APPLIED MACHINE LEARNING: PROJECT MANAGEMENT PERFORMANCE PREDICTION AT INFORMATION TECHNOLOGY COMPANY PROJECT MANAGEMENT OFFICE

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"I feel a longing for a country faraway where everyone lives freely"-The Disconnected, Oğuz Atay

ABSTRACT

Recently, sophisticated decisions and predictions are being done with a very high success rate by computers. Because of the lack of entrepreneurial cultures in an organization, many of the traditional methods are still being used today. The aim of this study is to initiate the usage of machine learning in the possible ways and to talk about the necessary culture and talent. Within the project management office, tomorrow's value management is an important capability to anticipate tomorrow's performance of the team, and neural networks can help project-based organizations. This thesis shows that machine learning can be applied to project management and helps decision support, saves time because of its prediction ability. Openness, structured approach, talent, organizational culture are major needs for absorbing new challenges to keep competitive advantage. For further work, performance of project management can be related to social behavior or external effects depending on various topics.

Key words: project management, team performance, prediction, technology consulting, earned value management (evm), machine learning, business intelligence

RIEPILEGO

Recentemente, le decisioni e le previsioni sofisticate sono state fatte con un altissimo tasso di successo dai computer. A causa della mancanza di culture imprenditoriali in un'organizzazione, molti dei metodi tradizionali sono in uso ancora oggi. Lo scopo di questo studio è quello di iniziare nell'utilizzo del machine leaning in tutti i suoi modi possibili e di parlare della cultura organizzativa e del talento necessario, per implementare questa metodologia. All'interno dell' organizzazione di progetto, la gestione del valore di domani è un aspetto molto importante al fine di anticipare le prestazioni future del team di progetto; le reti neurali possono aiutare le organizzazioni "project-based" a fare questo tipo di previsione. Questa tesi dimostra che il machine learning può essere applicato alla gestione del progetto e aiuta il supporto decisionale, consente di risparmiare tempo, questo grazie alla sua capacità di previsione. L'apertura, l'approccio strutturato, il talento, la cultura organizzativa sono tra le principali esigenze per l'assorbimento di nuove sfide e per mantenere un vantaggio competitivo. Per ulteriori lavori, le prestazioni della gestione di un progetto possono essere correlate al comportamento sociale o ad altri effetti esterni di vario genere.

Parole chiave: gestione del progetto, le prestazioni della squadra, di previsione, di consulenza tecnica, earned value management (EVM), apprendimento automatico, business intelligence

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LIST OF ABBREVIATIONS

EVM	Earned Value Management
BAC	Budget at Completion
EV	Earned Value
PV	Planned Value
EAT	Estimate at Completion
SPI	Schedule Performance Index
VAC	Variance at Completion
CPI	Cost Performance Index
TCPI	Total Cost Performance Index
KIF	Knowledge Intensive Firm
IT	Information Technology
AI	Artificial Intelligence
AC	Actual Cost
N	Number of Team Members
CC	Communication Channels
LS	Late Start
ES	Early Start
LF	Late Finish
EF	Early Finish
ANN	Artificial Neural Network
ACWP	Actual Cost of Work Performed
AOA	Activity on Arrow
AON	Activity on Node
PERT	Program Evaluation and Review Technique
CPM	Critical Path Method
PDM	Precedence Diagramming Method

EXECUTIVE SUMMARY

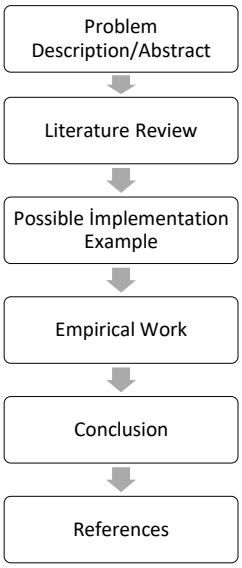

Figure 0-1 Methodology of the work

Research Objectives

Recently machines are taking over humans in complicated tasks. This work aims to describe and discuss possible application of artificial intelligence, with the advance of AI in decision making which its success is proven in many complicated tasks. Trends in businesses such as artificial intelligence and design thinking is actively changing knowledge intensive sectors and shaping knowledge workers' daily life.

Project management office is place where companies started to give control of their projects, many IT companies are seen as project based companies and projects are extensive education for organizations with their change culture.

To enable knowledge workers sophistically make decisions, business intelligence systems are becoming important for every organization soon artificial intelligence application will be important in organizations. Through right methodology artificial intelligence can be applied to many cases, also how these changes should be absorbed by organization is another important question. Starting from project management offices due to change culture within their nature, project management office is good place to start. Many theories

are hard to implement directly in real world due to fears nested and communication problem.

This work starts with design thinking methodology as it is used for finding solutions and used for enabling innovation in many other companies. Project management work can be assigned to artificial intelligence by changing work into quantitative measure. Using artificial intelligence to predict earned value calculations is becoming popular. Predicting near future possible result, gives insight to create relations to understand unpredicted measures relation to outcome for the given input.

Literature review

To cover the topic and understand its interdisciplinary needs, it is very important to have interdisciplinary look and use various sources. Mainly in journals for project management, books for systems, researches related to machine learning is used for understanding relation and application possibility.

Empirical Implementation

Design thinking approach used to idea generation and execution. New program developed depending on the needs of project management lead. Program helps to easily track project status. Tracking generates data which is applied to created neural network to predict project earned value management calculations. Also, person who should do this job is discussed.

Conclusion

To survive in today's competitive business world, projects are intensive learning opportunity for companies, many organizations are seen as project based organizations in today's economy. Project based approach also brings many repetition due to its nature of quantitative approach for work. Machine learning is advancing and it is coming to take over companies and jobs of many people while creating many jobs at the same time. To apply new developments and enable competitive advantage, transformation should be accomplished without losing the talented employees. This work shows that machine learning can be applied to project management and decision support.

1. INTRODUCTION

Business world is changing and companies which can not absorb this change is not able to keep competitive power. In a regular work day, repetitive tasks are expected to exist and usually seen as demotivating and time consuming while having effect on talented employee turnover. This work aims to answer how to implement machine learning in project management in order to have intelligent decision making in project management office. Neither design thinking in IT sector nor machine learning is new, this work tries to give end to end approach for an organization, starting from the employee and changing the way of work. Knowledge workers are being used for time consuming repetitive tasks and their kept fears coming from many sources let many decisions done intuitively. Business intelligence systems can be great for sophisticated decision making and data generated by such systems can be used for machine learning applications. With further researches every process in project management office can be rationalized and transformed to create a bigger system that can decide by itself in the organization to help leads to keep organization's competitive advantage. Assigning computers to repetitive tasks may help increasing employee happiness and communication in office resulting less turnover. Computers could bring chaos after replacing humans with machines but it is hard to understand what it will bring to business world.

This work introduces an example of usage for machine learning in technology company and implementing tools to find and define problem and solution by ascending trends such as design thinking, project management, machine learning.

2. LITERATURE REVIEW

2.1. Design thinking methodology on knowledge intensive firms

Today from management courses to software classes or IT company to architecture companies it is used various methods to find the answers for the challenges.

Many controversial ideas exist on design thinking, some believe it is an existing method that tells what we already now in a fancy way, some people say it is a tool that helps to implement that we already now but cannot go further. 'Design Thinking' is the term of the collective methodology to approach issues and create consciousness, it is one of the pillars for today's design researchers since Rowe titles his book (Rowe, 1987). A methodological research on design thinking is accepted as the exploratory approach into design and methodology by research symposium of design thinking (Cross, Dorst, & Roozenburg, 1992). Today it is a big trend that interdisciplinary work is being used by applying of design thinking methodology and tools. World's biggest tech companies now state that they use design thinking approach to handle issues and innovate. Empirical studies of knowledge intensive firms typically include professional services firms and high-tech companies, but management and IT consulting are the firms most commonly referred (Alvesson, 1995;Kärreman et al., 2002; Morris, 2001; Morris & Empson, 1998; Robertson & Swan, 2003, 2004; Starbuck, 1992; Rylander, 2009) and studied. To conclude, on the one hand, better understanding of design thinking as problem-solving may help kifs and how value is created by designers to widening the "knowledge economy" theories on knowledge work practices can be studied on KIFs. On the other hand, applying the perspective of knowledge work to the work of designers could contribute to filling the gap in design (Rylander, 2009).

There are not much studies for design firms with this literature due to design approach is not very well applicable to create a methodological cumulative knowledge reference. Conceptualization and knowledge creation is more related to work of organizational approach (Elkjaer, 2000).

Today popular culture tech companies (e.g. Apple, Google) are agile ones and they adapt and use methodologies generating knowledge, that's why many tools and methodologies are tested in IT sector, tech or consulting firms. Work of Schreyögg and Geiger (2007) represents this generalizing "knowledge-intensive firms are first firms which make intensive use and/or generate knowledge in the discursive mode" (p. 91) in other words consulting or IT companies are good trial zones for all these new approaches to be tested and used. As it is seen in many modern companies' private rooms are transforming into open space working zones to preclude embodied tacit knowledge to enable internal communication and most of the cases it is promoted (Selig, Stettina, Baltes, 2016). Enabling and adapting new methods suits better for Startups but as it is shown by researches, seems better suited for radical innovation (Salerno, Gomes, Leonardo Augusto de Vasconcelos, Silva, Bagno, & Freitas, Simone Lara Teixeira Uchôa, 2015). They are highly reactive and fast organizations with flat organizational structures (Paternoster, Giardino, Unterkalmsteiner, Gorschek, & Abrahamsson, 2014; Selig, Stettina, Baltes, 2016).

Recently rise of tech companies increased project domain works and most commonly companies payed by projects performance and total job done in a specified boundaries and functionalities. Given the project managers increased importance, project managers are becoming important with increasing number of projects and project based organizations (Eriksson, 2013; Selig, Stettina, Baltes, 2016). It is expected as a role to lead multinational and multidisciplinary teams that creates the necessity of being high level and high scope. Hence a project manager needs to be a generalist with a high level of interpersonal skills (Pettersen, 1991; Pitsis, Kornberger, & Clegg, 2004; Selig, Stettina, Baltes, 2016).

Mostly it is expected and missioned as the manager role should encompass functional junior, middle and senior managers. They may be responsible for planning, leading and controlling parts within an organization (Paternoster, Giardino, Unterkalmsteiner,

Gorschek, & Abrahamsson, 2014; Selig, Stettina, Baltes, 2016) it is important to focus on controlling part especially. It is another supporting reason for this work to be focused on knowledge intensive firms and IT sector. Companies applying high level systems and technology, it is called knowledge intensive work where people use their intensive knowledge. Focusing on IT sector leads this work to topic of project management or other way around focusing on project management lead this work to IT sector. As a highly dependent to projects, IT work expected to be managed by daily tracking and dependent to project manager.

As it is very popular methodology, "Design Thinking" is accepted as an exciting new paradigm for dealing with problems in many professions, most notably Information Technology (IT) (e.g. Brooks, 2010) and business (e.g. Martin, 2009).

Many technical universities of today, launched design education under their educational activities which can be accepted as the eagerness to adopt and apply design practices in to other fields and benefit from, also many companies are already adopting Design Thinking tools and methodology knowledge or willing to adapt into their organizations. It may also be founding as a controversial problem from design point of view as it is an oversimplifying approach and conflicting with the design approach which cherishes of the idea to have multiple perspectives and rich pictures (Dorst, 2011).

New organizations are the ones who is keeping up with the transformation velocity same with the trends and able to provide new era's needs. New organizations are differentiated from others with their usage of design in business. "The approach is in large part a response to the complexity of many products, services, and processes. People need help--they need their interactions with technologies and other complicated systems to be intuitive and pleasurable. Design thinking is an essential tool for simplifying and humanizing." describes Jon Kolko(2015) in "Design Thinking Comes of Age" article on HBR. Some knowledge intensive firms are very confident in thinking processes, design thinking methodology on consulting is described and formulated with 5 steps by Deloitte as "discover, define, develop, demonstrate, deliver".

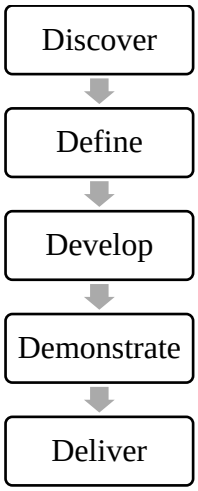

Figure 2-1: Design thinking approach to describe culture in new organization.

Note. Adapted from "The New Organization: Different by Design", Deloitte University Press (2016)

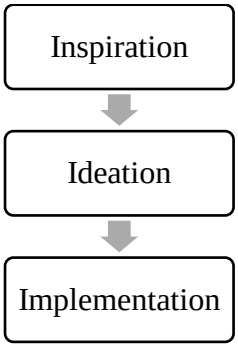

Figure 2-2 Design thinking methodology by Brown (2008)

Note. Adapted from "*Design Thinking."* by Brown, Tim. (2008) Harvard Business Review (2008). Web. 12 Oct. 2016 at [www.hbr.com]

Brown (2008) describes (fig.2-2) design thinking as inspiration, ideation, implementation. As it is described before, companies are looking to generate ideas and many design firms are working with the companies such as IDEO. Implementation of design thinking is described by CEO of Ideo as "Design thinking is a human-centered approach to innovation that draws from the designer's toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success.".

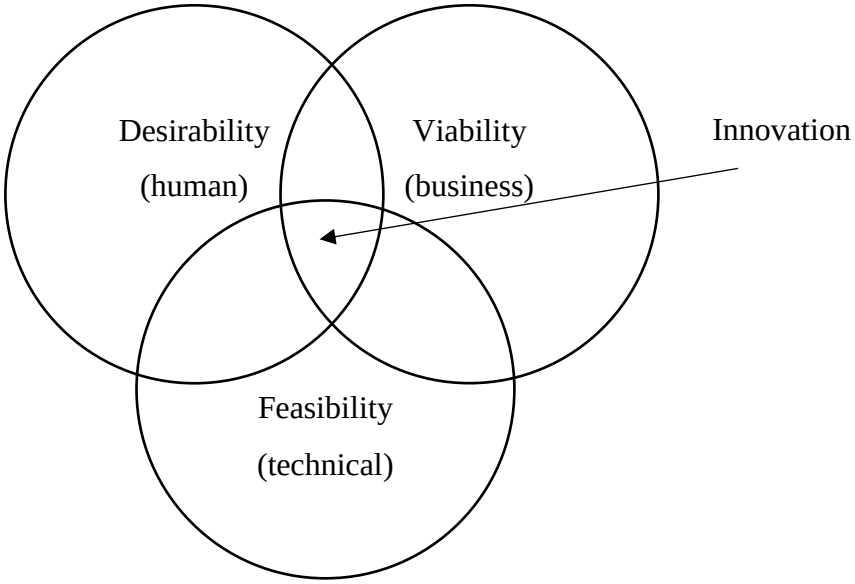

Figure 2-3 IDEO's Design Thinking Approach

Note. Adapted from web http://www.ideou.com/pages/design-thinking Feb.2017).

