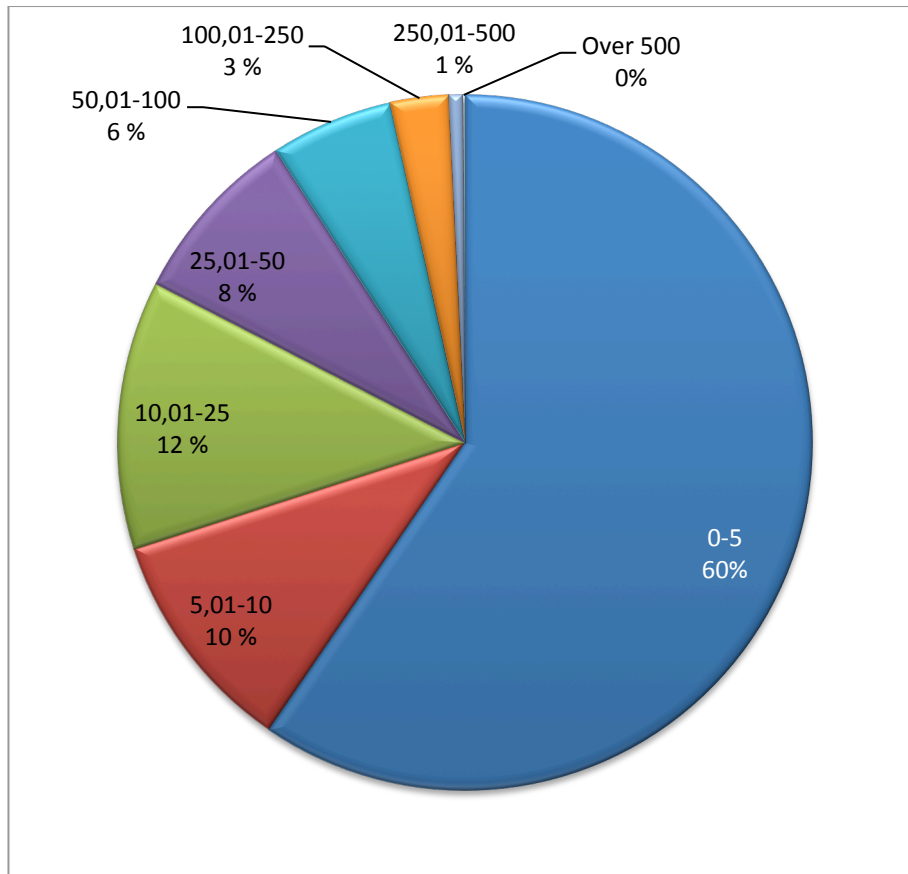


Figure 10. The Task duration groups

### 4.3 Getting the task durations shorter and standardized

The first questionnaire focused on finding out solutions for the tasks with durations over two working weeks. Additionally two alternative methods for assessing progress of a task:

1. The 0-50-100 percentage method, in which 0 percentages equals a task not yet started, 50 percentages the task in progress, and 100 percentages the task completed. The rule can be applied for the tasks one working week or less.
2. The 0-25-50-75-100 percentage method, in which 0 percentage equals a task not yet started, 25 percentage task in progress, 50 percentage task half way done, 75 percentage task almost done, and 100 percentage task completed. The rule can be applied for tasks two working week or less.

The questionnaire was sent to everyone in the project department of the case company and time frame of a week was given for answers. Most of the answers were given in last couple of days bringing an average response rate to 71 percentages. Team A was the most active with 86 percentage response rate and Team B the least active with 62 percentage response rate (See Figure 11).

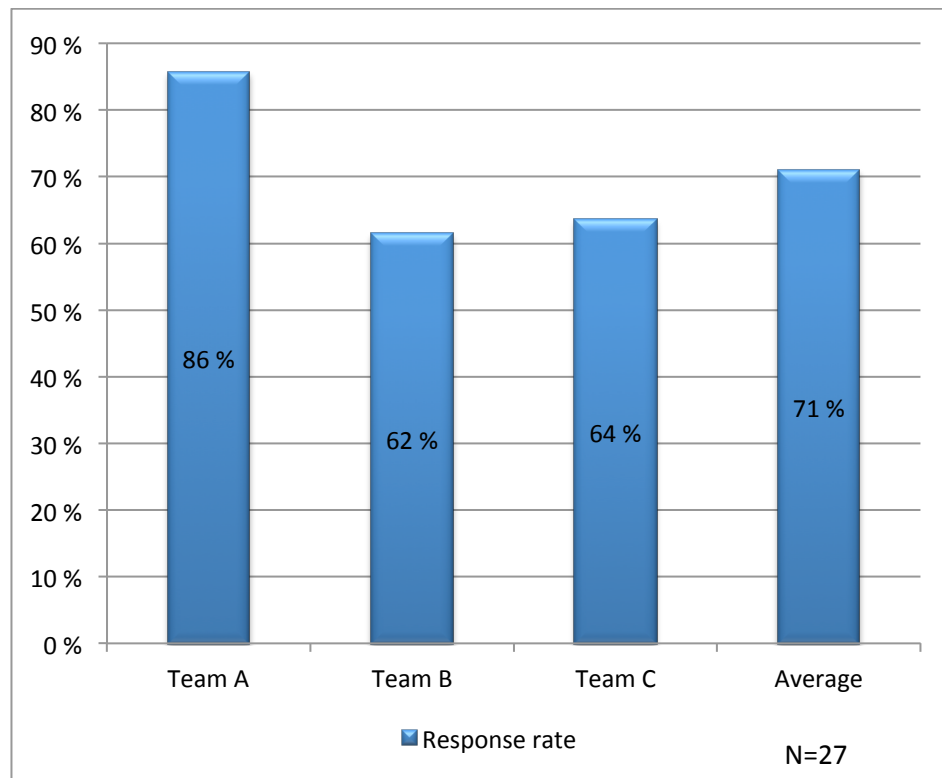


Figure 11. Response rate of the first questionnaire

The 0-25-50-75-100 percentage method was found a favorable choice among respondents since 81 percentages of respondents had chosen it (See Figure 13). The Team C was favoring this model the most, with 86 percentage of team members and the Team B favoring it least with 75 percentage of the team members (See Figure 12). This can be caused by slightly different background of the team members in the team B and nature of projects the team B has been working with compared to other teams (See Table 8). The C category project are normally shorter and more straight forward projects compared to the A or B category projects and that is why 25 percentages of the team B members have seen possibility for using the simpler, the

0-50-100 percentage method. The Team B was working with almost half of all the category C projects during the observation period.

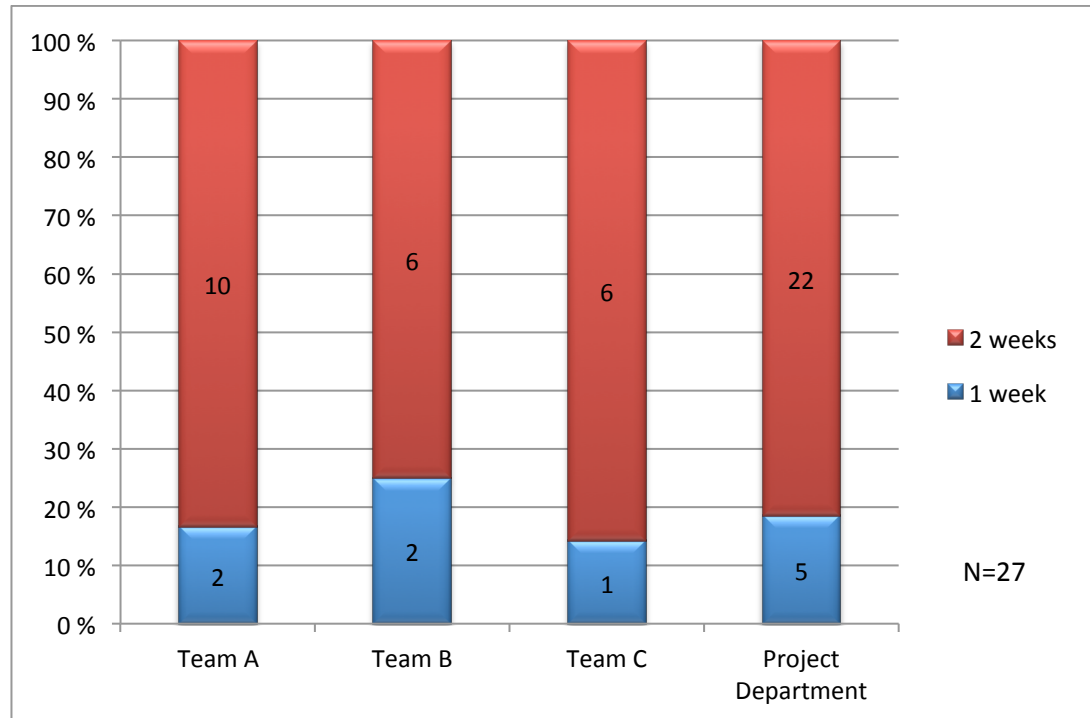


Figure 12. The Choices for the method by the Teams

The respondents of the age categories of 46-55 or 56+ were favoring either method. But the respondents of 20-35 and 36-45 year groups saw possibility in both. Besides favoring the maximum of two weeks task 0-25-50-75-100 percentage method as a better method, a few votes were given for the maximum of one week 0-50-100 percentage method (See Figure 13).