Design thinking is a deeply human process that taps into abilities we all have but not seen as more conventional problem-solving practices. It relies on our ability to be intuitive, to recognize patterns, to construct ideas that are emotionally meaningful as well as being functional and to express ourselves through means beyond words or symbols. Nobody wants to run an organization on feeling, intuition, and inspiration, but an over-reliance on the rational and the analytical can be just as risky.

Ideo's design thinking practice is described in four courses. In the process of design thinking Ideo as a company has an impact on businesses, suggests that to get the hearth of your business challenge, it is important to make empathy and observation. They sum up the first stages as four courses.

From ideas to action phase, aims to generate new ideas and bring them to life as a product or service. It is applicable for any real-world challenge as Ideo states. In businesses, you are not alone and senior management is usually on power, to motivate other and win seniors, storytelling is a major ability to influence others toward action. Furthermore,

organization's creativity should be enhanced by leading for creativity, it is important to benefit from organization's creative potential. Strategically it is very important to set high vision expectations and create actionable challenges for reach it, adjusting culture by guiding teams to designing rituals and spaces, through the process of experimentation (Brown, 2008).

2.2. Project Management

Business world is being changed by projects, influenced and employees are being pushed to make implementation in more methodological ways. Changing and shifting are an intensive learning for organizational firms to survive in changing environment as an organization (Gareis, 2010). Project based approach is challenging and expected as needs some skills such as management's ability to enhance flexibility and remove barriers to let company more adaptable in these shifts (Gomes et al, 2008; Lockett et al, 2008; Lord, 1993; Adjei, D. Rwakatiwana, P., 2009). In many project examples chaos and order are being productivity enhancer which is a need of project (Geraldi, 2008). It is accepted as two approaches exist, which are plan or process approach (Turner 1999, Boehm 2002). Some researchers criticize as a case of use in very well settled and planned situation without uncertainties (Atkinson 2006), which are mostly used in classical projects with less uncertainties.

Companies are being called as project based firms as increasing number of companies are being shifted to project based instead of old method (Fernandez and Fernandez, 2016; Sauser et al, 2009; Grundy and Brown, 2004; Kerzner, 2003; Adjei, D. Rwakatiwana, P., 2009).

Unprecedently evolving business sectors (Shenhar, 2004; Nobeoka and Cusumano, 1997; Hauc and Kovač, 2000; Gallo and Gardiner, 2007) bring projects that are becoming more and more complex day by day in professional life (Papke-Shields et al, 2009; Rodrigues and Bowers, 1996) making it difficult to predict project behavior (Fernandez and Fernandez, 2016) not like in old projects and slowly changing technology.

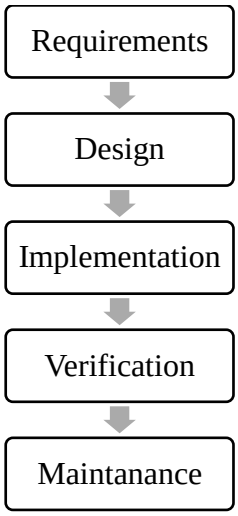

Figure 2-4 Classic Waterfall Model for Large Software Programs

Note. Adapted from "Classic Waterfall Model for Large Software Programs," by R. Winston, 1970, *Managing the Development of Large Software Systems*

In many IT companies, it is being seen that many customer are doesn't have a clear decision on what they want (Cadle and Yeates, 2008), especially in IT consulting many problems related to functions, while every change effects project success ratio. By being dependent to stakeholders (PMBOK5th, 2013) and project management measurables (e.g. time/cost), quantitative manners are being used to track the status while project success goes further such as focusing on longer-term and customer-oriented results (Papke-Shields et al., 2010). It is expected to be known possible effects on the project management work, ongoing situation and predictions, on the other hand it should not be overseen how Jugdev and Müller (2005) states as project success and project management success are different terms.

As many disciplines are evolving also project management discipline is evolving to be able to succeed in today's circumstances. To keep pace with fast evolving project climax one approach is agile project management which is mostly used in software development as an approach for development in software sectors. Many references accept agile methodology, such as PMBOK, an applicable approach on other projects.

Schuh (2005) suggests that agile project management is an approach that uses iterations to proceed in steps of project management compared to traditional method which needs some sharp certain borders. Not having these certainty boundaries makes agile management method a good way to approach high uncertainty hence it eliminates last minute decisions which are very costly in traditional method of project management. Agile methodology is a need for uncertain projects such as IT which is not totally clear and without determined borders. Organizations aim to have effective results are accepted to adapt these methodologies inside their cultures (Sharifi and Zhang, 2001). Every change increases the costs of project that are not planned before and hence it is important to keep project under the budget limitations, it is very important to keep track and take early decisions to prevent having over budgeting problem. For the uncertainty issues related to project management, prioritizing is a core aim of agile management methodology. Agile is being used and adopted increasingly related to success cases in knowledge intensive firms to various industries, dealing and clustering complexities and uncertainties (Griffiths, 2007).

Nowadays it is being loudly said that agile is a successful approach and seen in many industries from consulting to IT. There are increasing numbers of programs, certificates and professional courses (e.g. PMI/Prince) to make people adapt and bring change, have successful results in projects. Some researchers found out that agile methodology has a value to add for successful ends to projects (Collyer and Warren, 2009). Very well-known project management methodology may fit the place where the other doesn't fit well but it does not mean that you should embrace one fits all approach. Depending on the project, inputs, formality, industry, customer and so on, there might be different benefits and match with the project related to project management needs. Cicmil (2006) suggest that there is no need to adopt only one method in project management method, ought to be approached more systematically to find better fit for related project with appropriate management system. Some other scholars (Alite and Spasibenko, 2008; Hass, 2007; Geraldi, 2008) also indicates that blending the two approaches may be the best way to proceed in project management. Common issue is to face with companies having difficulty to not understand project management exercise, creates obstacles for that are new or established ones (Fernandez and Fernandez,2016).

2.2.1. Rigid and detailed planning

PMBOK (2013) states that planning process group finalize the project plan, it becomes the base for how project will be executed, monitored, controlled and closed. Traditional approach on project management(TPM) is mostly stressed on the need of having a detailed roadmap (Shenhar, 2004) and developing the project budget and schedule (Saladis and Kerzner, 2009). Due to the need of the structured and rigid plan, process will be detailed and follow formal procedure for changes (Conforto and Amaral, 2008; Fitsilis, 2008; Schuh, 2005). Executing phase of the project, execution group doesn't have the power to apply the changes if it is proposed by themselves and look for an approval from senior management, here it is a good point to state again it is important to have storytelling and open communication to convince seniors. Monitoring and control phase benefits from detailed planning, for example in order to preclude confusion among the stakeholders (Saladis and Kerzner, 2009). Also as responsible of measuring progress and identifying variances of reality and plan, monitoring and control group may take some actions. Saladis & Kerzner (2009) states that this ability to check plan versus real-time process in the project, increases delivery rate on time.

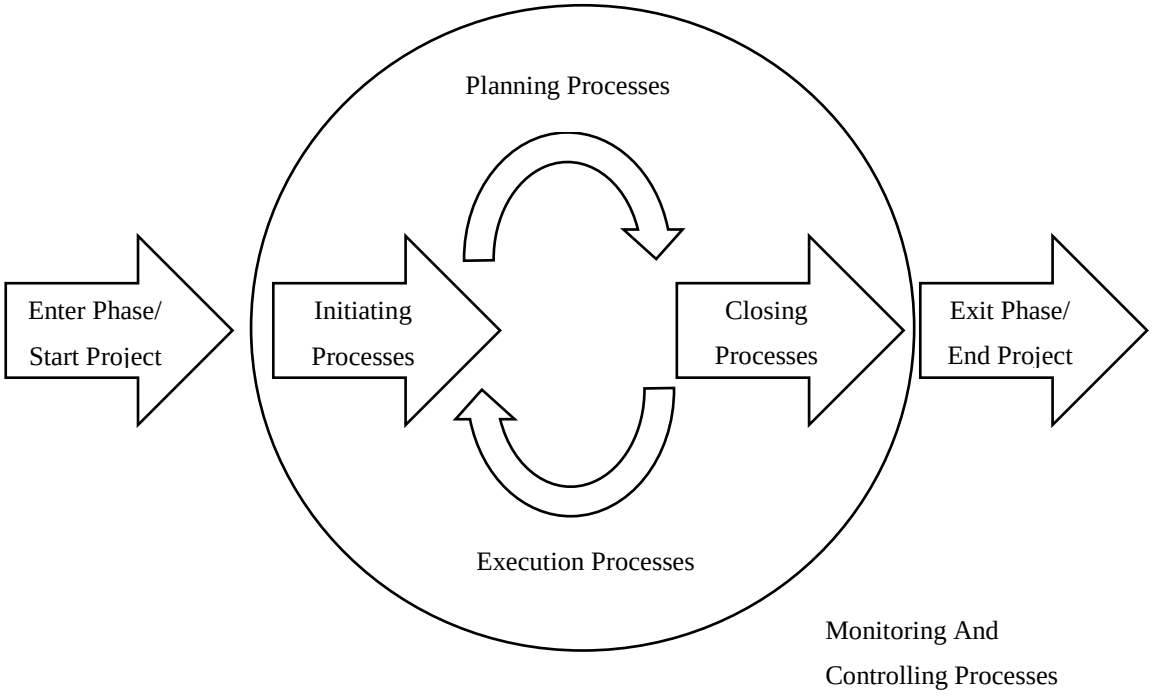

Figure 2-5 Monitoring and Controlling Processes in Project Management

Note. Adapted from *A Guide to the project management body of knowledge PMBOK5th* (p. 50), by PMI Institute, 2013, Pennsylvania: Project Management Institute Inc. Copyright 2013 by " Project Management Institute Inc ".

Project is divided to phases and small processes to make an analytical evaluation of project. In this work, it is mainly focused on monitoring and controlling. Daily monitoring to understand status, updated situation on project, which is execution, and its effects to earned value management. Execution is done by people and it is hard to analytically evaluate people in this cost-effective approach, performance can be measured as monetary value.

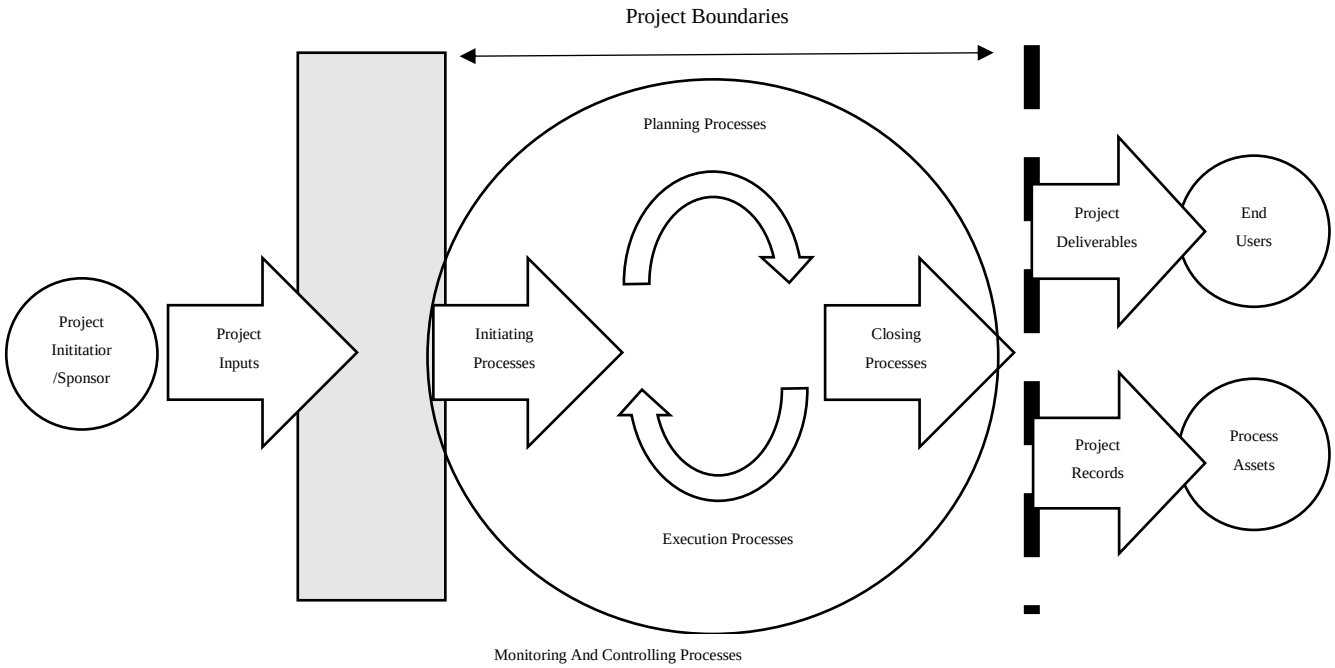

Figure 2-6 Project Boundaries to divide project into processes
Note. Adapted from *A Guide to the project management body of knowledge PMBOK5th* (p. 54), by PMI Institute, 2013, Pennsylvania: Project Management Institute Inc. Copyright 2013 by " Project Management Institute Inc ".

It is very important to create flow charts to understand how processes can be represented as steps and in every step circumstances, people can change the detail level in order to sophisticated analyze of the situation in project. In an example execution can be spread to couple of remote places around the world, all these inputs should be considered to have precise decision making. Here importance of information system's importance is seen.

2.2.2. Agile Project Management Approach

Increasing number of businesses are being evolved to pace up with digital transformation and methods are being created to push for better results in order to bring change. Big organizations, big decisions or complex systems are pushing higher the standards of planning, processing. Sometimes traditional approaches are not able to answer the needs of complex projects such as complex software developments where agile is being answer in software development methodology. Uncertain complex issues in software development, producing an airplane or complex systems, all need specific knowledge including managerial tasks in a gigantic scale(fig.2-7) where uncertainty is high relatively it is complexity.

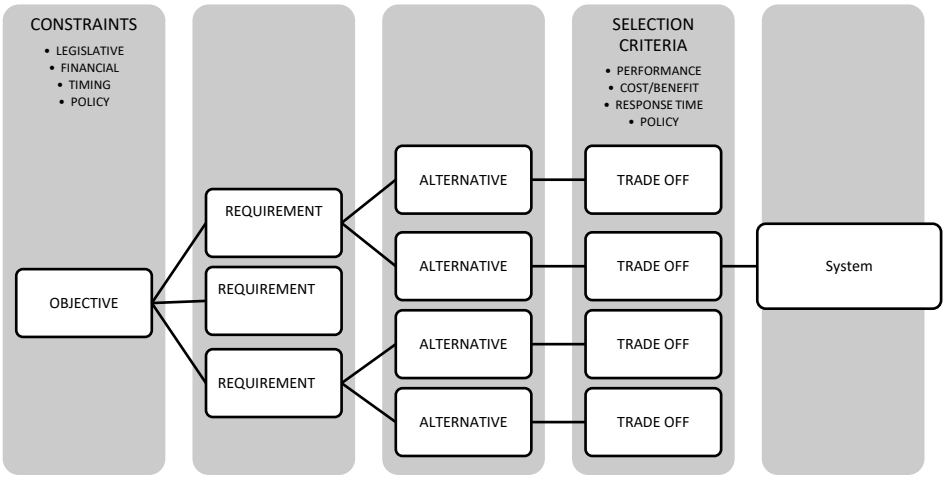

Figure 2-7 Components of a system by Kerzner, H. (2013)

Note. Adapted Kerzner, H. (2013). *Project Management: A Systems Approach to Planning, Scheduling, and Controlling. (11th edition)*, USA, New Jersey: John Wiley & Sons, Inc.