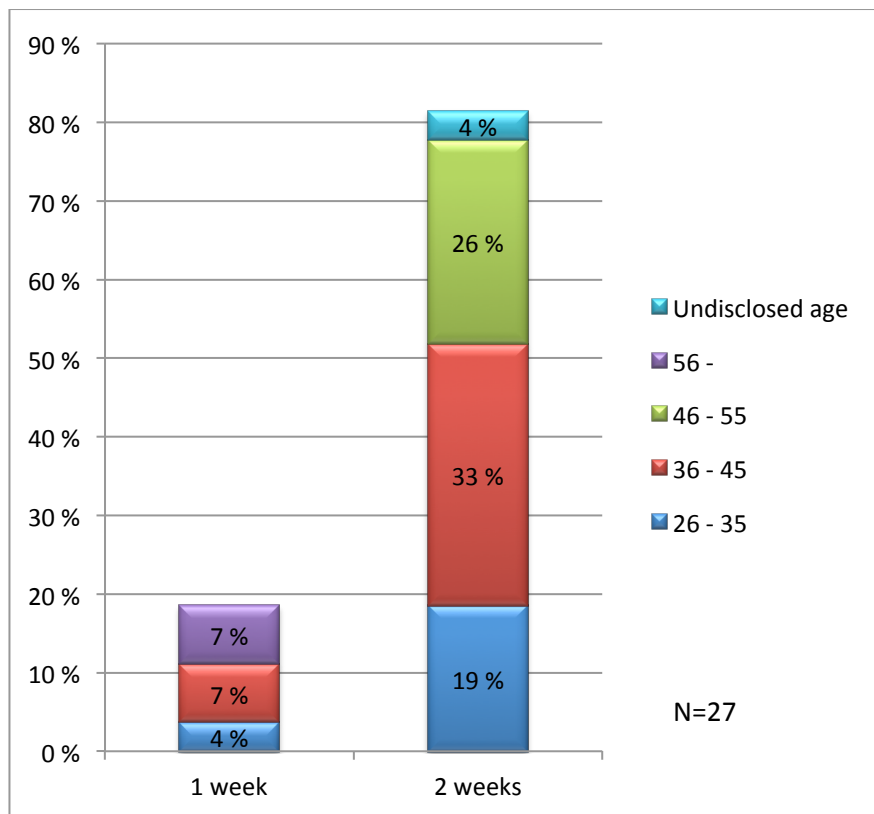


Figure 13. The Choices for the method by respondent's age

A positive response was mainly given for these methods in open-ended questions. Presenting required action into more detailed level was a common remedy for over lengthy tasks. Breaking down the over lengthy task into number of sub tasks was the most common suggested remedy. Planning towards more precise tasks can be done geographically, timely, based on phases, or some other way suiting for the project.

A 0-50-100 or A 0-25-50-75-100 model was not fully accepted as is. Some respondents wanted to keep options open to use tasks with durations over two weeks when it suited better for the task concerned. According to those respondents, it was challenging in some cases to reduce duration of a task into required level of the model. Additionally, longer tasks will require more accurate progress percentage estimations than proposed models in default can offer.

There are moments in project where a task goes through a process or set of processes that can take in some cases much more than two working weeks without project manager having a possibility to break the task into set of shorter sub tasks.

Some delivery and order processes were mentioned as examples of such cases. One possibility for describing it in a project plan can be to set task only for an action needed to start the process and milestone task at the end of the process.

There were also respondents who did not see these models contributing of any help for them in projects. They saw it better to continue presenting project progress with few long tasks, because they felt that in some cases it would become too complex for them to plan required tasks and update them to show project progress. Additionally customers in some cases have caused long tasks because of their unique requirements for a project.

Maximum of one week long task with 0-50-100 percentage model was seen suiting well for on/off type of short tasks like orders done or not done and maximum of two weeks long task with 0-25-50-75-100 percentage progress presentation model for giving progress estimations for specialist work.

It was seen that two week model applied better for the category A projects and one week model for the category B and the C projects. It will also need more precise task definition and common view with a person responsible of the task to have a common understanding of the progress of the task. A project manager has to form this common understanding with people responsible of tasks with required level of communication. Predominantly partners or sub-contractors must give detailed briefing for longer set of the tasks and should be able to break the tasks into required levels.

#### **4.4 The Early earned value experiences**

It transpired at the end of the observation period that earned value has already been used once in a project department. An interview with a project manager, who had used earned value in one of her projects, gave some insights, and first discoveries, how the earned value method should be used in the project department.

The nature of her earned value project was unique compared to average projects in the department. It focused on producing set of definition documents. The whole

project group under her lead was focusing for designing and composing definition documents for a new service.

An idea for using the earned value tools in the project had come from being interested of following the project management blogs, the chat groups, and the news. The Earned value had come up in several sources and a curiosity to see if it can be a helpful tool in project management had been a driving force for testing it in a project.

She found the MS Project chat groups helpful in getting initial help for becoming familiar with the earned value method. She used the basic MS Project earned value tools. Daily or hourly cost was used for a project member work except for the customer resources since her aim was to follow up cost cumulated by the project members of the case company or its subcontractors for the customer.

She soon discovered that default earned value calculation method was not right for her project. The default method was good for measuring used work hours but not for the completion percentage of each document. The Physical completion percentage method fitted perfectly for measuring physical readiness of each document instead. She used the document version number data in estimating task's physical completion percentage.

It was important for the project that everyone was using similar manner in updating the version numbers, because the version numbers were used in estimating their physical completion percentage. It took some effort and time to get common understanding of the matter among project group, but after it was formed, it was easy to give the physical completion percentage for all definition documents under work in the project.

According to her the MS Project was working well with the basic earned value information. When hourly or daily work costs of all project members were stored to the project plan in MS Project, it was ready to calculate the earned value information. Task-by-task progress information from all project members was all she needed to keep updating during the project for the earned value calculations. One

thing she was not pleased with was reporting tools of MS Project (version 2010). She did not ascertain them useful for her needs in her project.

She pointed out that it was important that the progress reporting was done regularly. Excel was used to collect weekly work amount information of every member of the project. Everyone was reporting own working hours for the project from the latest working week. Additionally task-by-task completion percentage was requested from the project members for weekly progress reports.

She had principally positive experiences about using the earned value tools in her project. She felt that use of earned value in her project was largely helpful for herself as it should have been since it is a tool; to a large extent for project manager to see competently progress of a project. It can be a profitable tool especially if a person has enough interest in getting introduced by the method.

She saw that it would be an equipped tool first introduced in internal projects prior to taking it into use in external project. Actual knowledge of how that method should be used in the projects will grow among the project managers when proceeding in that order. Acceptable practices will be constructed and required features of the earned value method will be implemented into the project management model and the project templates of the department.

According to her experiences the earned value should be applied for tasks in a critical path at the minimum. In that way only tasks critical for a project will need extra attention from a project manager working with an earned value data collection and analyzing compared to basic project work done previously. The Cost performance index (CPI) and the schedule performance index (SPI) are key formulas derived from the planned value (PV), the earned value (EV), and the actual costs (AC) of the earned value method. According to her, right interpretation of the CPI and the SPI will assist a project manager to see if corrective actions are needed. The Earned value variables and the formulas need to be implemented into the project templates as own columns so that a project manager cannot overlook the important project progress information that they are giving for a project manager. Implementing the earned

value variables and formulas into the project templates, make them visible for a project manager as well as part of project manager's daily routine.

She used the physical completion percentage instead of default, more automatic completion percentage, because she had difficulties in running all required reports otherwise. According to her experiences the physical completion percentage method suites well in measuring tasks that have some concrete physical result. What she was not sure were issues like, can the earned value method be used fittingly in measuring the tasks like startup workshops. In her opinion, one decent sub type of project that can benefit on the earned value method was product development projects

#### **4.5 Integrating the earned value into project practices**

When the tasks of projects during observation time were analyzed and common ways to reduce durations of longer tasks were found, following step was to study how the earned value tools were suiting for the projects in the project department of the case company. The studying started with introduction of how the earned value has been implemented into the Microsoft Project Professional client-server system. Version 2010 of MS Project was in use in the case company during the study period.