Complex systems are being solved by prioritizing the needs and approaching them as systems. Every component including various disciplines and decision making procedures.

Figure 2-8 Agile Approach Principles cheat sheet

Note. Adapted from web http://www.dummies.com/careers/project-management/agile-project-management-for-dummies-cheat-sheet/).

In figure 2-8 represented agile approach principles for prioritizing and approach for complex environments such as software development.

Some researchers observed that %6 percent of projects are classified as totally agile success (Serrador and Pinto 2015). Foundings from other scholars indicated that project size is more important for delivering the success or not successful result and success is not depending on the methodology. Indicated that large projects are 10 times more likely to fail compared to a small project. (Henriksen, 2016). It is not surprising the way how agile methodologies are increasing their usage as an influencing or directly be used in many projects as much as 65 percent as Pinto and Serrador (2015) stated. Scrum is the majorly used agile methodology approach (Henriksen, 2016)

On the other hand, depending on the project there are different principles for agile project management. Fitsilis (2008) and Larman (2004) give only five principles i.e. embrace change, focus on customer value, deliver part of functionality incrementally, collaborate and, reflect and learn continuously while Alleman (2005) gives 10 principles which among other things include simplicity, embrace change, enabling the next effort (Bailey,

S. & Cohen,D, 1997) ensuring that the team is strengthened through learning, incremental change, maximizing stakeholder value, rapid feedback, deliver and manage with purpose. (Henriksen, 2016).

As a conclusion for the agile project management principles approach, fusion of these principles as being employee oriented, customer focused, less bureaucratic, iterative development focused, acknowledges collaboration (Larman, 2004; Hewson, 2006; Conforto and Amaral, 2008; Serrador & Pinto, 2015).

2.2.3. Agile Project Management's Problem Solving Approach

Agile Project management methodology focuses on priorities related to problems and approaches them as short and incremental iterative development (Sauer and Reich, 2009; Larman, 2004; Hewson, 2006; Conforto and Amaral, 2008; Serrador & Pinto, 2015). To be able to solve problems agile methodology uses an approach which is combined with phases of TPM (Hewson, 2006). Agile methodology's solution and prioritization approach by iterating to find answers and get over obstacles, makes agile project management suitable for projects which highly includes uncertain paths that are carried out during conditions of rapid changing in complex environments (Alleman, 2005; Hewson, 2006; Serrador & Pinto, 2015). List of pre-selected requirements is followed by analyze, develop, test and evaluate during a short, fixed period of iteration called 'sprint' (R. Hoda, J. Noble, and S. Marshall, 2008). What makes agile an important matter of risk assessment is also carried out to minimize the effect of anticipated risks in the given activity and provides a steady process. In apm it is important to have feedback by communication cycles to improve and provide information for future iterations. Apm approach is divided into several iterations each adding some functionality or perhaps improved performance to its predecessors (Cadle and Yeates, 2008). As it is described as most of the time, client is not really aware what they want so here an important feature of apm, answers the need of continuous collaboration between consultant and the client during the progress of the project which enhances understanding of both. Having this communication between client and project team, enables companies to have excessive

documentation of every step which means a lot of data to use for further iterations. Owen et al (2006) and Pinto (2015) states that APM increases managerial and personnel skills, it may derive from the high communication levels bringing responsiveness, speed, flexibility, quality and predictability. On the other hand, argued that by achieving these benefits the organization may also have downstream gains through cost minimization, short time delivery helping team to deal with more clients and increased customer satisfaction, good customer retention. %93 organizations found productivity improved, %88 quality improved, %83 experienced better business satisfaction with the software (Agile methodologies, 2003).

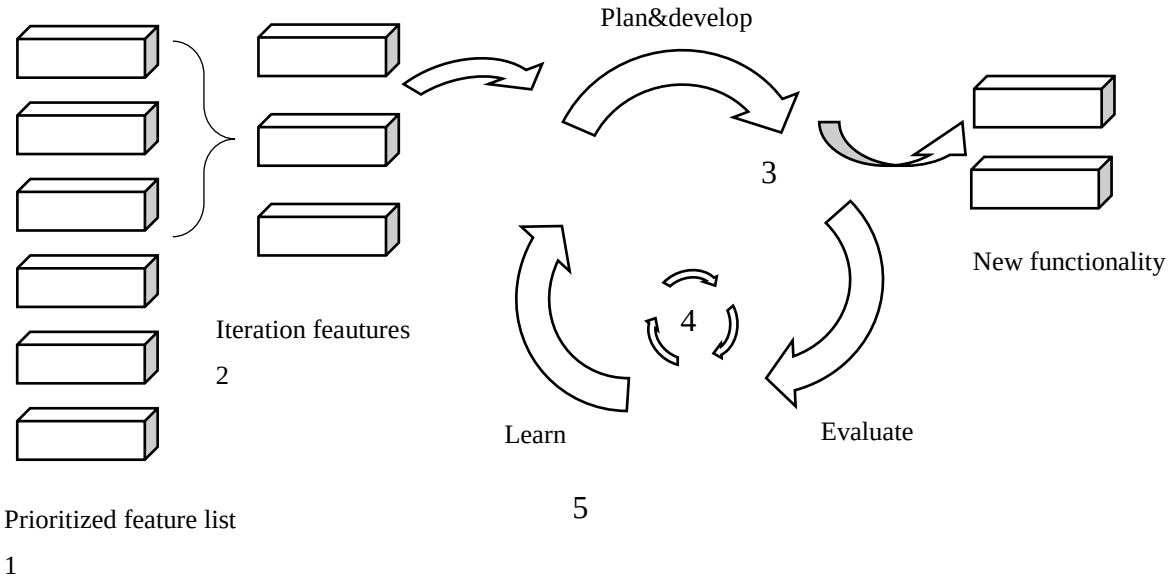

Figure 2-9 Agile development methodology processes

Note. Adapted from “Agile Control and Execution Processes,” by M. Griffiths, 2007, *Pmi Global Congress Proceedings*. Atlanta, Georgia.

Using quantitative methodology is important to evaluate a project but at the same time all these number may create stress and let project tracking miserable activity and burden on team.

That is why it is important to understand meaning of the steps of agile (fig.2-9) to apply it properly. Mike Griffith (2017) describes agile control and execution progress in general frame with his 5-exhibit approach.

Exhibit 1, prioritized requirements are to be realized depending on the priority assigned by business. Prioritized requirements should be selected to have a subset (2) to develop. High priority takes first place. Then analysis, development, testing and evaluation during a short, fixed time iteration (3) is to have decision to start next process. In this period team members self-select the tasks. In this 1-4-week phase, daily communications and risk assessment cycle meeting held repeatedly (4). This meeting is also called as 'sprint'. It is conducted as a short daily meeting where development team members briefly answer questions as Griffiths (2004) suggests:

1. "What have you been working on since the last meeting? "
2. "What are you working on today? "
3. "Do you have any problems, issues or impediments to making progress? "

Via these short daily meetings, project stakeholders hear about incremental progress, team members learn what others are working on. Also, roadblocks and risks are raised quickly for removal and mitigation by the PM.

Agile methods also perform mid-project retrospectives (5) where the lessons learned questions of

1. "What went well?",
2. "What did not go well?"
3. "Recommendations for the future?"

are captured and factored into the planning of the next iteration.

In many modern researches and example cases it has been acknowledged that this high-level focus on high-level objectives creates an autonomy, ownership. Team members self-selects work, these foundings are criticized as agile management has more similarities to leadership guidelines than traditional project management guidelines which is more role based (Griffiths,2007)

2.2.4. Project Success and quantitative approach to project management

PMBOK (2013) describes business process and performance measurement is integrated through the integration process within the project management. Aim is to direct and control various individual processes that is monitored by the project manager (Griffiths, 2004) to keep in accordance with the project planning. As a term, it is used Monitoring and Control Project Work activity, Kpis measurement should be used to rationalize the process (Griffiths, 2004; Pinto & Slevin 1987).

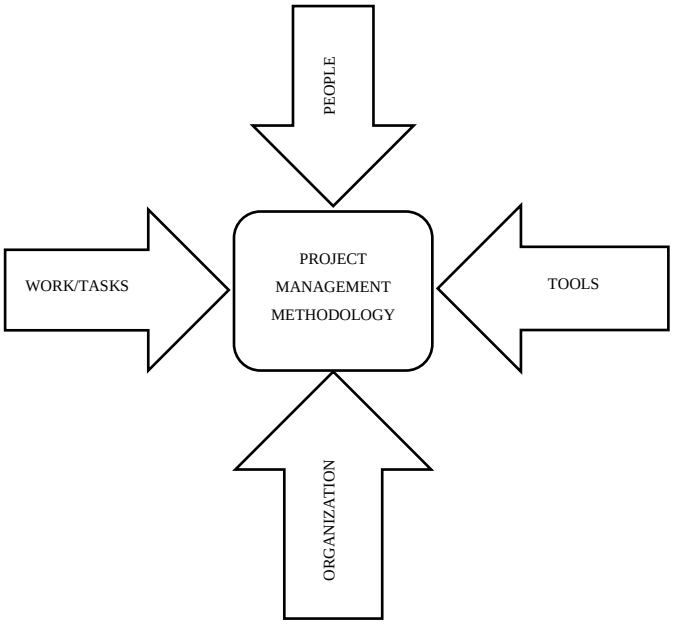

Figure 2-10 Components of project management methodology (2013).
Note. Adapted Kerzner, H. (2013). *Project Management: A Systems Approach to Planning, Scheduling, and Controlling. (11th edition)*, USA, New Jersey: John Wiley & Sons, Inc.

A project can be seen as system of various inputs and combinations that are qualitative and quantitative. Usually it is project manager's role to enhance the performance with good leading practice which means that due it is human nature, projects are mostly managed by qualitative skills, to have competitive advantage it is important to eliminate intuition based decisions in big organizations (Vercellis, 2009).

A matrix to classify kpis relevant to their importance represented as an example for further data collection to analyze and use in the artificial intelligence supported predictions. Related to their weighted importance, which helps to cluster and list key performance indicators and other measurable, effects of chosen numerical representations could be classified. They can lead for further analytical processes on constants of unmeasurable such as every team member's or machine's performance input, creativity input. In order to keep up with fast changing environment where project management team have to understand outcomes, outcomes should be clear and pointing. How they are being measured also effects measurable influence which is called Hawthorne effect (Griffiths, 2004; Gillespie, 1993), it is important to try and improve which is main idea of design thinking mentioned in previous sections.

There are various methodologies to transform qualitative or non-existing measure to measurable assigning them Kpis.

Table 2-1 Kpi Prioritization Table

WEIGHT	DEFINIITION
1	Both kpi are equally important
3	One kpi moderate important than other
5	One kpi stronger important than other
7	One kpi very stronger than other
9	One kpi extremely important than other

Note. Adapted from "Prioritization of key performance indicators: An integration of analytical hierarchy process and goal setting," by Arash Shahin, M. Ali Mahbod, 2007, *International Journal of Productivity and Performance Management, Vol. 56 Issue: 3, pp.226-240*

It is important to create kpis related to same objective with organization, calling for action and understandable with a good data collection ability. Having data can lead to analyze and use machine learning in various organizational measures. Good kpis are chosen as quantitative outcomes (Shahin & Mahbod, 2007). To ensure that projects are completed on time, project managers need to monitor and understand their team's work process and lead the project towards long-term goals. The quickest way to get a complete overview of

your project performance is to use a project KPI dashboard. In this work, there will be no kpi classification because it is more important in program management which includes couple of projects, for this work it is focused on single project level and no Kpi classification analyzed. In various project management offices depending on the sector or aim, it is possible to create quantitative understanding such as integration of project management to organizations. (Fernandes, Ward, Araújo 2015).

Project management practice approach encourages systemization and formulization of processes by schemas and formulas mostly, also to perform quality assurance, it suggests tools and techniques for the process of the quality management and control. Depending on the business context organizations can create project management control prioritization to have decision making in different levels (Pascual, DelCastillo, Louit, Knights, 2009).

Affinity diagrams

Like in the mind mapping techniques affinity diagram is to have an organized patterns of thought problem, one of the main activity which is work breakdown structure may be enhanced by using affinity diagram by its decomposition of process.

Process decision program charts (PDPC)

It is important for the teams to visualize and anticipate team to understand intermediate steps of the aimed goal.

Interrelationship digraphs

Today's many complex projects may need more creative problem solving where uncertainties are high. To increase value added process, suggested that it is better to use data generated from other diagrams to create interrelationship diagrams.

Tree diagrams.

This systematic diagram used to represent decomposition hierarchies used as work breakdown structure, RBS (risk breakdown structure), and OBS (organizational

breakdown structure). Visualizes parent-to-child relationship of decomposition hierarchy. Tree expected to be structured horizontally (such as a risk breakdown structure) or vertically (such as a team hierarchy or OBS). Having tree diagrams allows project management to the creation of nested branches that terminate into a single decision point. It is very important to be able to divide and categorize processes in project management which may help for future system where all the activities are being tracked by a system and project management task are totally done by the system let manager provide a full leader role in the project.

Prioritization matrices

Criterias are prioritized and weighted before being applied to all available alternatives to obtain a mathematical score that ranks the options.

Activity network diagrams

Previously known as arrow diagrams. They include both the AOA (Activity on Arrow) and, most commonly used, AON (Activity on Node) formats of a network diagram. Activity network diagrams are used with project scheduling methodologies such as program evaluation and review technique (PERT), critical path method (CPM), and precedence diagramming method (PDM).

Matrix diagrams

A quality management and control tool used to perform data analysis within the organizational structure created in the matrix. The matrix diagram seeks to show the strength of relationships between factors, causes, and objectives that exist between the rows and columns that form the matrix.

Some scholars are experimented that industrial systems such as wind mills can control and monitor themselves depending on their data input to output aiming to reach expected outcomes by themselves (Hein, Hentschel, Sterzing, Tokic, Udluft 2016). It is clear that, soon standalone machines will manage themselves, to perform better in activities they need to understand how to control data using control tools.

2.2.5. Project cost management

2.2.5.1. Actual cost (ac)

The Actual Cost KPI is also referred to as Actual Cost of Work Performed (ACWP) (PMBOK5, 2013). This kpi indicates how much money you have spent on a project until chosen date. It is a cumulative expense total to calculate the project's actual cost, all expenses that spent until chosen date is actual cost. Budget of the project is calculated by considering all the hours planned for the project work, to have every expense in a single unit measure such as time spent on tasks, helps to calculate the actual cost.

2.2.5.2. Earned value (ev)

To calculate earned value it is needed to calculate how much planned work have completed and what's the planned budget for these accomplishments.

2.2.5.3. Cost variance (cv)

Cost variance Kpi is an important parameter to understand how project is performing related to its spending. Converted to cost of accomplished work versus planned work, indicating whether the estimated cost of project is below or above the planned baseline.

2.2.5.4. Cost performance index (cpi)

Project performance is to understand how project is performing related to its performance index, gives an output in terms of time. Outcome is given as being behind or ahead of the approved project schedule. To calculate cost performance index should be calculated as the ratio of the planned budget to what you've spent to accomplish these tasks. It is an indicator for the project's cost efficiency.

2.2.5.5. Schedule variance (sv)

Projects scheduling performance is tracked by project schedule variance kpi. Subtracting the project's planned value of its earned value.

2.2.5.6. Schedule performance index (spi)

It represents projects scheduling performance and shows project is behind or ahead of schedule.

2.2.5.7. Project Data Information report flow

Below diagram represents the project information flow across various project processes used to manage project. These steps are divided into many components in big projects.

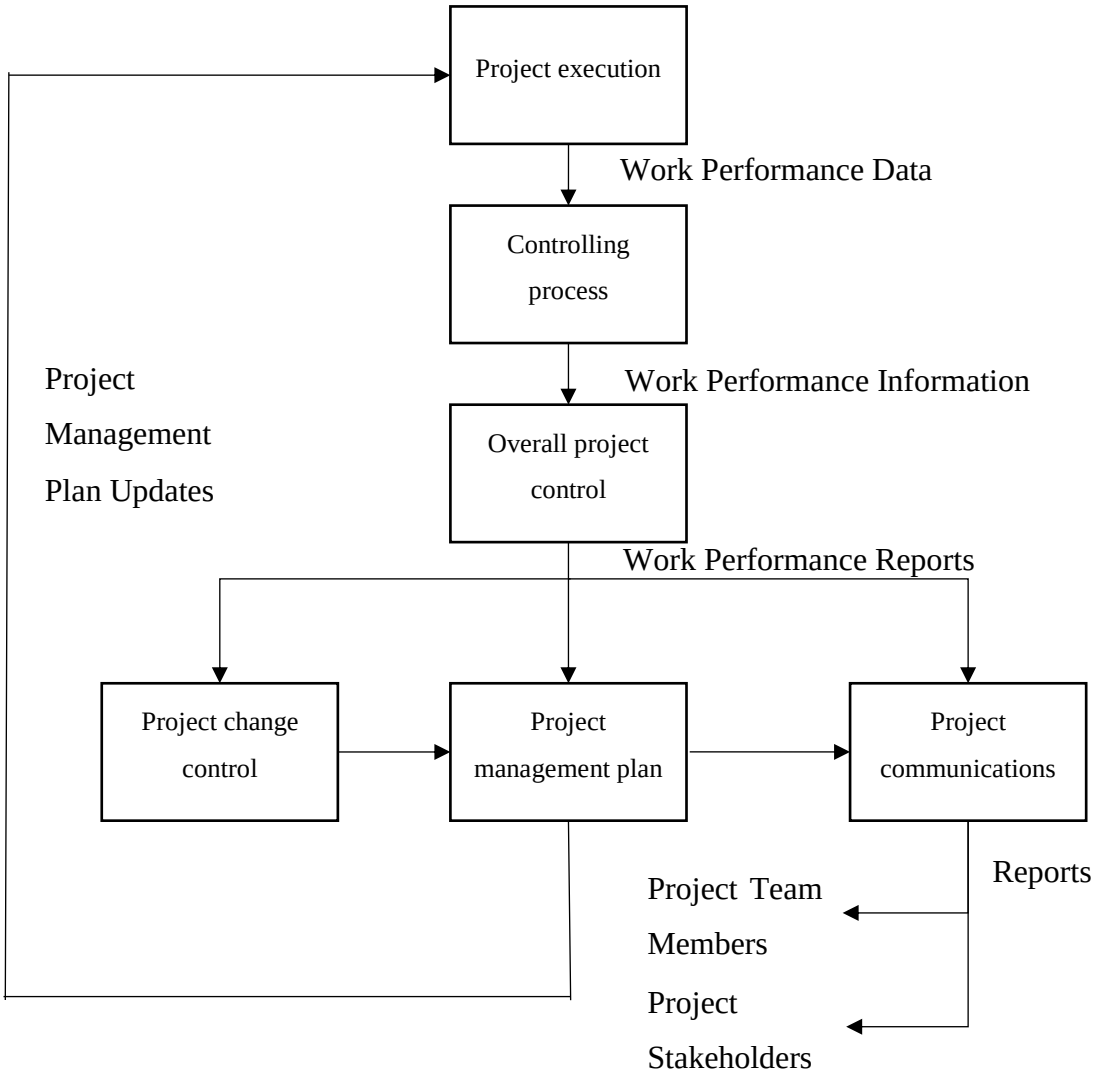

Figure 2-11 Project data, information and report flow in project management

Note. Adapted from *A Guide to the project management body of knowledge PMBOK5th* (p. 59), by PMI Institute, 2013, Pennsylvania: Project Management Institute Inc. Copyright 2013 by " Project Management Institute Inc ".

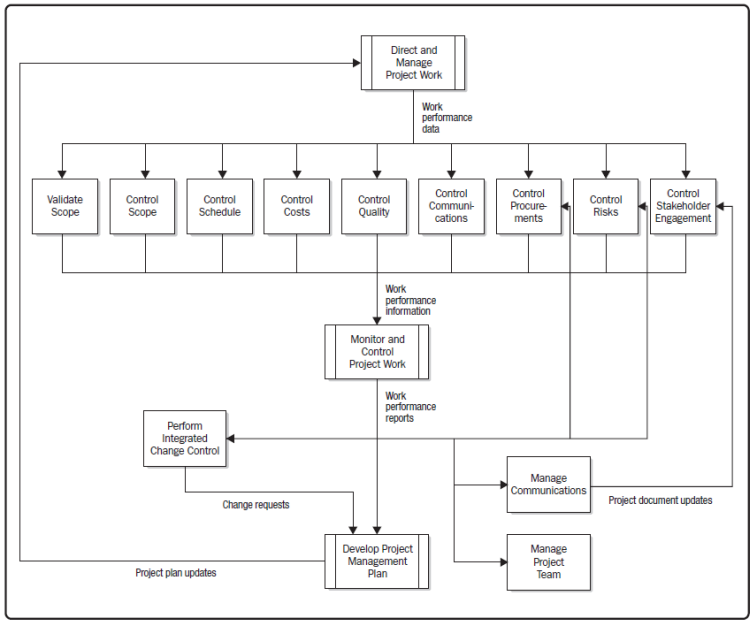

Figure 2-12 Data Model of a project

Note. Adapted from *A Guide to the project management body of knowledge PMBOK5th* (p. 466), by PMI Institute, 2013, Pennsylvania: Project Management Institute Inc. Copyright 2013 by " Project Management Institute Inc ".

Since projects are temporary in nature, the success of the project should be measured in terms of completing the project within the constraints of scope, time, cost, quality, resources, and risk as approved between the project managers and senior management.
To ensure realization of benefits for the undertaken project, a test period can be part of the total project time before handing it over to the permanent operations (sometimes quality environment). Project success should be referred to the last baselines approved by the authorized stakeholders. The project manager is responsible and accountable for setting realistic and achievable boundaries for the project and to accomplish the project within the approved baselines. (Pmbok, 2013, pg. 61)

2.2.6. Project Team

Project team is a group of people who works together to perform activities related to bring project success. Team includes the project manager, project management staff, other team members who carry out the work but who are not necessarily involved with management

of the project. This team is comprised of individuals from different groups with specific subject knowledge or with a specific skill set to carry out the work of the project. Even though many of the components are changeable from many aspects dependent on various conditions. Project manager's role as a leader is still important (Meng and Boyd, 2017)

Project management staff

The members of the team who perform project management activities such as scheduling, budgeting, reporting and control, communications, risk management and administrative support.

Project staff

Project stuff is people who are delivering work to provide project deliverables as expected.

Supporting experts

Supporting experts perform activities required to develop or execute the project management plan. These can include such roles as contracting, financial management, logistics, legal, safety, engineering, test, or quality control. Support is required depending on the size of the project and support needed. Supporting experts may involve full time or just for specific knowledge needed area.

User or Customer Representatives

People who are focused on proper coordination, understand requirements and inform team or check if the project's result are acceptable.

Sellers

Suppliers, contractors, external companies are also called vendors who provides deliverables to project externally.

Business partner members

In some cases, it is seen that business partner is involved in the project to increase coordination and increase validity of the project deliverables.

Business partners

In many projects, includes jobs that company doesn't cover by its corporate knowledge, such as installation, customization, training, or specific knowledge may create need of external player who provide specific knowledge related to activity. In the project management, it is mostly agreed on theory but in the field, such as application of those theories and related to needs there are couple of conflicts (Alleman, 2008).

2.2.7. Task breakdown and allocation

Traditional project management simplifies and structures activities very rigidly, this also critized as being a methodology that makes detailed documentation of every activity process obliged where it is hard when there are uncertainties (Rodrigues and Bowers, 1996). However having this deterministic approach makes resource allocation efficiently. This is seen useful for creating milestones and points (Saladis and Kerzner, 2009) also in agile methodology it is an important part of project management.

Elliot (2008) sees TPM as a methodology which is easy to change employees within the project, it is important in consulting sector which has high turnover rates compared to many other sector. Some scholars find this as demotivating for the employees due to its machine part similarity which creates less involvement from people within the project (Rodrigues and Bowers, 1996). Griffiths (2007) argues that it is important to see employees as stakeholders and not just parts of the project to overcome this demotivating figure.

Command and control

Project manager's role is to plan and allocate tasks in most of the cases (Kerzner, 2003; Meng and Boyd, 2017). Combination of methodologies is critical to answer the different needs of project components depending on people or processes. Larman (2004) argues that planned rules on team roles and responsibilities, team organization, relationships and activities are important to succeed in TPM approach as TPM describes a very

deterministic approach. Controlling role ensures project is always tracked by someone or group (Saladis and Kerzner, 2009). Management role may be overwhelming under the burden of many tracking requirement. Good communication to have qualified tracking is crucial (Tomaszewski and Berander, 2008; Atkinson et al, 2006).

Therefore, TPM as a common methodology of project management, it has a problem when it faces unpredictability and complex environment. Various circumstances related to nature of project, especially in IT where customer also does not have a complete understanding stresses Tpm. In this situation, stressful work burden may end up project manager turnover or burnout. Possible application of computers to help project manager is important because update and predict outcomes with use of data saves more time for leadership roles and communication, as it is very important aspect of projects success.

Common project success algorithms applied to measure success rate of projects (Fernández-Rodríguez and Martinez, 2017)

1. Bayesian Model
2. Evolutionary Fuzzy Neural Inference Model - EFNIM
3. Neural Networks
4. Support Vector Machine
5. Fast Messy Genetic Algorithm
6. K-Means Clustering
7. Bootstrap aggregating neural networks
8. Adaptive boosting neural networks

2.3. Evolution of Computing and Artificial Intelligence

Turing machine is invented by Alan Turing as an automatic machine (Andrew Hodges, 2012). From Turing machine to today's sophisticated computers main usage area is in complex calculations. Taking human tasks and assigning to machines is a common measure of success (Fernández-Rodríguez and Martinez, 2017). Soon experimental computers will start to take stage.

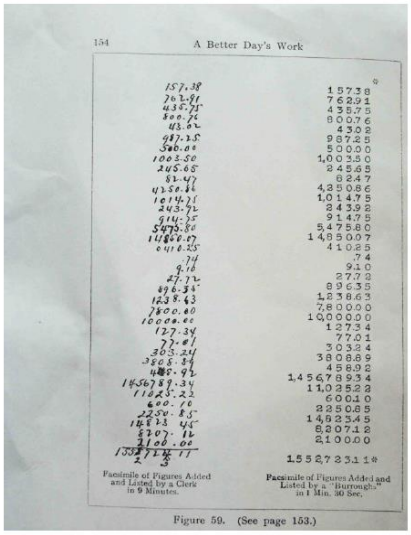

Figure 2-13 Comparison of Manual Calculation with Manual Calculator

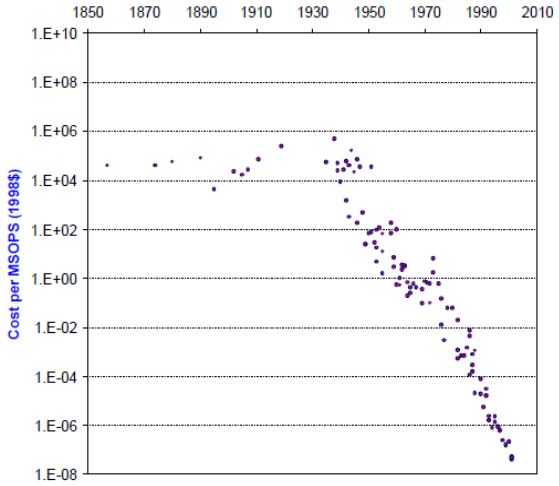

Figure 2-14 The progress of computing measured in cost per million standardized operations per second(msops)deflated by the consumer price index.

Note. Adapted from "The Progress of Computing" William D. Nordhaus Yale University and the NBER August 30, 2001 version 4.4

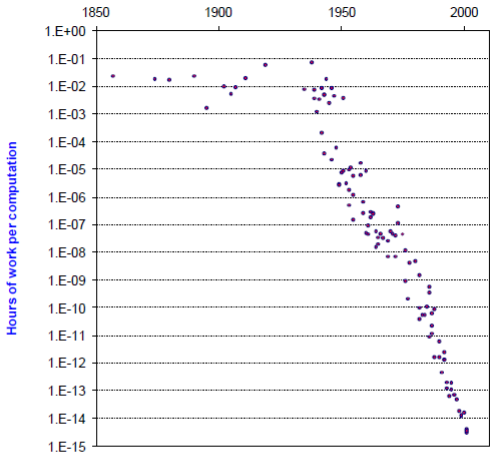

Figure 2-15 The progress of computing measured in cost per standardized computation measured in terms of labor cost.

Note. Adapted from "The Progress of Computing" William D. Nordhaus Yale University and the NBER August 30, 2001 version 4.4

We are witnessing domination by computers in sophisticated jobs. It became a reality by the decrease of computational cost, thanks to advancing technology. Increasing capability of computers enabled replacing humans with computers as a cheaper and more durable solution for many cases. Such as described in the early literature review project lead or people are effective on project management but we don't know how to evaluate and transform people in to calculations.

Machine learning is a scientific discipline that deals with the construction and study of algorithms that can learn from data (Ron Kovahi, 1998). ALICE (Autonomous Learning in Complex Environments) research project is an example (2014) for machine learning, experts collected information on how to optimize wind turbines. Wind turbines demonstrated their learning abilities in field tests that were held as part of the project. The wind power systems learned by using their own measurement data and achieved a noticeable increase in efficiency. However, it is still not quite clear by how much the efficiency increased, so additional larger-scale research projects are needed. This is an example of how systems can learn by themselves and eliminate knowledge intensive labor cost by learning and optimizing. Sophisticated computing can be used in many cases where knowledge required to repeat, such as project management.