The Microsoft has made using earned value straightforward procedure for a project manager. Addition to basic project planning procedures like plan all required tasks, their durations, resources, and dependencies to other tasks, three steps are required. Firstly a project manager just adds hourly or daily standard and overtime pay rates for work performed by a resource, and task-by-task estimations of work required for completing each task and how completion percentage of each task is calculated. When the plans are required level ready, it is time to take the second step. A project manager saves first baseline for a project, and the MS Project is now ready for the earned value calculations. The third and last step for the project manager is to set status date for the earned value calculations.

One of the first discoveries after typing the required data for the earned value was how it can be used in estimating the project management costs at the end of pre-study phase of a project. Previously Excel-form has been used in project management cost calculations to give best estimate for a future project management

work of a project. When the project managerial tasks were added to the project plan and work estimates were planned, a value in EAC was giving the same results as Excel-form previously. What made the MS Project better tool for the work was its better adaptability to the project concerning giving increased accurate data if the project managerial tasks were planned in more detailed manner.

The project management work can be presented several ways in a project plan. It can be presented in a task if project is simple and short, like the C level project of the case company. More detailed, week-by-week tasks are often enough for the B level projects. Complete task-by-task presentation is best with the A level projects.

The earlier project office in the case company did not have proper tool to analyze how closely the project plan done in pre-study phase will meet the project at its end. Such a tool, like the earned value, helps collecting the valuable information for planning the future project plans of similar nature better beforehand in pre-study phase.

The Earned value with its baselines gives possibilities to store up to ten different baselines during the lifecycle of a project, and a status day data can be compared to any of the stored baselines giving opportunity as well to compare a pre-study project plan to the end results. This supports Fleming & Koppelman's recommendation that a baseline of a project must be kept under continuous analysis due to proposed changes affect to the baseline. (Fleming and Koppelman 1998, 21-22)

Besides storing baseline at the end of the pre-study phase decision point (Figure 9), it should also be stored at all decision points if approved changes have been introduces to the project scope or schedule. Normally latest baseline stored will be used in the status day earned value calculations.

The Baseline itself is an intuitive tool for the project manager in the MS Project, because preferred baseline of a project stored can be shown in a Gantt chart along with the current tasks. The project manager can see quickly how changes will roughly affect to later on tasks in a project even without analyzing the task-by-task SPI-values.

For the reason that the A level projects are furthermore complex than the B or especially the C level project, using the earned value allows increased benefits in the A level project than in other less complex projects. Additionally costs of an A level project are greater as well as the monthly customer invoicing after a project is over. Since the earned value transmits early indicators if a project is on track or not, it is possible to prepare corrective actions earlier. As an end result the project has better change to complete in the planned schedule and costs helping the case company to start invoicing its customer earlier than otherwise. This is why it is best to introduce earned value in the A level projects in the case company. After increased knowledge and finding best practices in the A level projects of the department, the earned value tools can be taken into use in the B and C level projects.

Earned value data is only as good as how it has been collected. The data needs to be collected timely and data needs to be correct. So planning appropriate kind of way and suitable interval to collect the data from all the project members is important since not all have direct access to the project management system in the case company.

Shorter intervals equal frequent status days. Reiterative status day's equal more earned value inspections that give better change for a project manager to respond to possible problems in a project. Interval cannot be too short because it increases managerial workload of all the project members. Too long interval on the other hand will reduce quality of data if the project members do not keep actively track on task-by-task progress. It is not easy to remember work hours done for a task after several days or even week or two.

Since every project is unique, it is the project manager's aim to find right balance between the data collection interval and the workload needed for collecting data. Additionally it is good to spend some moment in making decision if an earned value of tasks in a critical path is enough or all tasks are used for the earned value calculations. In some cases tasks in a critical path is enough because problems in them will have bigger effect for a project than problems in the other tasks.

Other decision for a project manager is to choose how completion percentage will be calculated. Default option is calculated based on amount of work used to the task called completion percentage in the MS Project. If completion percentage is estimated by a physical factor like amount of the installed devices, a physical completion percentage is better option to use.

Since resistance was expected in taking the earned value tools into use in the project department in the case company, instructions, training, and updated project templates was seen ways to ease up the introduction of the earned value tools for the project managers. A project manager must see its value for his or her project before it will be taken into use in a project. It was expected that after positive experiences in first few projects, it will encourage other project managers to use it too.

#### **4.6 The recommendations for new project management practices**

Subsequently analyzing projects of the project management department of the case company, task durations suiting for an earned value, and how the earned value has been introduced in the MS Project, most immediate actions were planned and implemented as recommendations.

It was seen that earned value is a good tool for longer and rather complex A level projects than the B or C level projects. The B or C level projects were seen as better training projects compared to the A level project, for internalizing the earned value tools in projects of the case company.

In view of, the projects are unique even though their nature remains loosely similar, no tight recommendations can be given for frequency of status days calculating an earned value. The considerable value for earned value tools was seen in beginning half of the project so more frequent interval for the earned value calculations was recommended.

It was recommended that the earned value tools should be used at least with tasks in critical path, but using them with all the task of a project will give more accurate



status information. It was up to the project manager to see either option suites best for a project in concern.

The Earned value was seen as a good tool for pre-study phase projects to evaluate the project management work estimate for following phases. Previously Excel-form has been used for calculating the project management efforts. It was recommended to add the project managerial tasks to the project templates, because they were found to be helpful and guiding a project manager through out a project to keep managerial work in mind. Additionally the project managerial work is easier to keep in the earned value calculations if the basic managerial tasks were included in a project template.

The Baseline has been in use previously in the projects of the case company but its potential was not fully seen. Since a baseline is an essential part of calculating the earned value in the MS Project, it should be stored in certain places during a project. The first baseline should be stored at the beginning of the planning phase if the project plan has been made during pre-study phase. Following baselines will be stored at the end of planning phase and every time there is changes in the project scope or the schedule during the execution phase.

Since the MS Project can use two different type of methods to calculate or estimate completion level of a task. Default method is called the percentage (%) complete and it is used in tasks where the value is earned by the hour. An alternative method is called the physical percentage (%) complete and it is used in the tasks where the value is earned by the physical work. Since the earned value is a new tool for the project department in the case company, it is recommended to update the project templates and task by task figure out suitable completion estimation methods. It reduces the project management work and makes projects in-line with other project in the department.

#### **4.7 Acceptance of recommendations as first earned value tools**

Second survey was arranged at the end of the study to examine how project managers in the department found recommendations and earned value findings. Like survey held earlier, this survey was Webropol online survey.

This time respondent rate was not as good as in the first survey. This time only 53 percentages of the project managers of the department answered to the survey. The Team C was the most active with 64 percentage respondent rate and the Team B was the least active with only 38 percentage respondent rates. Survey software log showed that addition to average 53 percentage response rate there were additional 25 percentages of the project managers that have showed interest for the survey but have not finished the survey for an unnoted reason.

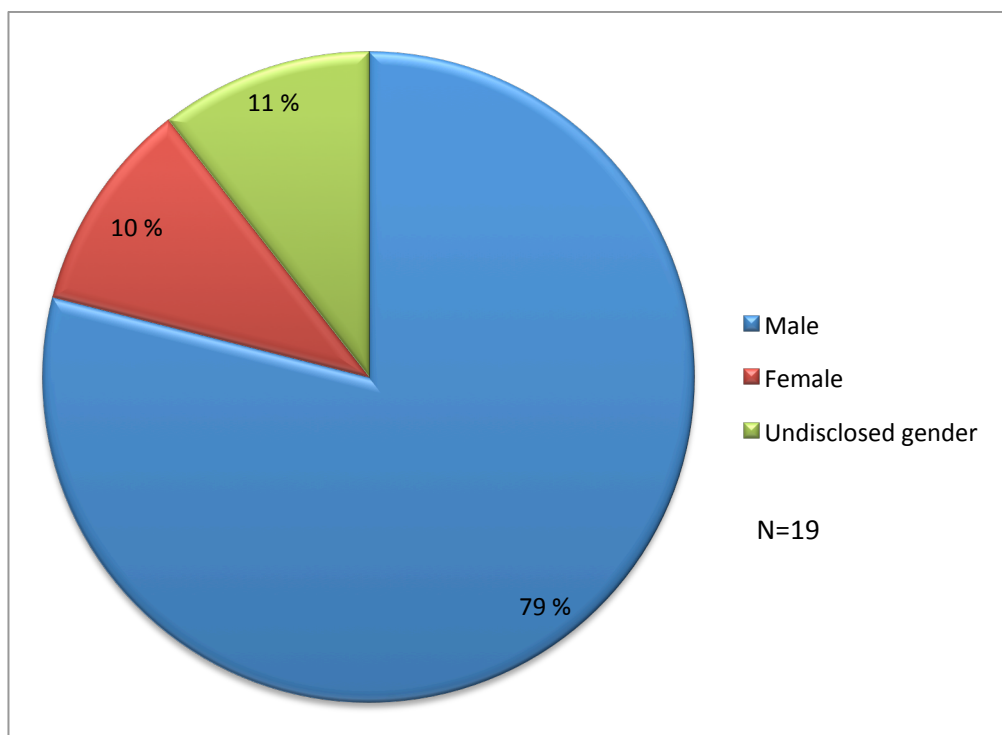


Figure 14. The Respondents gender

As Figure 14 shows, female ration of respondents were only 12 percentages. It also means that only 22 percentages of all women in the department answered to the questionnaire compared to 56 percentages of all men in the department.