2.3.1. Optimizing complex systems with machine learning

Professor Thomas Runkler who is an expert for machine learning states “The associated processes offer many possibilities for making systems smarter and more efficient". Machine learning can also be used to reliably forecast the prices of energy and raw materials or to predict energy demands.

In computing, artificial neural networks(ANNs) are used based on a large collection of simple artificial neurons. Neural networks are intended to simulate the behavior of biological systems composed of neurons (Vercellis,2009; Sterzing 2014). Each neuron relates to many others. Between neurons each of them may have threshold function or limiting function on each connection including the unit itself, such that the signal must surpass the limit before propagating to other neurons. These systems are self-learning and trained, rather than explicitly programmed, and excel in areas where the solution or feature detection is difficult to express in a traditional computer program. To enable machine learning precondition is to have data and optimize their behavior depending on data accordingly the algorithms to let machines learn. Sterzing (2014) study machine learning to increase electricity output on wind turbines, his work on “Machine Learning: Optimizing How Wind Turbines Work”. Data coming from wind data shows us to understand connection between different type of process and external inputs has a relation and machine learning is a good way for analyzing and modeling various dependencies and interrelationships (Fernández-Rodríguez and Martinez, 2017). They learn from examples, recognize patterns, and use past measurement data to make forecasts (Hein, Hentschel, Sterzing, Tokic, Udluft 2016) and ideal models regarding the future behavior of complex systems (https://www.siemens.com/innovation/en/home/pictures-of-the future/digitalization-and-software/from-big-data-to-smart-data-machine-learning-in-windturbines.html).

The training, also called learning stage, is performed by analyzing in sequence the observations contained in the training set one after the other and by modifying at each iteration the weights associated with the arcs (Vercellis, 2009 p.259)

In a feed forward artificial neural network wherein connections between the units do not form a cycle. Its ability to accurately and consistently estimate software development efforts, especially in the early stages of the development life cycle, is required by the project managers in planning and conducting software development activities (Kumar, Krishna, Satsangi, 1994)

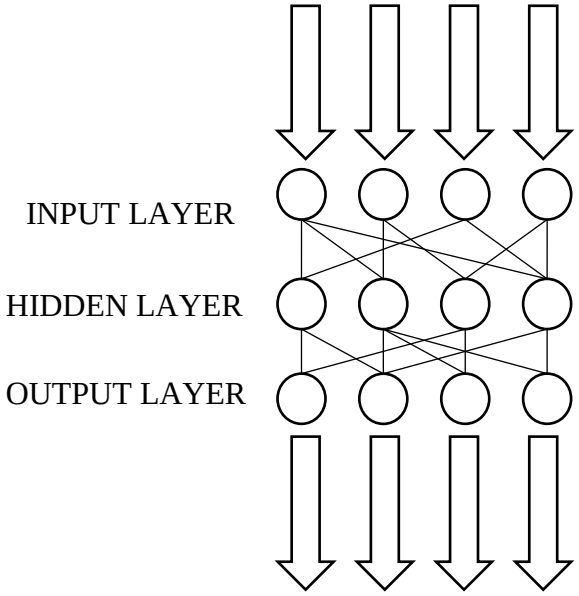

Figure 2-16 Feedforward neural network representation

Note. Retrieved from*https://en.wikipedia.org/wiki/Feedforward_neural_network*

Input nodes receives the values of the explanatory attributes for each observation. It is observed input nodes are same in manners of quantity of the number of explanatory variables.

Hidden nodes are to apply transformations given to the input values inside the network. Nodes are connected to incoming arcs that go from other hidden nodes or from input nodes, for the output side nodes are connected with outgoing arcs to output nodes or to other hidden nodes. There might be more than one layer of hidden nodes that creates more than one hidden layer which is connected to each other in the hidden layer zone.

Output nodes receive connections from hidden layer nodes or from input nodes and return an output value that corresponds to the prediction of the response variable. Each node of

the network basically operates as a perceptron, in the sense that given weights are associated with the input arcs, while each node is associated to activation function and distortion coefficient (Vercellis, 2009).

2.4. Backpropagation

The backward propagation of errors or backpropagation, is a method of training artificial neural networks and used in conjunction with an optimization method. Following repeated two phase cycle, propagation and weight update. A represented input vector propagated forward through the network, layer by layer, until it reaches the output layer. Compared to the desired output, using a loss function, and an error value is calculated for each of the neurons in the output layer for the given output from network (Vercellis, 2009). Propagating errors backwards, output to associated error neuron, it roughly represents its relation to the original output. However, neural networks require very long times for model training, provide results with modest interpretability that are dependent upon the order in which the examples are analyzed, and also present a lower robustness with respect to data affected by noise. Noisy or uncomplete arbitrary input will be responded with an active output if this input seen by the network as a resembling pattern learned by the network. To create a backpropagation desired output sometimes called target needed, this is because backpropagation needs to calculate the loss function gradient for the input. It is a generalization of the delta rule to multi-layered feedforward networks, made possible by using the chain rule to iteratively compute gradients for each layer. Important rule for enable backpropagation is having differentiable activation function used by the artificial neurons.

The feedforward neural network was the first and simplest type of artificial neural network devised. In this network, the information moves in only one direction, forward, from the input nodes, through the hidden nodes (if any) and to the output nodes. There are no cycles or loops in the network (Vercellis, 2009)

2.5. Alphago: Machine vs. Human

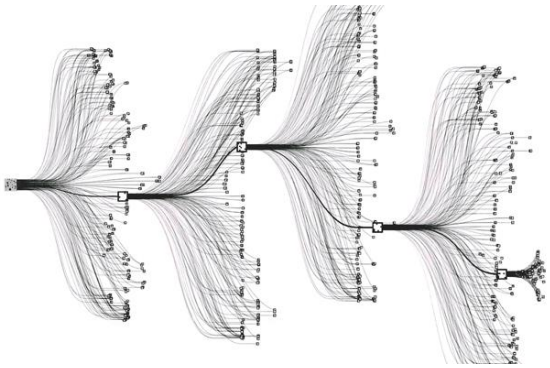

Figure 2-17 Alpha Go decision tree, representation of possible moves in game of go retrieved from web March 2017.

Machine learning systems are advancing with an inertia that is faster than ever, alpha go which Google achieved a milestone in the development of self-learning machines and artificial intelligence in March 2016 (https://research.googleblog.com/2016/01/alphago-mastering-ancient-game-of-go.html). AlphaGo succeeded in defeating one of the world's best Go player Lee Sedol. Go game was considered as too complex for a computer. In the game, there are almost infinite number of possibilities which let players go with their intuition. Artificial intelligence technic used in AlphaGo is called reinforcement learning. The system learns to utilize a value function that rates game positions by analyzing millions of past games and then playing against.

3. APPLICATION OF MACHINE LEARNING ON PROJECT MANAGEMENT

Industry	Business Consulting and Systems Integration
Founded	1996
Revenue	705.6 Million Euros
Number of Employees	5,245
Website	Reply.Com

Founded in 1996 in Turin, Italy, Reply utilizes a network model consisting of companies operating in different sectors, including big data, cloud computing, digital media and the internet of things.

Since 2006 the company has expanded its operations in Europe, particularly in England and Germany, opening new offices as well relying on existing acquisitions.

Reply's revenue increased from €33.3 million in 2000, the year the company was listed on the STAR segment of the Italian Stock Exchange (Borsa Italiana), to €705.6 million in 2015.

3.1. Development of a Business Intelligence System

Implementation and contract type of projects are mainly work of in todays IT companies, business intelligence system implementation is an important system for corporate companies with big scale related to their people, products, regions. Business intelligence system development phases are below shown in a simple diagram in 4 phases which are analysis, design, planning, implementation and control(Vercellis, 2009).

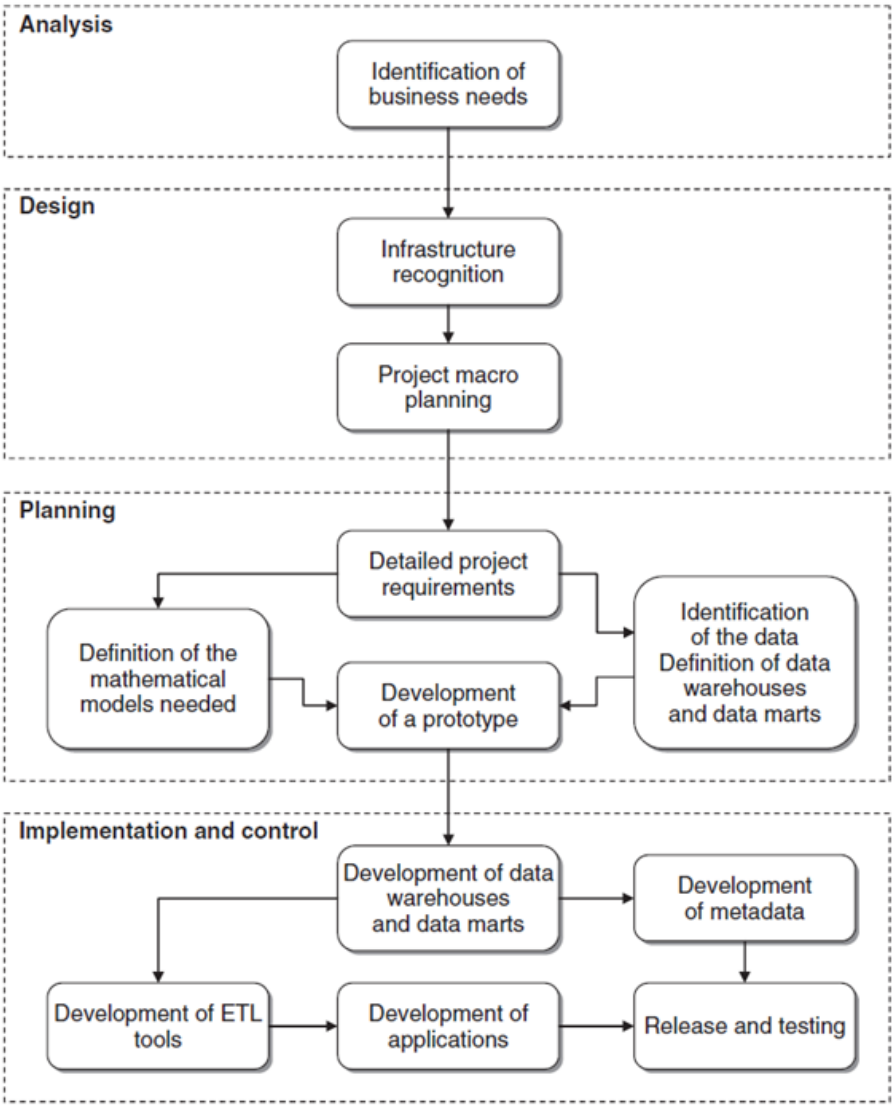

Figure 3-1 Phases in the development of a business intelligence system

Note. Reprinted from *Business Intelligence: Data Mining and optimization for decision Making* (p. 14), by Vercellis, C., 2009. John Wiley & Sons

Analysis phase is the first phase, where requirements of the organization from business intelligence system should be understood very well with a series of meetings with the client side. Knowledge workers performing different roles requires different needs that is why it is important to describe general objectives of the project. This phase should be considered costs and benefits.

Design phase includes two sub-phases which are infrastructure recognition, project macro planning. System in terms of development in the near future and the following evolution

of the system should be evaluated. It is important to understand infrastructure capacity before designing the system. All decision making processes should be examined to be supported by intelligence system to understand information requirements. After realizing design phase project plan should be developed to efficient execution of development such as phases, priorities, expected execution times, costs, resources.

Planning phase, data types and further retrieving data are addressed. Information flow depended architecture should be designed, including central data warehouse, data marts. Obtained available data should be understood to relate with mathematical models which data will be used for having insights. Last step in the phase a prototype of the system should be created, at low cost to understand needs of the system clearly.

Implementation and control phase focuses on five main sub-phases. The data warehouse and specific data marts are developed. Information structure that feeds intelligence system is represented. A metadata should be created in order to understand warehouse data and it is transformations. Extract Transform Load procedures applied to the existing data in the primary sources, loading them into the data warehouse and the data marts. Further step aims to carry out core business intelligence applications for carry out planned analysis. Finally, the system is released for test and usage.

3.2. Effective and timely decision making

Organizations with complex structure, decision making is continuous process in fast paced business world. Short or long term more complex or less complex decisions have impact on peoples and roles at various hierarchical levels. To give these knowledge workers ability to have decisions in a consistent manner, it is very crucial for the organizations to keep competitive strength in complex systems and markets (Vercellis, 2009. p.4).

Intuitive decisions are mainly taken decision type by most of the knowledge workers in the organizations with easy methodologies mainly depending on experience, knowledge of the application domain and the available information. Stagnant decision-making style which is inappropriate for the unstable conditions with uncertainties, frequent and rapid changes. Today’s organizations are often too complex and dynamic to be effectively dealt with existing primitive decision making through an intuitive approach. Complex and rapid

changing businesses require a decision making process which is more rigorous attitude based on analytical methodologies supported by mathematical models. In figure (fig.3-2), it is shown available business intelligence system portfolio.

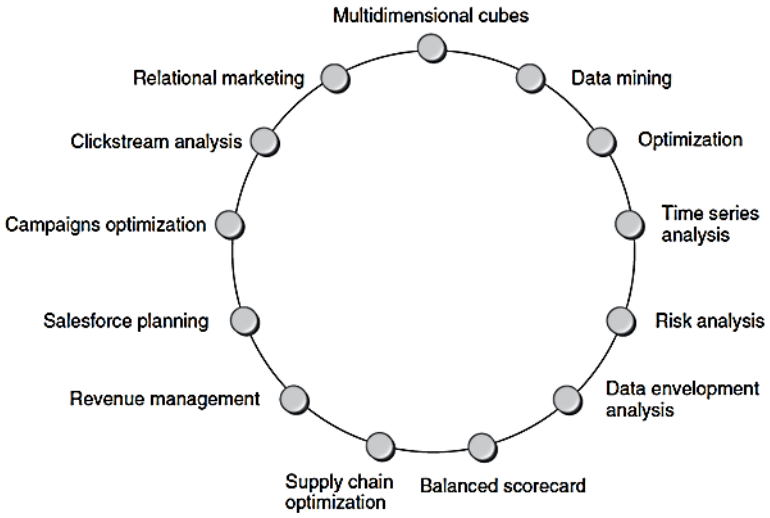

Figure 3-2 Portfolio of available methodologies in a business intelligence system

Note. Reprinted from *Business Intelligence: Data Mining and optimization for decision Making* (p. 17), by Vercellis, C., 2009. John Wiley & Sons

New tools used by businesses and organizations to predict performance and keep competitive advantage such as predictive analytics. Supporting policy of decision making in science and technology, and help formulate recommendations for action. (Erdi, Makovi, Somogyvari, Standburg, Tobochnik, Vold, Zalanyi)

While agility has recently attracted considerable attention in studies of systems development and management of information technology (IT) (Mathiassen, Lars; Pries-Heje, Jan., 2006). Business agility is a relatively new paradigm painted as a solution for maintaining competitive advantage during times of uncertainty and turbulence in the business environment (Sharifi & Zhang, 2001). Agile organizations respond quickly, they are good with resources, and they can adapt to their environment and keep competitive advantage.

3.3. Project Management Dashboard graphical user interface

A very important role in the IT sector following different projects in a macro scale. Project manager would like to understand daily process and it is effects on the project cost thus daily performance based on the cost spend and actual earned value related to actual costs spent. In pmo, for tracking the requirements of project management kpis chosen below, it is created a standalone executable file to standardize daily tracking and give manager ability to have proactively decisions and keep manager in the project updated.

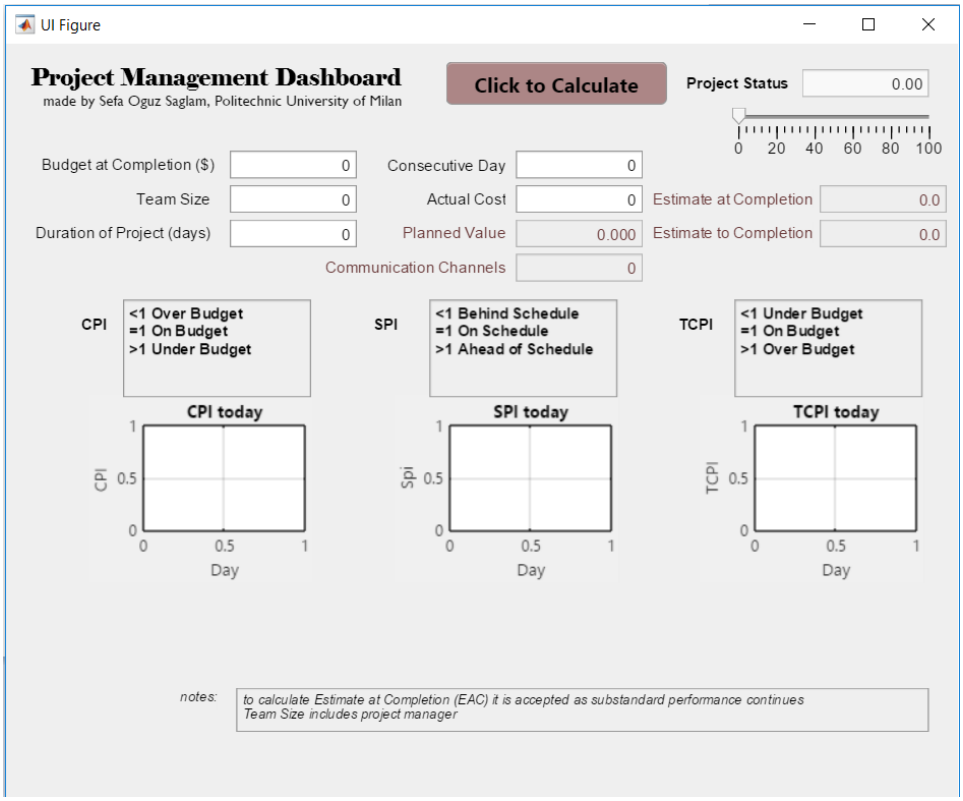

Figure 3-3 Project management dashboard graphical user interface snapshot by Sefa Saglam (2017)

3.3.1. User Program Interaction

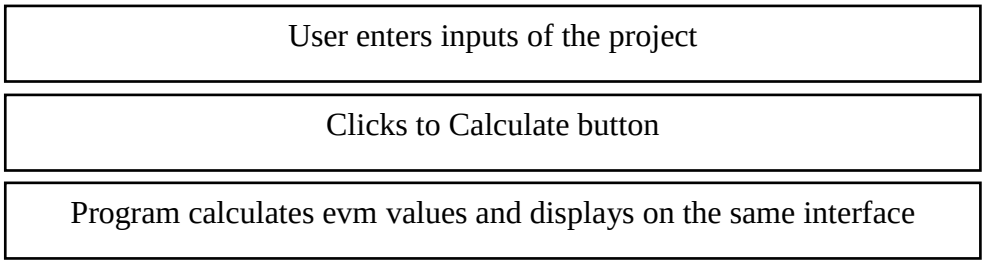

Figure 3-4 Steps of user experience for the time saving project management dashboard

Project management dashboard program calculates, after button clicked (See Appendix-A).

$$\%\ Button\ pushed\ function: ClicktoCalculateButton \quad (5.1)$$

$$function\ ClicktoCalculateButtonPushed(app, event) \quad (5.2)$$

$$BAC = app.BudgetatCompletionEditField.Value; \quad (5.3)$$

$$AC = app.ActualCostEditField.Value; \quad (5.4)$$

$$NP = app.TeamSizeEditField.Value; \quad (5.5)$$

$$CC = (NP * (NP - 1))/2 \quad (5.6)$$

$$DRT = app.DurationofProjectdaysEditField.Value; \quad (5.7)$$

$$Day = app.ConsecutiveDayEditField.Value; \quad (5.8)$$

$$app.CommunicationChannelsEditField.Value = CC; \quad (5.9)$$

$$PV = Day * (BAC/app.DurationofProjectdaysEditField.Value); \quad (5.10)$$

$$app.PlannedValueEditField.Value = PV; \quad (5.11)$$

$$EV = app.ProjectStatusEditField.Value * BAC; \quad (5.12)$$

$$EAC = AC + ((BAC - EV)/((EV\text{^}2)/(AC * PV))) \quad (5.13)$$

$$app.EstimateatCompletionEditField.Value = EAC; \quad (5.14)$$

$$ETC = EAC - AC \quad (5.15)$$

$$app.EstimatetoCompletionEditField.Value = ETC; \quad (5.16)$$

$$for\ i = 1: Day \quad (5.17)$$

$$CPI(i) = EV/AC; \quad (5.18)$$

$$SPI(i) = EV/PV; \quad (5.19)$$

$$TCPI(i) = (BAC - EV)/(BAC - AC); \quad 5.20$$

$$end; \quad 5.21$$

$$plot(app.UIAxes, Day, CPI, 'rx'); \quad 5.22$$

$$plot(app.UIAxes\_2, Day, SPI, 'ro'); \quad 5.23$$

$$plot(app.UIAxes\_3, Day, TCPI, 'r+') \quad 5.24$$

$$end$$

Earned value management (EVM) is used for understanding project costs in an estimation approach and can be applied for many projects within a company with provided data from management information system (Lipke, Zwikael, Henderson, Anbari, 2009).

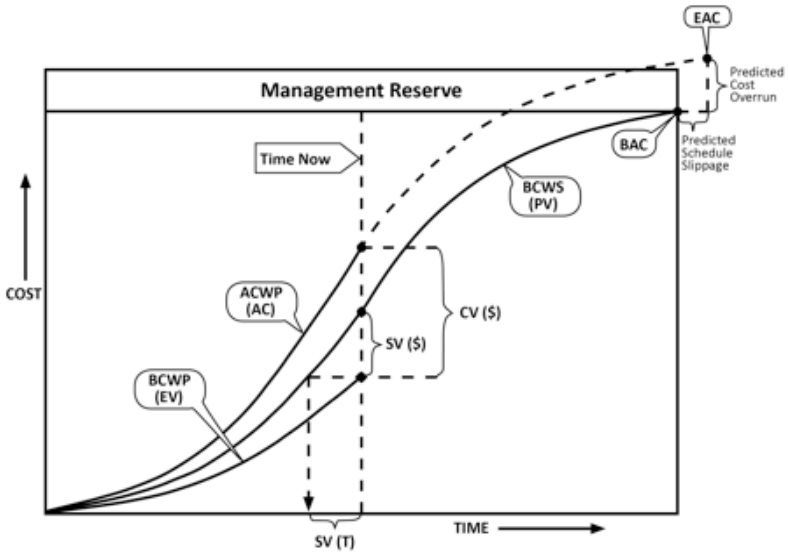

Figure 3-5 Cost versus time graph for earned value management in project management

Note. Retrieved from [http://www.dummies.com/careers/project-management/earned-value-management-terms-and-formulas-for-projectmanagers]

Table 3-1 Earned value calculation terms by PMBOK (2013)

Abbreviation	Equation	Interpretation of Results
Ev (Earned Value)	$EV = \%complete * BAC$	Monetary value of completed job until given day
Pv (Planned Value)	PV=Authorized budget assigned to scheduled work	Monetary value planned to complete until given day
Ac	$AC = Sum\ of\ total\ spendings$	The actual cost of all the work completed to a point in time.
No. Of Communication Channels	$n\ (n-1)/2$ $n = number\ of\ team\ members$	Number of communication channels in a project
Schedule Performance Index (Spi)	$SPI = EV/PV$	< 1 behind schedule, = 1 on schedule , > 1 ahead of schedule General scheduling performance until today.
Cost Performance Index (Cpi)	$CPI = EV/AC$ $EV = Earned\ Value$ $AC = Actual\ Cost$	<1 Over budget, =1 On budget ,>1 Under budget General cost performance until today.
Variance At Completion(VAC)	$VAC = BAC - EAC$ $BAC = Budget\ at\ completion$ $EAC = Estimate\ at\ Completion$	< 0 Over budget, = 0 On budget, > 0 Under budget The estimated difference in cost at the completion of the project.
Estimate At Completion (EAC) If Original Is Flawed	$EAC = AC + New\ ETC$	If the original estimate is based on wrong data/assumptions or circumstances have changed
Estimate At Completion (EAC) If BAC Remains The Same	$EAC = AC + BAC - EV$	The variance is caused by a one-time event and is not likely to happen again
Estimate At Completion (EAC) If CPI Remains the Same	$EAC = BAC/CPI$	If the CPI would remain the same till end of project, i.e. The original estimation is not accurate
Estimate at Completion (EAC) If Substandard Performance Continues	$EAC = AC + \frac{BAC - EV}{(CPI * SPI)}$	Total value estimated for project to be spend at the end
Etc (Estimate to Complete)	$ETC = EAC - AC$	Assuming work is proceeding on plan, the cost of completing the remaining authorized work can be calculated using
Etc (Estimate to Complete)	$ETC = REESTIMATE$	Reestimate the remaining work from the bottom up.
To-Complete Performance Index (Tcpi)	$TCPI = (BAC - EV)/(BAC - AC)$	< 1 Under budget, = 1 On budget, > 1 Over budget

	$TCPI = Remaining\ Work /Remainig\ Funds$	
Pert Estimation	$(O + 4M + P)/6$	The estimated duration of the activity as a weighted average
Standard Deviation	$(P - O)/6$	This is a rough estimate for the standard deviation
Float/Slack	$LS - ES$ $LS = Late\ start$ $ES = Early\ start$ $LF - EF$ $LF = Late\ finish$ $EF = Early\ finish$	Important for critical path calculations.

Note. Adapted from *A Guide to the project management body of knowledge PMBOK5th* (p. 224), by PMI Institute, 2013, Pennsylvania: Project Management Institute Inc. Copyright 2013 by " Project Management Institute Inc ".

3.4. Neural network and machine learning algorithm

In figure 3-6, it is represented feed forward backpropagation neural network setup. From the simplest version of neural network models to complex ones, actively used for predictive purposes such as classification, regression of continuous target attributes (Vercellis, C 2009).

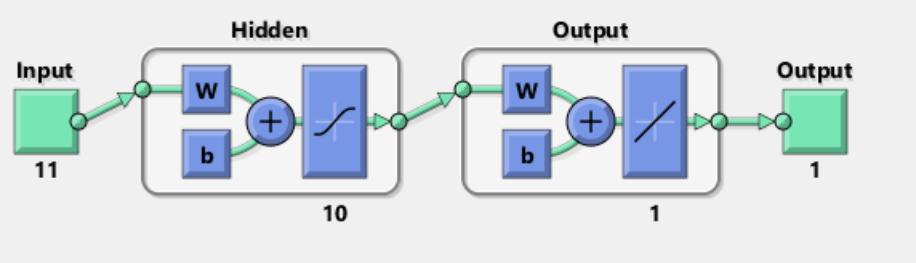

Figure 3-6 Created neural network for apply machine learning on project

Levenberg-Marquardt backpropagation function is chosen to train neural network.

3.4.1. Created machine learning function flow

```
% Output Fitting problem with a Neural Network
% Script generated by Neural Fitting app
% This script assumes these variables are defined:
%
%  inputs – input data.
%  targets – target data.

x = inputs;
t = targets;

% Choose a Training Function
% For a list of all training functions type: help nntrain
% 'trainlm' is usually fastest.
% 'trainbr' takes longer but may be better for challenging problems.
% 'trainscg' uses less memory. Suitable in low memory situations.
trainFcn = 'trainlm';  % Levenberg-Marquardt backpropagation.

% Create a Fitting Network
hiddenLayerSize = 10;
net = fitnet(hiddenLayerSize,trainFcn);

% Setup Division of Data for Training,Validation,Testing
net.divideParam.trainRatio = 70/100;
net.divideParam.valRatio = 15/100;
net.divideParam.testRatio = 15/100;

% Train the Network
[net,tr] = train(net,x,t);

% Test the Network
y = net(x);
e = gsubtract(t,y);
performance = perform(net,t,y)

% View the Network
view(net)

% Plots
% Uncomment these lines to enable various plots.
%figure,plotperform(tr)
```

$\%figure, plottrainstate(tr)$
$\%figure, ploterrhist(e)$
$\%figure, plotregression(t, y)$
$\%figure, plotfit(net, x, t)$

3.4.2. Testing neural network with data

Given dataset for 50 days (see Appendix-B) created neural network is able to calculate consistently eac value and predict eac value for 51st day. 5th day and 40th day is tested to understand neural network created performance formula.

Table 3-2 Formula calculation of EAT comparison to neural network calculated EAT for 5th day for given 50 days.

KPIs and Day	Calculation EAT by formulas	Given test input to neural network for 5th day	Neural network prediction for given input for 5th day EAT
Day	5,00	5	
Bac	100000,00	100000	
Duration	100,00	100	
Ac	800,00	800	
Pv	5000,00	5000	
Ev	3000,00	3000	
Status	0,03	0,0300	
Cpi	3,75	3,7500	
Spi	0,60	0,6000	
Tcpi	0,98	0,9800	
Team Members	5,00	-	
Cc	10,00	-	
Eac	43911,11		43911,0954488107

Table 3-3 Formula calculation of EAT comparison to neural network calculated EAT for 40th day for given 40 days.