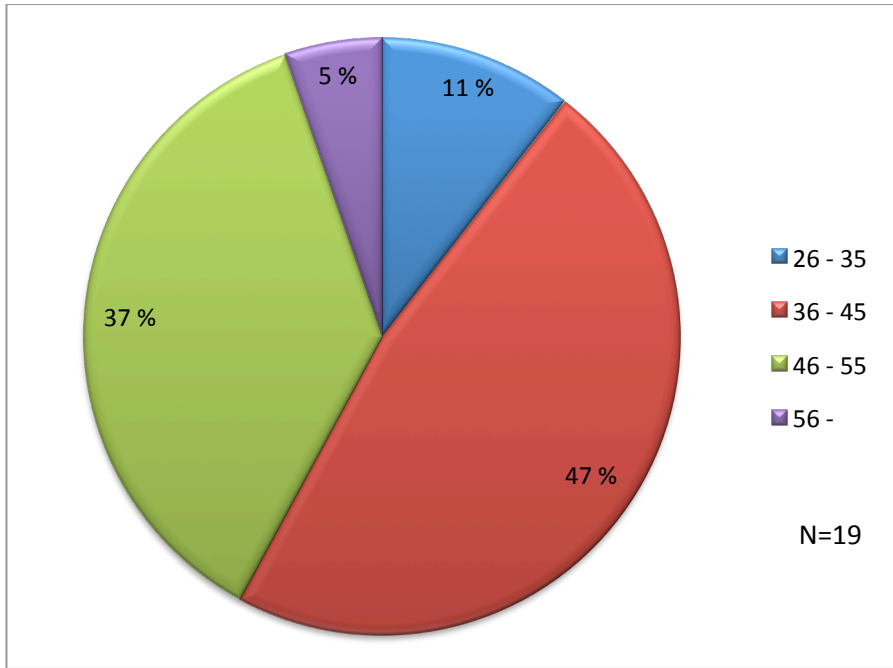


Figure 15. Age groups

Almost half of the respondents were 36 to 45 years age group and largely rest were age group 46 to 55 (See Figure 15). Since much of the project managers of the department have been working with projects several years, respondents have solid project management knowledge working with the projects of the case company.

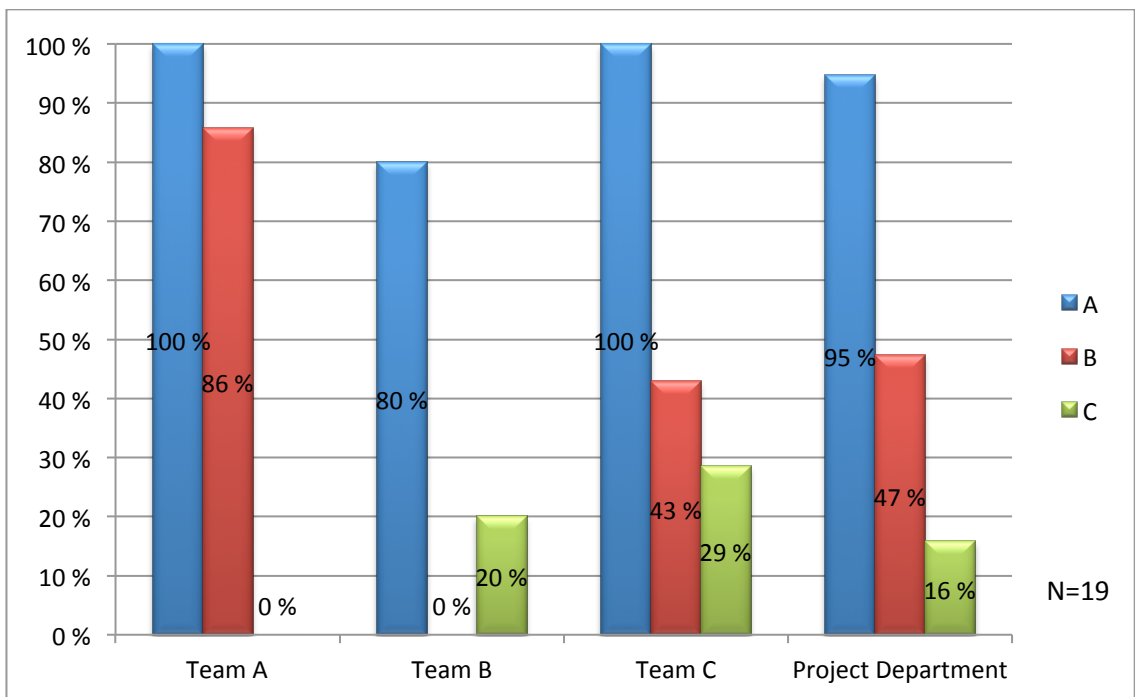


Figure 16. The Team-by-Team view for suitable project level for an Earned Value

Almost all the respondents had a mutual opinion (See Figure 16) that the earned value tools fit best for the A level projects or administer desirable result with more complexes and longer A projects compared to the B or C projects.

Additionally the respondents pointed out in following open ended question that using the earned value tools in a short C or even the B level project can slow the project down or distinct benefits are too minor for the earned value tools used in such a project. These claims have not actually been tested during the first cycle of this action research.

One respondent noted that the earned value data and forecast for the future is valuable addition in steering group progress reports.

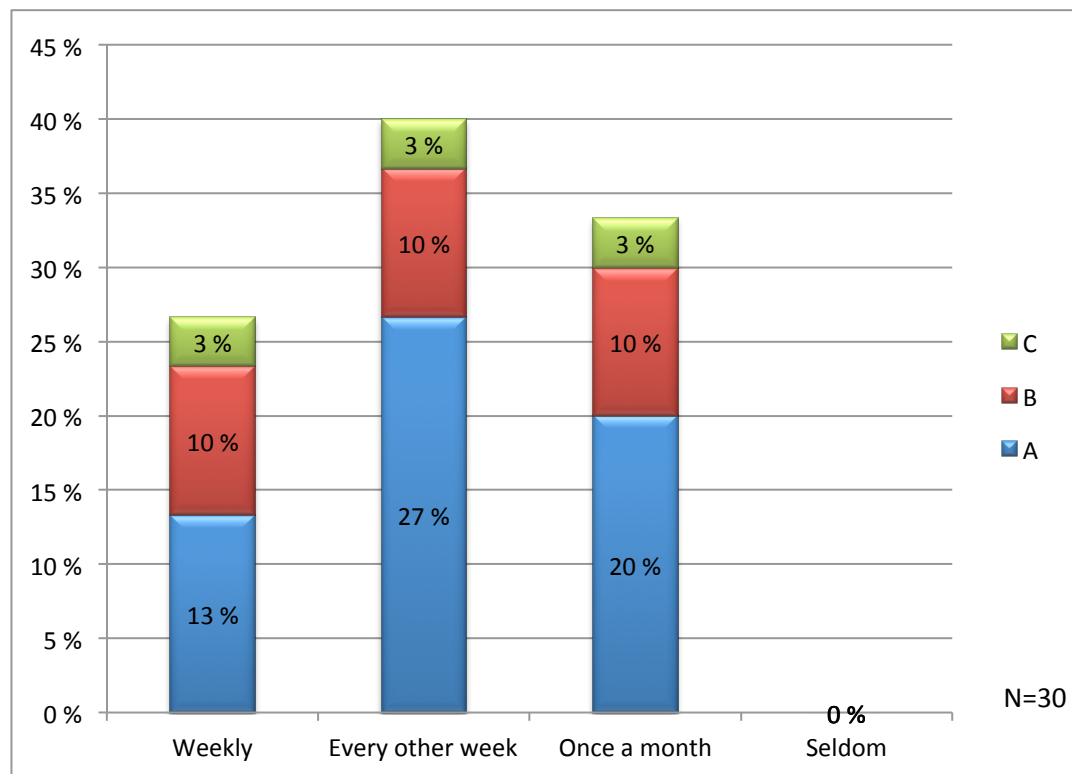


Figure 17. The Interval of the earned value analysis

The respondents evaluated that every other week is the best interval between two earned value analyses. This result formed mainly from the respondents giving answers keeping the A level projects in mind (See Figure 17), since replies for both the B and C levels remained equal in all three first options, 14 percentage for the B level projects and 5 percentage for the C level projects. Interval longer than a month

for the earned value analysis got zero percentage result, so from every ones opinion interval cannot be longer than a month.