KPIs and Day	**Calculation EAT by formulas**	**Given test input to neural network for 40 day**	**Neural network prediction for given input for 40st day EAT**
Day	40,00	40	
Bac	100000,00	100000	

Duration	100,00	100	
Ac	3020,00	3020	
Pv	40000,00	40000	
Ev	53000,00	53000	
Status	0,53	0,5300	
Cpi	17,55	17,5500	
Spi	1,33	1,3300	
Tcpi	0,48	0,4800	
Team Members	5,00	-	
Cc	10,00	-	
Eac	5041,22		5041,963663297162

Table 3-4 Formula calculation of EAT comparison to neural network calculated EAT for 51th day for given 50 days.

KPIs and Day	Calculation EAT by formulas	Given test input to neural network for 51st day	Neural network prediction for given input for 51st day EAT
Day	51,00	51	
Bac	100000,00	100000	
Duration	100,00	100,	
Ac	4890,00	4890	
Pv	51000,00	51000	
Ev	64000,00	64000	
Status	0,64	0,6400	
Cpi	13,09	13,0900	
Spi	1,25	1,2500	
Tcpi	0,38	0,3800	
Team Members	5,00	-	
Cc	10,00	-	
Eac	7081,90		6995,20511821840

Tables 3.2,3.3 and 3.4 are used for evaluation of fitting. It is important to understand what kind of machine learning need to be used. Depending on context method should be chosen. Such as new branch decision or pricing of product is different than prediction of cost, there are different approaches for machine learning such as supervised or unsupervised learning. For the 51st day table prediction output gives %1 of mismatch. This can be solved by having a big data set and better optimized application.

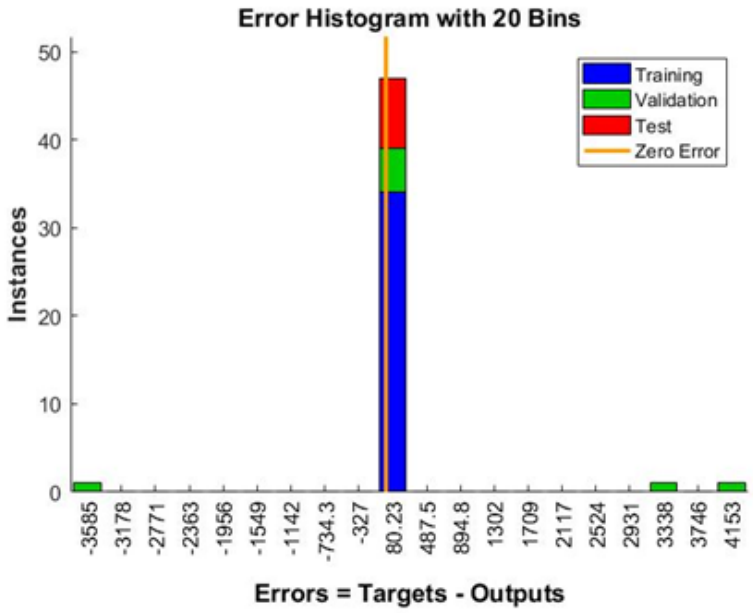

Figure 3-7 Error histogram

Error histogram is expected to be better if error is aggregated in one simple point.

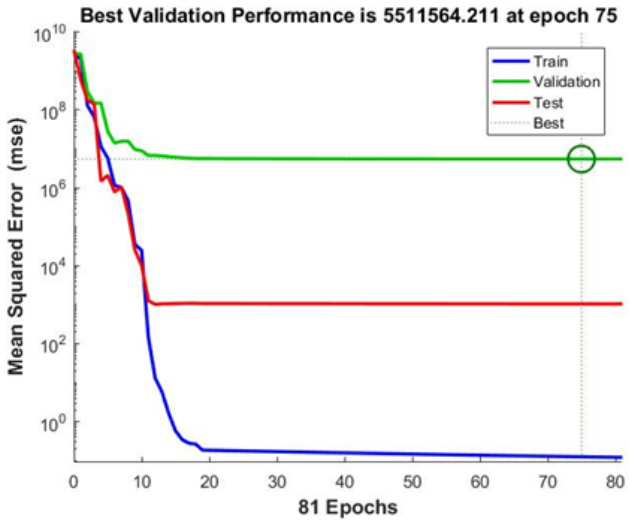

Figure 3-8 Performance of validation screenshot for trained neural network

For the validation of network less error is better after error mean is stable training is stopped. The validation and test curves are very similar. If the test curve had increased significantly before the validation curve increased, then it is possible that some overfitting might have occurred.

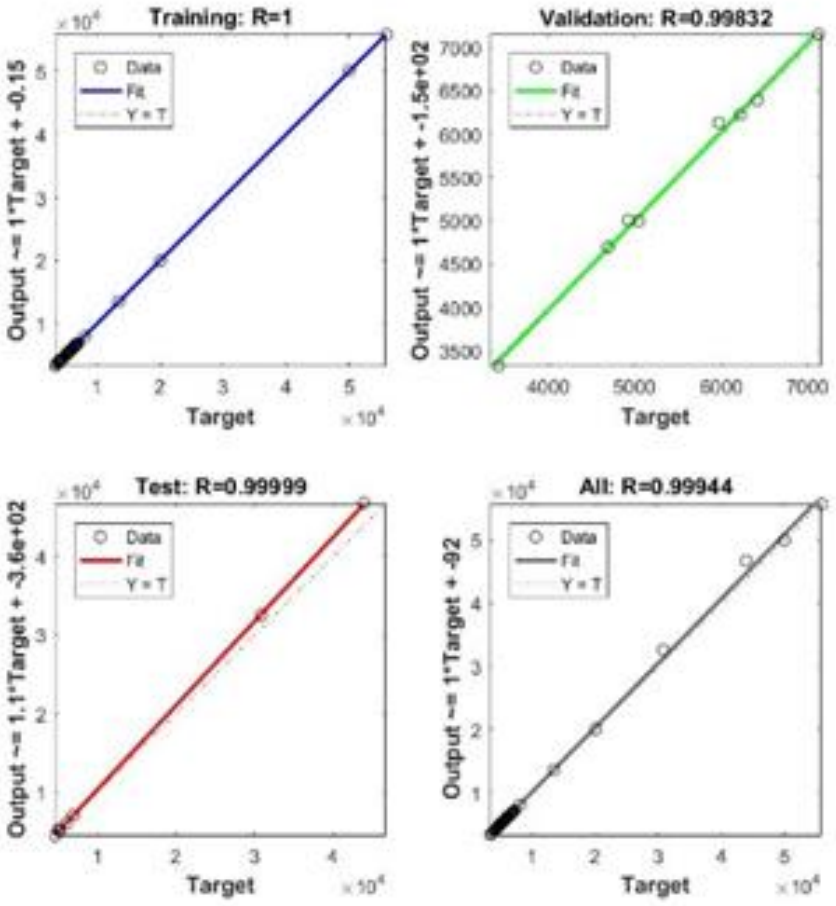

Figure 3-9 Regression screen shot for trained neural network

It is important to validate the network, regression plot created which shows the relationship between network's outputs and targets. In a perfect training, outputs and the targets expected to be exactly equal, in practice it is not common. Regression graphics are shown above is better if linear lines are close to 45 degrees. It is accepted as better if R is bigger than 0.93. The represented three plots in figure (3-9) the training, validation, and testing data. The dashed lines represent the perfect result – outputs = targets. For the given graphs' solid lines represents the best fit linear regression line between outputs and targets. R value indicates the relationship between the outputs and targets. If R = 1, this indicates that there is an exact linear relationship between outputs and targets. If R is close to zero, then there is no linear relationship between outputs and targets.

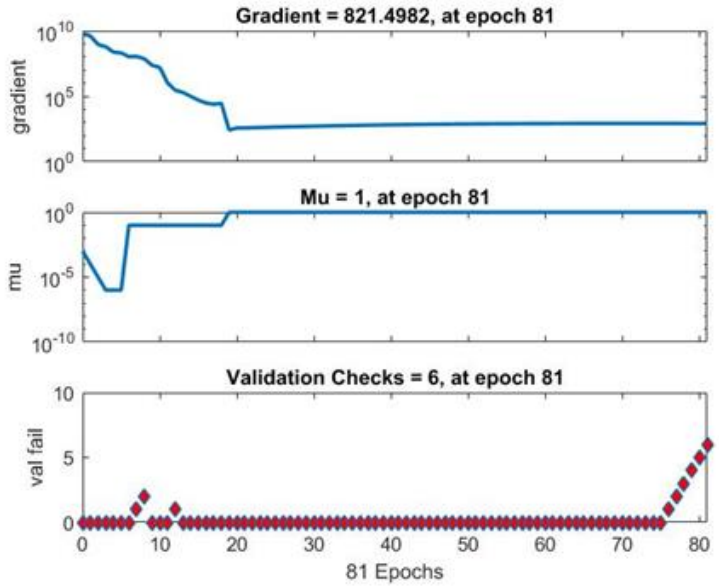

Figure 3-10 Validation and learning curve for trained neural network

Last graphic for validation shows how neural network learns in terms of performance. High performance learning curve is expected to be like elbow.

For the validation and controlling it shows that by applying right matrice representation and sophistically created key performance indicators can give predictions for project management. Especially if these systems are combined in an organization with business intelligence systems, organisations will have the ability to establish relations and discover hidden future patterns in their organization such as manager turnover related to project components, performance bindings in a social behavioral manner, project cost related to complexity.

3.5. Change process, creativity and adapting machine learning

Introducing new solutions or roles for transformation needs change and change is usually source for fear. Employees are not likely to have change in their work life especially if it is not well explained. Many scholars point out that clearing fears and having open clear goals are needed in order to doubt free involvement and support.

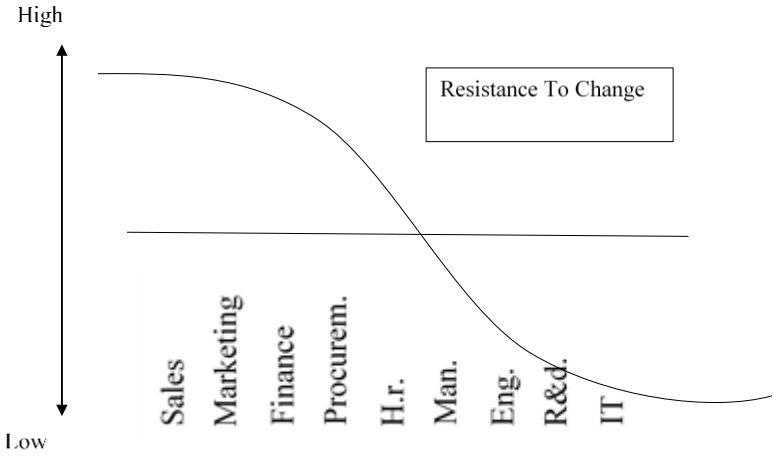

Figure 3-11 Resistance to Change in an organization

Note. Reprinted from *Project Management: A Systems Approach to Planning, Scheduling, and Controlling (11th edition)* (p. 78), by Kerzner, H., (2013), USA, New Jersey: John Wiley & Sons, Inc

It is experienced in manufacturing to consulting fear of change always exists depending on different problems. Organizations in every sector contains fear (fig. 3-11) related to various topics including job loss, status loss, social group change and so on. Kerzner (2013) states that in his work, IT and R&D departments are almost entirely project-driven, in this departments the project management is not facing with resistance at all due to their way of work. On the other hand, individuals may show resistance and it is usually more complex and more difficult to overcome. Usage of machine learning, in the offices it may face difficulties from individuals who afraid of change in work habits. At the same time a loss of a talented IT employee is a critical loss for technology firm during a major organizational change (Naidoo, 2016).

Overcoming the resistance stated as Kerzner (2013) at his book Project Management: A Systems Approach to Planning, Scheduling, and Controlling,

Fear of failure - Educate workforce on benefits of changes

Fear of termination - individual/corporation

Fear of added workload - Show willingness to admit/accept mistakes

Fear or dislike of uncertainty/unknowns - Show willingness to pitch in

Fear of embarrassment - Transform unknowns into opportunities

Fear of a “we/they” organization - share information

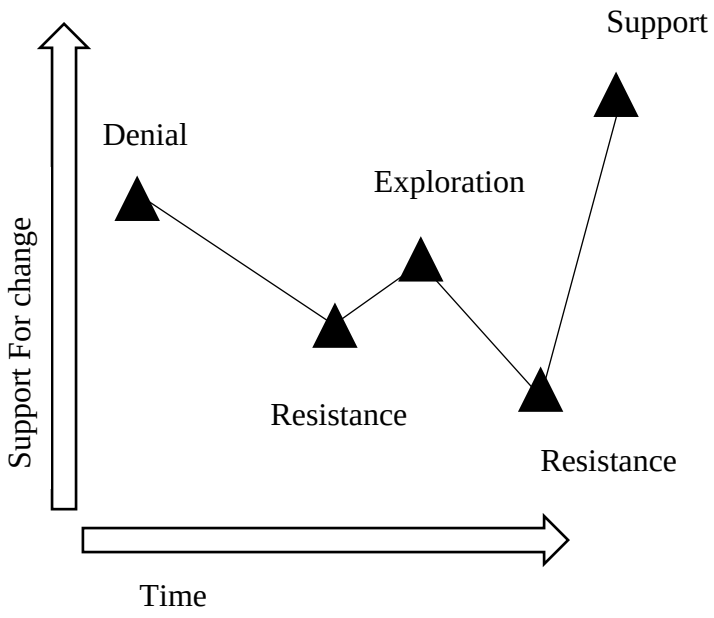

Figure 3-12 Change process in an organization

Note. Adapted from *Project Management: A Systems Approach to Planning, Scheduling, and Controlling. (11th edition (p.80)*, Kerzner, H. (2013). USA, New Jersey: John Wiley & Sons, Inc.

In cooperative cultures, based upon trust and effective communications, internally and externally change happens, if change proceeeds in non-cooperative cultures, provoke mistrust and self-worry prevails (Kerzner, 2013).

Small wins theory to motivate a team

Amabile and Kramer (2011) came up with a methodology to help teams achieve regular small wins. As well as using these approaches, it is expected to encourage your people to recognize and celebrate their own success which are small or big.

Amabile and Kramer's progress theory (2011) sets six clear rules meaningful progresses. Setting clear goals and objectives and erase all uncertainty in terms of goals, allowing autonomy in work place, providing resources needed while allowing ample time, providing support and expertise such as mentoring and openness, learning from failures and persevere. After all important cover topic is to celebrating success and recognizing it.

Person to bring change

Focus on corporate entrepreneurship increased as a result of increased market volatility (Dess & Lumpkin, 2005; Guth & Ginsberg, 1990; Kollmann & Stöckmann, 2014 cited in Selig, Stettina, Baltes, 2016). Small teams act entrepreneur like in organizations (Garrett & Covin, 2013). These "semi-autonomously" acting teams aim to impact performance and success (Burgers, Jansen, Van den Bosch, Frans A.J., & Volberda, 2009; Hill & Birkinshaw, 2014 cited in Selig, Stettina, Baltes, 2016). Corporate entrepreneurial teams are helping creation of a new. Examples for this are proactive, passion for work and self-efficacy, experimentation skills, communication skills and networking skills (Herron, 1992; Rauch & Frese, 2007; Ray, 1993 cited in Selig, Stettina, Baltes, 2016). Expectations from these people or teams are extraversion, agreeableness.