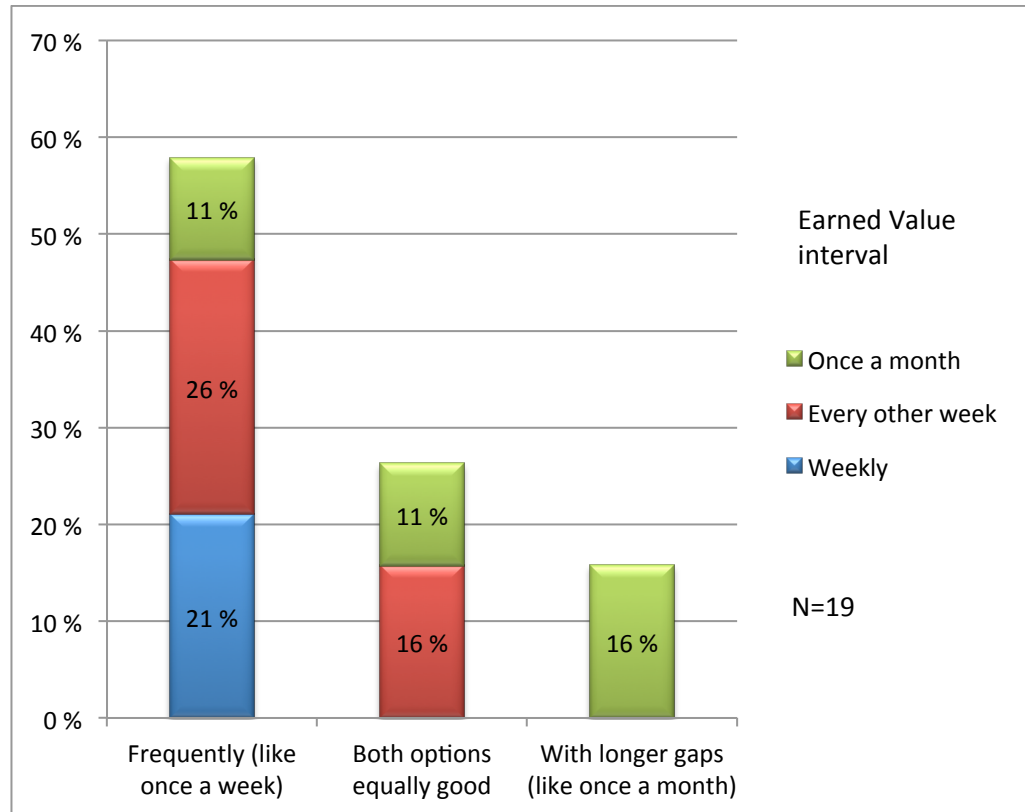


Figure 18. The Data collection interval vs. The Earned value analysis interval

It was interesting to see that even if every other week and once a month got total of 73 percentage of answers for a right earned value analysis interval in Figure 17, 58 percentage of respondents evaluated frequently (like once a week) as a best choice as an interval for collecting progress data from project members (See Figure 18). Why not to collect data for earned value analysis same time with other progress data?

In the open ended follow up question the best options for collecting progress data is the project management system itself with the project members having access to the system. Otherwise the Excel form is used in collecting data from the project members not having access to the project management system. The third option was finding other common system for all the project members and to collect progress

data via that system. Such a system was not mentioned in answers so it was just a theoretical option for the Excel form and the project management system.

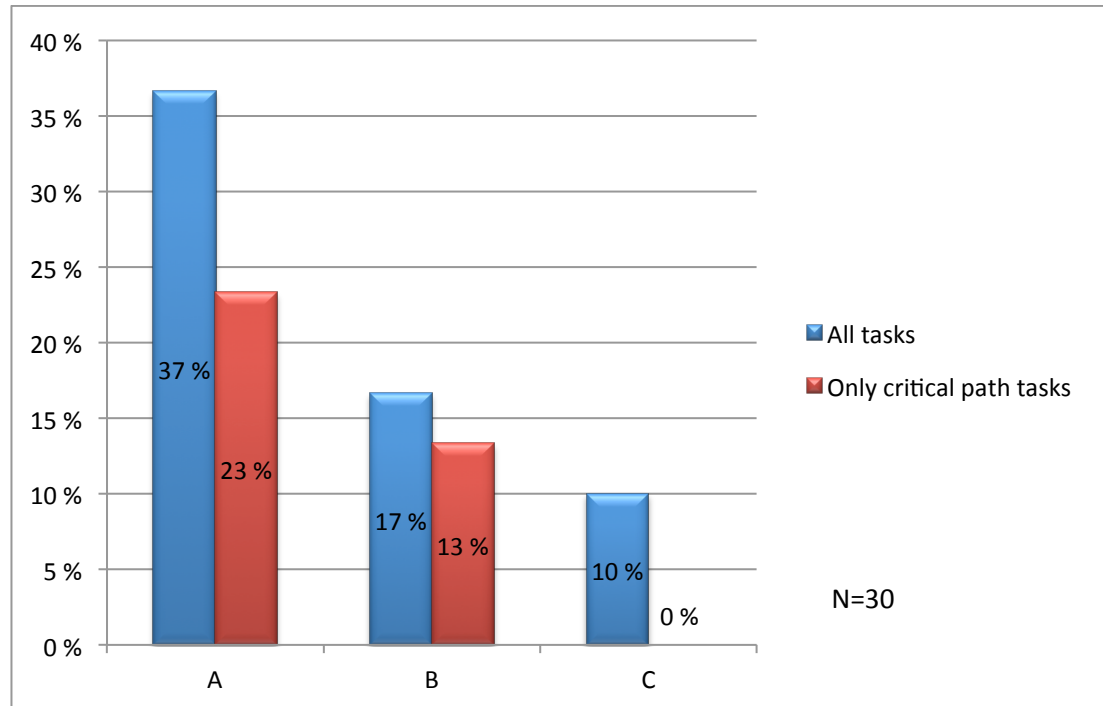


Figure 19. The Critical path tasks vs. all tasks

The Critical path tasks has the maximum importance for the project, but in all the project levels, from A to C, the respondents were favoring all tasks option more than only critical path tasks (See Figure 19). The closest difference was with the B level projects, where 17 percentages of the respondents were favoring all tasks option and 13 percentage only critical path tasks. The C level projects are that simple that no-one has chosen only critical path tasks option.

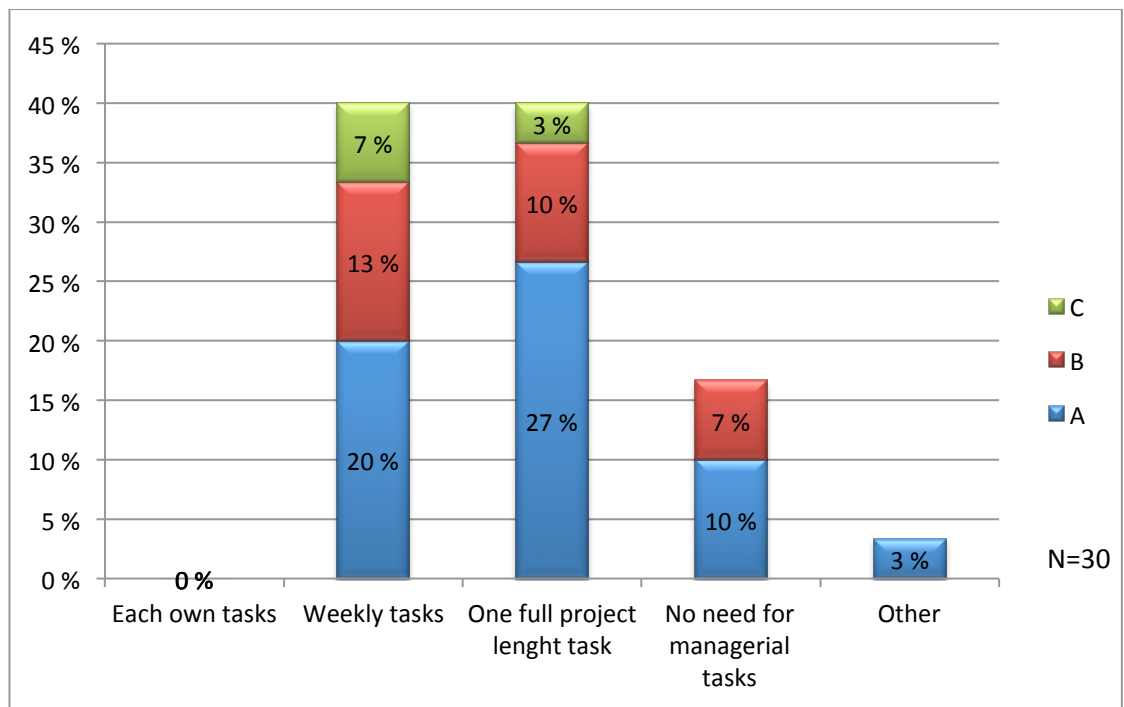


Figure 20. The Managerial work in projects

To have a managerial work included in an earned value, it must exist in the tasks of a project plan. The options, weekly tasks and one full project length task got same amount of answers, 40 percentages each (See Figure 20). Respondents did not see use for a more detailed, each managerial tasks option recommendation. There were also respondents that did not see the value for presenting the managerial tasks at all in the project plans in the B or A levels.

One respondent gave a new view in an open-ended section of this question. Instead of all these choices, the project management work can be stored into heading tasks. Intelligent use of breaking down a project into small sub phases or set of the tasks will create right type of heading tasks for storing the project management work for those tasks.

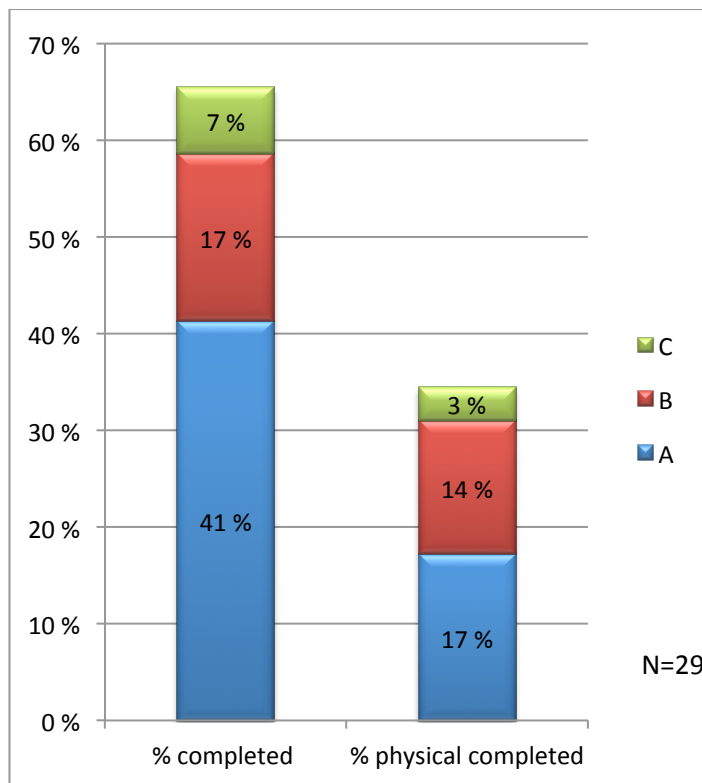


Figure 21. The measurement of a task progress

The percentage (%) completed was a primary option among the respondents with result of 66% of all the answers (See Figure 21). It got more votes in each project level (A-B-C) than the percentage (%) physical completed. Additionally respondents reflected in the open ended questions that, in which kind of tasks percentage (%) completed should be used as their measuring practice and in which kind of tasks physical percentage (%) completed should be used.



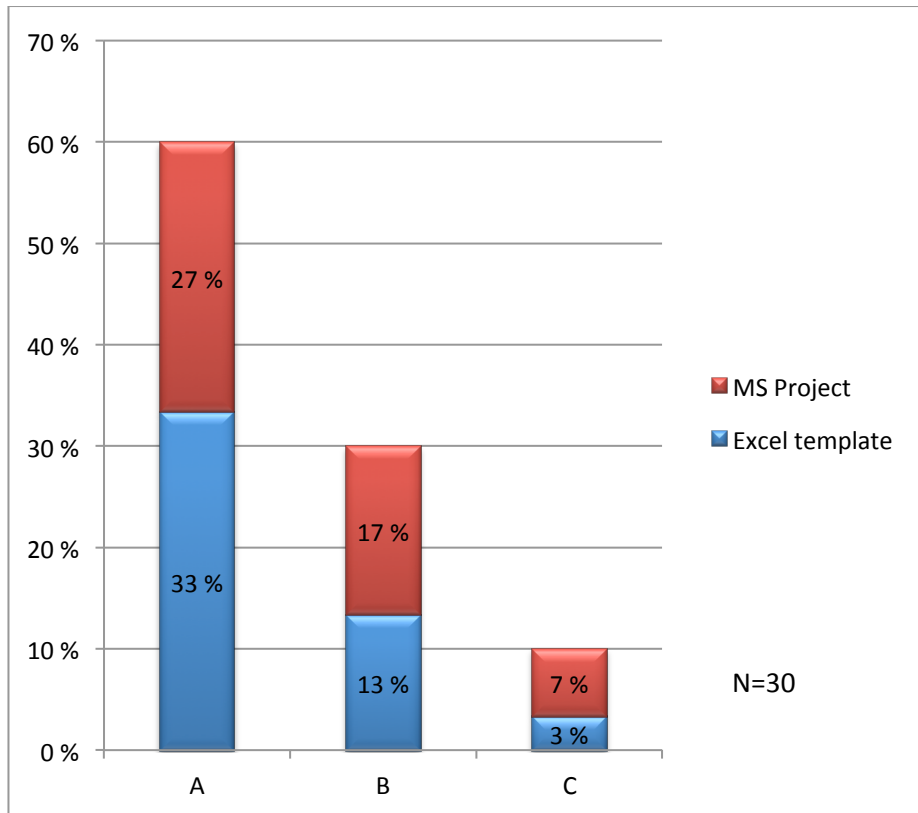


Figure 22. The Tool for calculating the project management work

Previously the Excel template has been in use in calculating first estimation of project management work for a full project. This calculation has been done at the end of pre-study phase of a project. The Excel template was favored more among the complex A level projects but the MS Project was seen as a slightly better option for more simple B and C projects (See Figure 22).

Most of the open-ended question of respondents favoring the MS Project mentioned that the primary reason for using the MS project is to use only one system instead of two. Excel users, on the other hand, liked simplicity of Excel form created for the task.

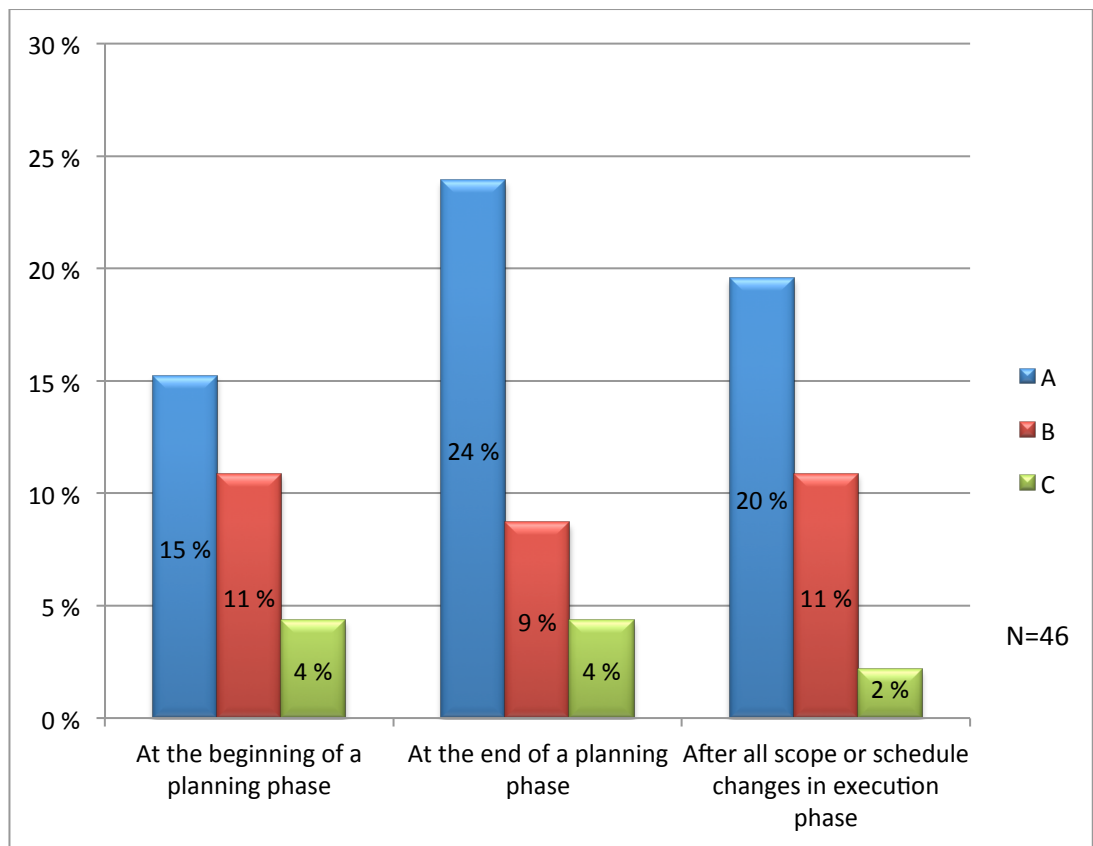


Figure 23. The Storing Baseline

The Baseline is an important element in calculating the earned value in the MS Project. That is why it must be stored in the right moments to get meaningful earned value analysis. All recommended options were evaluated important among respondents (See Figure 23). The least importance was given to a choice – storing the baseline first time at the beginning of a project. This option is only valid if the first version of a project plan has been created in the pre-study phase. Considering a baseline has never been previously stored at an early point of a project, it was not seen as important as other two options.

## 5 DISCUSSION

### 5.1 Conclusions

Earned value and earned schedule tools guide a project manager in project work. A project manager has more data available for decision making with earned value

tools. With more accurate and timely correctly collected methodical data, a project manager can operate more productively because the right decisions can be made faster and less corrections are required during the life cycle of a project.

A project manager has more time to take corrective actions because with earned value tools possible problems can be recognized early on in a project. Considering that corrective actions can be started faster, it advocates project to be cost efficient by minimizing extra costs with quick responses to a surfaced problem or an issue. Furthermore, it counsels a project manager to keep the project in a planned schedule.

Without earned value tools a project manager cannot be sure if the project is definitely on the right track, and when a project manager is not sure about the project status he or she cannot compose reliable progress reports. In other words, when a project manager can rely on the earned value data it will be easier to make progress reports for steering group.

The project department of the case company is aware of what the delay of a project schedule often means. The company will lose money due to delayed invoicing when a project cannot be ended according to the planned schedule of an ICT customer delivery project. With earned value, the project department has better tools for keeping the project costs and schedule under control.

Even though earned value can be used in a project of any size, biggest impacts can be registered in big and midsize complex ICT customer delivery projects. Service fees after a completed project of this magnitude is usually much greater for a customer than in minor project. Therefore every month project prolongs from the original schedule, the case company lacks revenue from missed customer services fees.

The main challenge for the earned value method is collecting the required data. It has to be collected timely and it has to be accurate. The project manager has to make the project group to understand the importance of accurate and timely data. The project manager and the project group also have to agree on a common tool for collecting data and how often everyone has to send their share of the progress data to the project manager.

Because projects have more uncertainties in the early phases, it is better to have frequent enough data collection interval agreed with the project group. This data collection interval can be extended later in the project after the major uncertainties have been passed. Even though the project managers of the department in the case company defined the right interval for progress data collecting to be a week, the suitable interval for earned value evaluation was every other week.

All the changes that occurred in the critical path tasks of a project have a greater effect on the project schedule and/or costs than changes in the other tasks. So, if a project manager wants to minimize the earned value related work, he or she should consider using earned value only with the critical path tasks. This notably reduces tasks that the project manager must keep track of in a project.

Previously an Excel form was used in calculating the cost estimation for project managerial work in a project. This calculation was made at the end of the pre-study phase. If the required tasks are added to the project plan instead, it is possible to get the same data directly from the MS Project with earned value tools. Many project managers of the department were not yet ready to give up the Excel sheet in the work even though three different types of choices to store managerial work in MS Project plans were introduced.

The baseline is an important earned value tool in a MS Project. It is needed in the earned value calculations. The MS project compares the current status date situation to a “snapshot” stored into a baseline. When a new baseline has been stored after every approved change in a project as a separate baseline, it is possible to conduct earned value analyses against all stored baselines, even if the latest baseline is mostly the right one used in analyses.

Besides being an earned value tool, it is also a very visual tool for a project manager, if the project manager puts the feature on. The baseline Gantt chart becomes visible and the project manager can easily view if the project starts getting behind the planned schedule and how different type of corrective actions would change the situation.

## **5.2 Limitations**

All the materials used in this thesis studies and technical articles were from freely accessible sources that were mostly discovered from Internet by using Google scholar article search tool.

It was interesting to find free material from the architect of the earned schedule method from the discovery to current existence of this method and find out that the method has not been changed or updated. So the method was still valid the way it was planned in the beginning.

Some handpicked books or paid articles would have been susceptible to the earned value and the earned schedule concepts besides the material found free from the Internet. There were some inconsistencies of earned value terms and formulas used in free materials. It would have been interesting to ascertain if some good non-free material would have explained those inconsistent issues with in-depth knowledge.

## **5.3 Generalization**

Project management practices are general in their nature. The general project management practices can be used in all type of projects. Undoubtedly software or systems development project is far from construction project, and construction project is far from a project of some other field, so it is good for a project manager to have some expertise or knowledge from a field he or she is going to lead a project. That way the project manager is not overly dependent on knowledge of the project members in understanding a nature of a product or a service produced in a project, and is adept to formulate project plan with deducing dependencies between tasks.

Most findings of this thesis can be used mainly as is with any project organizations that are using the MS Project as their project tool. There were some special practices used in the project department of the case company, but otherwise everything else can be taken into use as such.

#### 5.4 Future research avenues

The research on the schedule adherence might be highly relevant to both academics and practitioners. The promising results on a small set of empirical projects trigger the need for more research. (Vanhoucke 2013)



Figure 24. The Action Research cycle of the thesis

This thesis research included only one action research cycle (See Figure 24). There were many earned value issues and the MS Project features relate to the earned value that can be studied and developed further in the case company. After 3-6 months period of collecting new project data, it is possible to see how findings of this study have benefitted the project department from the user experiences that have been collected during that time period. Additionally comparing this new project data to the old ones studied in this thesis will give insights of the direction the project department has taken between these two data gathering periods.

With best practices collected during the next data gathering period and following the data feedback and the data analysis periods, there are enough data for improving the project work practices further in the project department of the case company. Expected targets for future improvements are mainly in the area of project templates. There are several issues that can be further developed for the project templates.

Fine tuning the task-by task completion level methods based on collected best practices are one issue to study further. It will help the project manager to collect right type of data per each task, improve the progress estimation accuracy, and help the project manager to produce even more accurate progress reports for a project steering group.

Another issue to study further is the use of baseline. There can be suitable supplementary practices found during the data gathering and the data feedback periods. The baseline has been mainly used in a managerial report of all projects in calculating the reliability of the delivery, and during the data gathering and the data feedback periods it should become a solid project management tool, but with new found foremost practices it can still be an even better tool for a project manager.

It is also expected that contemporary practices, or at least the candidates for best practices, will be formed for collecting an earned value related data along with other progress data during the data gathering and the data feedback periods of an action research cycle. Fundamental aim is to find an initial manner for collecting the earned

value data from a project group not just for the status day earned value analysis in the A level projects but also the B and C level projects.

During the next data gathering and the data feedback periods, a fresh and improved ways of storing the project management workload in projects will be expected, so that the project work will be included in the earned value calculations. Also tools for finer suitability to the B and C level projects will be expected.



## RESOURCES

Alleman, Glen B., and Michael Henderson. "Making Agile Development Work in a Government Contracting Environment - Measuring velocity with Earned Value." *Agile Development*. Salt Lake City: IEEE Computer Society, 2003. 6.

Anbari, Frank T. "Earned Value Project Management Method and Extensions." *Project Management Journal*, 2003: 12.

Association of Modern Technologies Professionals. *Project Management Body of Knowledge (PMBOK) Guide*. 2014. <http://www.itinfo.am/eng/project-management-body-of-knowledge-pmbok-guide/> (accessed 3 2014, 2014).

Avison, David, Francis Lau, Michael Myers, and Peter Axel Nielsen. "Action Research - To make academic research relevant, researchers should try out their theories with practitioners in real situations and real organizations." *Communications of the Acm*, 1999: 4.

Axelos. 20. March 2014. <http://www.prince-officialsite.com/> (haettu 20. March 2014).

Barton, Brent, Thomas Blackburn, and Tamara Sulaiman. "AgileEVM – Earned Value Management in Scrum Projects." *AGILE 2006 CONference*. Minneapolis: IEEE Computer Society, 2006. 10.

Brydon-Miller, Mary, Davydd Greenwood, and Patricia Maguire. *Why Action research?* SAGE Publications, 2003, 20.

Cable, John H, Javier F Ordonez<sup>1</sup>, Gouthami Chintalapani, and Catherine Plaisant. "Project Portfolio Earned Value Management Using Treemaps." *Proc. of Project Management Institute research conference*. London: [www.pmi.org](http://www.pmi.org), 2004. 13.

Cabri, Anthony, and Mike Griffiths. "Earned Value and Agile Reporting." *AGILE 2006 CONference*. Minneapolis: IEEE Computer Society, 2006. 6.

Cadle, James, ja Donald Yeates. *Project Management for Information Systems, 5th ed.* Pearson Education Limited, 2008.

Christensen, David S. "The Costs and Benefits of the Earned Value Management Process." *Acquisition Review Quarterly*, 1998: 14.

Christensen, David S. "Value Cost Management Report to Evaluate the Contractor's Estimate at Completion." *Acquisition Review Quarterly*, 1999: 14.

Coughlan, Paul, and David Coughlan. "Action research for operations management." *International Journal of Operations & Production Management*, 2002: 21.

Crumrine, Kevin T., ja Jonathan D. Ritschel. "A Comparison of Earned Value Management and Earned Schedule as Schedule Predictors on DOD ACAT 1 Programs." *The Measurable News*, nro 2 (2013): 37-44.

Davidson Frame, J. *The New Project Management - Tools for an age of rapid change, complexity, and other business realities*. Second Edition. San Francisco, California: Jossey-Bass A Wiley Company, 2002.

Dinsmore, Paul, and Jeannette Cabanis-Brewin. *AMA Handbook of Project Management, 2nd ed.* AMACOM, 2006.

Fleming, Quentin W, and Joel M. Koppelman. "Earned Value Project Management, A Powerful Tool for Software Projects." *The Journal of Defense Software Engineering (CROSSTALK)*, July 1998: 5.

Fleming, Quentin W, and Koppelman Joel M. "Earned Value Management. Mitigating the Risks Associated with Construction Projects." *PM: March - April*, 2002: 6.

Hedeman, Bert, and Ron Seegers. *PRINCE2 2009 Edition - A Pocket Guide*. Zaltbommel: Van Haren Publishing, 2012.

Henderson, Kym. "Further Development in Earned Schedule." *The Measurable News*, 2004: 15-22.

ILX Group. *What is Prince2?* 2013. <http://www.prince2.com/what-is-prince2> (haettu 20. March 2014).

IPMA. *About IPMA / IPMA: International Project Management Association*. 2014. <http://ipma.ch/about/> (accessed March 20, 2014).

—. *Certification / IPMA: International Project Management Association*. 2014. <http://ipma.ch/certification/> (haettu 20. March 2014).

Järveläinen, Pekka / Wakaru, interview by Marko Häkkinen. *Prince2 foundation training* (02 17, 2014).

Kananen, Jorma. *Toimintatutkimus yrityksen kehittämisessä*. Edited by Eva Ijäs. Jyväskylä: Tampereen Yliopistopaino Oy - Juvenes Print, 2009.

Levine, Harvey A. "Practical Project Management: Tips, Tactics, and Tools." *A Quarter Century of Project Management Evolution*, 2003.

Lewis, James P. *Fundamentals of Project Management: Developing Core Competencies to Help Outperform the Competition - 2nd ed.* New York: AMACOM, 2002.

Lipke, Walt. "Earned Schedule - Ten Years After." *The Measurable News*, March 2013: 15-21.

Lipke, Walt. "Earned Schedule Contribution to Project Management." *PM World Journal*, no. 2 (2012): 19.

—. *Earned Schedule Terminology*. 2006. <http://www.earnedschedule.com/Terminology.shtml> (accessed April 16, 2014).

Lipke, Walt. "Project Duration Forecasting ... A Comparison of Earned Value Management Methods to Earned Schedule." *The Measurable News*, 2009.

Lipke, Walt. "Schedule Is Different." *The Measurable News* (Tinker AFB), 2003: 31-34.

Lipke, Walt, and Kym Henderson. "Earned Schedule – A Quantum Advance." n.d.

Lipke, Walt, and Kym Henderson. "Earned Schedule: An Emerging Enhancement to Earned Value Management." *CROSSTALK The Journal of Defense Software Engineering* (CROSSTALK online), November 2006: 26-30.

Microsoft Corporation. *Applying earned value analysis to your project - Project - Office.com*. n.d. <http://office.microsoft.com>.

MP, The Rt Hon Francis Maude. *New deal will market government professional qualifications*. April 26, 2013. <https://www.gov.uk/government/news/new-deal-will-market-government-professional-qualifications> (accessed March 31, 2014).

PMDAN. <http://pmdan.org/en/certification/ipmas4lcsystem/>. 2012.  
<http://pmdan.org/en/certification/ipmas4lcsystem/> (haettu 20. March 2014).

PMstudy. *PMP Training Boston*. 2014. <http://www.pmstudy.com/Boston/pmp-training.asp> (accessed March 20, 2014).

Project Management Institute. *A Guide to the Project Management Body of Knowledge (PMBOK Guide) - 2000 ed*. Newtown square: Project Management Institute, Inc., 2001.

Project Management Institute PMI. *Which Certification is Right for You*. 2014. <http://www.pmi.org/Certification/Which-PMI-Certification-is-Right-for-You.aspx> (haettu 20. March 2014).

PRY - Projektiyhdistys ry. *PRY / IPMA-sertifiointi*. 2014. <http://www.pry.fi/ipma-sertifiointi> (accessed March 20, 2014).

Queensland University of Technology. *Creating value in project management using PRINCE2*. Queensland University of Technology, 2010.

Reason, Peter, and Hilary Bradbury. *Handbook of action research, Participative Inquiry and Practice*. n.d. <http://www.gobookee.org/sage-handbook-action-research/>.

Schwaber, Ken, and Jeff Sutherland. "Scrum Guide - Scrum.org The home of Scrum." *Scrum.org The home of Scrum*. July 2013. <https://www.scrum.org/Scrum-Guide> (accessed March 20, 2014).

Scoll Methods. *PRINCE2 Intro*. 2009.  
[http://www.scoll.co.uk/PRINCE2\\_Intro/Using\\_PRINCE2\\_/Design\\_and\\_appoint\\_the\\_project\\_management\\_team.htm](http://www.scoll.co.uk/PRINCE2_Intro/Using_PRINCE2_/Design_and_appoint_the_project_management_team.htm) (accessed March 21, 2014).

Siegelaub, Jay M. *How PRINCE2 Can Complement the PMBOK Guide and Your PMP*. Impact Strategies LLC. Ossining, New York: APMG-International, n.d.

Turkey, Frank. *An Introduction to PRINCE2*. MgmtPlaza, 2010.

Turner, J Rodney. *Gower Handbook of Project Management, 4th ed.* Gower Publishing Limited, 2007.

Van Haren Publishing. *Prince2 in 3 minutes*. July 31, 2012.

<http://blog.vanharen.net/project-management/prince2-in-3-minutes/> (accessed March 21, 2014).

Vanhoucke, Mario. "Measuring Schedule Adherence." *The Measurable News*, no. 4 (2013): 21-26.

Velde, Robert Van De. "Earned Schedule for Agile projects." *The Measurable News*, 2014: 29-35.

Velde, Robert Van De. "Time Is Up: Assessing Schedule Performance with Earned Value." *PM World Today* 9, no. 10 (2007): 10.

Wideman, R. Max. "Comparing PRINCE2 with PMBoK." *PM4success - Looking for new perspectives*, 2002: 9.

Wysocki, Robert K. "Effective Project Management—Traditional, Adaptive, Extreme." *Information Systems Control Journal, Vol 5*, 2007.