Expected motivating factors are autonomy, need for achievement, intrinsic and extrinsic motivation. In terms of skills there is a matching between communication skills, networking skills, interpersonal skills and experimentation skills.

In Michaelides's The Art of Innovation (Michaelides 2007) he describes a model to help organizations how to have innovation in their core business. Possible benefits for regular companies which are unable to innovate, approach is methodological and segmented in terms of resources culture and structure, it is brilliantly describes how to encourage this culture within their existed culture. Described in his work to create a culture of ideas, freedom, engagement, humor, risk organization should be organized as individual, team, target, system by having sources of talent, energy, method. In general, ability to act within

an organization entrepreneurial culture must be encouraged. Amabile and Kramer (2011) clarifies in their work that creativity is unleashed when an individual is motivated to success in a challenging situation while they are doing what they would like to be doing.

4. CONCLUSION

It is seen that project management is increasing their validity over years and many organizations has transformed into project-based organizations. Projects are seen as extensive learning for organizations and many challenges in project management needs interdisciplinary approach. Usage of artificial intelligence supported by intelligent systems will help people make better decisions. As it is understood from extensive literature review design and information technology are promising when they are used together for tomorrows' organization and healthy systems. Organizations strongly rely on decision support systems, such as business intelligence systems, to have competitive advantage. Answer of analyzed outcome of such systems should include creative approach, design thinking can be used to generate new solutions for organizations in order to understand how answers can be created within organization. Increased importance of project manager also brings necessity of proactive management and increased working hours. It is shown adapting artificial intelligence can help to predict and analyze performance, find insights about not previously associated effects. Personal skills of person who is expected to bring organisations such new approaches observed as openness and good communication. Departments where is easy to implement new methodologies are mostly project based departments such as IT. Decisions made by analyzed data, this points out importance of data collection within organisation for further intelligent activities. By having detailed and clean datasets machine learning can be applied in many cases.

For further research, it is very important to see organization as an organism and relate every department with each other. Study domains can include employee turnover prediction related to internal and external effects, manager motivation sources, leadership background or even external distortions such as performance depending on weather, work place dialogue effects on project performance.

5. REFERENCES

1. Adjei, D. Rwakatiwana, P.(2009). Application of Traditional and Agile Project Management in Consulting Firms. (Master's Thesis), Umeå School of Business: Umeå.

2. Alite, B. and Spasibenko, N. (2008) 'Project Suitability for Agile methodologies', Thesis, Umea School of Business, Sweden

3. Alleman, G.B. (2005) 'Agile project management methods for IT projects', in Chapter 23 of The Story of Managing Projects: An Interdisciplinary Approach, Carayannis E.G., Kwak, Y.H., and Anbari, F.T., (editors), USA: Greenwood Press, Praeger Publishers, pp. 324-334.

4. Alleman, G.B. (2008) 'Essay – Can Software Project be Managed using PMBOK–like Processes?' Retrieved on 10th December 2009 from: http://www.niwotridge.com/Essays/Editorials/PMEditorial.htm

5. Alvesson, M. (1995). Management of Knowledge-Intensive Companies. Berlin/New York.

6. Arash Shahin, M. Ali Mahbod, (2007) "Prioritization of key performance indicators: An integration of analytical hierarchy process and goal setting", International Journal of Productivity and Performance Management, Vol. 56 Issue: 3, pp.226-240

7. Atkinson, R., Crawford, L., and Ward, S (2006) 'Fundamental uncertainties in projects and the scope of project management' International Journal of Project Management, Vol. 24(8), pp. 687–698

8. Bailey, S. & Cohen, D (1997). What makes teams work: Group effectiveness research from the shop floor tho the executive suite. Journal of Management. 23 (3),239-290.

9. Bente Elkjaer (2000) Learning and getting to know: the case of knowledge workers, Human Resource Development International, 3:3, 343-359.

10. Boehm, B. (2002) 'Get ready for Agile Methods, with care.' IEEE Computer, Vol. 35(1), pp. 64-69.

11. Brooks, F. P. (2010). The design of design: essays from a computer scientist. NJ: Addison-Wesley Professional and Business

12. Brown, Tim. (2008)."Design Thinking." Harvard Business Review (2008). Web. 12 Oct. 2016 at:[www.hbr.com]

13. Cadle, J., and Yeates, D. (2008) Project Management for Information Systems (5th edition), England: Pearson Education Ltd.

14. Christoph J. Selig, Christoph J. Stettina, Guido H. Baltes, (2016). The Corporate Entrepreneur: A driving force for strategic renewal and radical innovation in established companies

15. Cicmil, S., Williams, T., Thomas, J., and Hodgson, D. (2006). 'Rethinking Project Management: Researching the actuality of projects.' International Journal of Project Management, Vol. 24(8), pp. 675 686.

16. Collyer, S., and Warren, C.M.J. (2009). 'Project management approaches for dynamic environments' International Journal of Project Management, Vol. 27(4), pp. 355–364.

17. Conforto, E.C., and Amaral, D.C. (2008). 'Evaluating an Agile Method for Planning and Controlling Innovative Projects,' Project Management Journal, Early View, (Articles online in advance of print), published online: 18 Dec 2008

18. Cross, N., Dorst, K., & Roozenburg, N. (Eds.). (1992). Research in design thinking. Delft, The Netherlands: Delft University Press.

19. Dorst, K. (2011). 'The core of 'design thinking' and its application' Design Studies Volume 32, Issue 6, Pages 515-610

20. Érdi, P., Makovi, K.,(2013). Somogyvári, Z. et al. Prediction of emerging technologies based on analysis of the US patent citation network. Scientometrics (2013) 95: 225.

21. Eriksson, E., (2013). Exploration and exploitation in project-based organizations: Development and diffusion of knowledge at different organizational levels in construction companies. International Journal of Project Management Volume 31, Issue 3 Pages 333-341

22. Fernandes,G. Ward,S., Araújo,M. (2015). Improving and embedding project management practice in organisations.

23. Fernandez, D.J., and Fernandez, J. D. (2016). 'Agile Project Management – Agilism versus traditional appraoches. Journal of Computer Information Systems 10-17

24. Fitsilis, P. (2008). Comparing PMBOK and Agile Project Management software development processes. in Advances in Computer and Information Sciences and Engineering. Sobh, T. (editor). Netherlands: Springer, pp. 378-383.

25. Gallo, M., and Gardiner, P.D. (2007). Triggers for a flexible approach to project management within UK financial services. International Journal of Project Management Vol. 25(5), pp. 446-456.

26. Gareis, R. (2010).Changes of organizations by projects. International Journal of Project Management, vol. 28, no. 4, pp. 314-327.

27. Geraldi, J.G. (2008) The balance between order and chaos in multi-project firms: A conceptual model. International Journal of Project Management Vol. 26(4), pp 348–356

28. Gillespie,R. (1993) Manufacturing Knowledge: A history of the Hawthorne Experiments, Cambridge, UK:Cambridge University Press

29. Gomes, C.F., Yasin, M.M., and Lisboa, J.V. (2008). Project Management in the Context of Organisational Change: The Case of the Portuguese Public Sector. International Journal of Public Sector Management Vol. 21(6), pp. 573-585.

30. Griffiths, M. (2004). Using Agile Alongside The Pmbok. Originally published as a part of 2004 Pmi Global Congress Proceedings Anaheim, California

31. Griffiths, M.,(2007). Agile Control And Execution Processes Source:Griffiths. Pmi Global Congress Proceedings – Atlanta Georgia

32. Grundy, T. and Brown, L. (2004). Strategic Project Management: Creating Breakthrough organisations. London: Thomson Learning

33. Hass, K. B. (2007). The Blending of Traditional and Agile Project Management. PM World Today, Vol. 9(5). Retrieved on 15th of March 2017, from: http://www.pmforum.org/library/tips/2007/PDFs/Hass-5 07.pdf

34. Hauc, A., and Kovač, J. (2000). Project management in strategy implementation-experiences in Slovenia. International Journal of Project Management Vol. 18(1), pp. 61-67

35. Henriksen Agile project management A case study on agile practices — André Henriksen Master's Thesis in Business Administration - February 2016

36. Hewson G., (2006). Agile Project Management: Much About Agile. The Agile Vancouver Conference 2006, Retrieved on 20th February 2017 from: http://www.kruchten.org/agilevancouver/presentation_slides/Hewson%20 PM%20intro.pdf

37. Hung, C.-L. (2016), Social networks, technology ties, and gatekeeper functionality: Implications for the performance management of R&D projects. Research Policy

38. Johnson, M. (2003). Shine Technologies:Agile Methodologies:Survey results http://www.shinetech.com/resources/ShineTechAgileSurvey2003-01-17.pdf

39. Judgev, K., Müller, R.(2005). A retrospective look at our evolving understanding of project success Project Management Journal; Dec 2005; 36, 4; Abi/Inform Global Pg. 19-31

40. Kärreman, D., Svenningson, S., & Alvesson, M. (2002). The return of the machine bureaucracy? Management control in the work settings of professionals. International Studies of Management and Organization, 32(3), 70-92.

41. Kerzner, H. (2003). Project Management: a Systems Approach to Planning, Scheduling, and Controlling (8th edition), USA, New Jersey: John Wiley & Sons, Inc.

42. Kerzner, H. (2013). Project Management: a Systems Approach to Planning, Scheduling, and Controlling. (11th edition), USA, New Jersey: John Wiley & Sons, Inc.

43. Kolko, J. (2015). Design Thinking Comes of Age. September 2015, [https://hbr.org/product/recommended/an/R1509D-PDF ENG?referral=02527&cm_vc=rr_item_page.articles], Retrieved on March, 2017

44. Kowahi,R. Provost,F. (1998). Glossary of terms, Special Issue on Applications of Machine Learning and the Knowledge Discovery Process. Machine Learning, 30, 271-274 (1998)

45. Kumar,S. Krishna,B.A., Satsangi P.S.(1994) Fuzzy Systems and Neural Networks in Software Engineering. Project Management Journal of Applied Intelligence, 4, 31-52

46. Larman, C. (2004). Agile and Iterative Development: A Manager's Guide. Agile Software Development Series, edited by Cockburn, A., and Highsmith, J. USA: Pearson Education Inc.

47. Lipke,W., Zwikael,O., Henderson K., Anbari,F., (2009) Prediction of project outcome The application of statistical methods to earned value management and earned schedule performance indexes.

48. Lockett, M., Reyck, B.D., and Sloper, A. (2008). Managing Project Portfolios. Business Strategy Review. Vol. 19(2), pp. 77-83

49. Lord, M.A. (1993). Implementing Strategy through Project Management. Long Range Planning Vol. 26(1), pp. 76-85

50. Martin, R. (2009). The design of business. Cambridge MA: Harvard Business Press.

51. Martinez,D. Fernández-Rodríguez C.(1989). Artificial Intelligence applied to project success: a literature review. International Journal Of Interactive Multimedia And Artificial Intelligence Issn: 1989-1660–Vol. 4, Number 3

52. Meng,X. Boyd,P.(2017). The role of the project manager in relationship management. School of Natural and Built Environment, Queen's University Belfast, Belfast, UK:Lagan Construction Group, Belfast, UK

53. Morris, T. (2001). Asserting property rights: knowledge codification in the professional service firm. Human Relations, 54(7), 819-838.

54. Morris, T., & Empson, L. (1998). Organisation and expertise: an exploration of knowledge bases andthe management of accounting and consulting firms. Accounting, Organizations and Society, 23(5/6), 609-624.

55. Naidoo,R. A communicative-tension model of change-induced collective voluntary turnover in IT. The Journal of Strategic Information Systems, archive Volume 25 Issue 4, December 2016 Pages 277-298

56. Nobeoka, K., and Cusumano, M.A. (1997). Multiproject Strategy and Sales Growth: The Benefits of Rapid Design Transfer in New Product Development. Strategic Management Journal, Vol. 18(3), pp. 169-186.

57. Owen, R., Koskela, L.J., Henrich, G., and Codinhoto, R. (2006) .Is Agile Project Management Applicable To Construction?. In: Sacks, R., and Bertelsen, S. (ed.), Proceedings 14th Annual Conference of the International Group for Lean Construction, Ponteficia Universidad Catolica de Chile, Santiago, Chile, pp.51-66.

58. Papke-Shields, K. E., Beise, C., & Quan, J. (2010). Do project managers practice what they preach, and does it matter to project success? International Journal of Project Management, 28(7), pp. 650-662.

59. Papke-Shields, K.E., Beise, C., and Quan, J. (2009) . Do project managers practice what they preach, and does it matter to project success? International Journal of Project Management, In Press, Corrected Proof, Available online 6 December 2009.

60. Pascual, DelCastillo, Louit, Knights, (2009). Reliability Engineering & System Safety. Volume 94, Issue 8, Pages 1308–1313

61. Paternoster, N., Giardino, C., Unterkalmsteiner, M., Gorschek, T., & Abrahamsson, P. 2014. Software development in startup companies: A systematic mapping study. Information and Software Technology, 56(10): 1200–1218.

62. Peter G. Rowe (1987). Design Thinking.MIT Press

63. Pettersen, N. (1991). What do we know about the effective project manager? International Journal of Project Management, 9(2): 99–104. Cited in Pitsis, T. S., Kornberger, M., & Clegg, S. 2004. The Art of Managing Relationships in Interorganizational Collaboration. Management, 7(3): 47.

64. Pinto J,K.,Slevin D,P.(1897). Critical Factors in Successful Project Implementation. IEEE Transactions On Engineering Management, Vol. Em-34, No. I, February 1987

65. R Hoda, J Noble, S Marshall.(2008). Agile project management, New Zealand Computer Science Research Student Conference 6, 218-221

66. Robertson, M., & Swan, J. (2003). Control—what control? Culture and ambiguity within a knowledgen intensive firm. Journal of Management Studies, 40(4), 831-58.

67. Robertson, M., & Swan, J. (2004). Going public: the emergence and effects of soft bureaucracy withina knowledge-intensive firm. Organization, 11(1), 123-148.

68. Rodrigues, A., and Bowers, J. (1996). The role of system dynamics in project management. International Journal of Project Management Vol. 14(4), pp. 213-220

69. Rylander, A. (2006). Making Sense of Knowledge Work. (Doctoral dissertation), Royal Institute of Technology: Stockholm.

70. Saladis, F.P., and Kerzner, H. (2009). Bringing the PMBOK Guide to Life: A Companion for the Practicing Project Manager. USA, New Jersey: John Wiley & Sons.

71. Salerno, Gomes,Vasconcelos,L., Silva, Bagno, Freitas, Simone Lara Teixeira Uchôa. (2015) Technovation. Vol 35, Pgs 1-72, (January 2015)

72. Sauser, B.J., Reilly, R.R., and Shenhar, A.J. (2009). Why projects fail? How contingency theory can provide new insights – A comparative analysis of NASA's Mars Climate Orbiter loss. International Journal of Project Management, Vol. 27(7), pp. 665–679.

73. Schreyögg, G. and Geiger, D. (2007). The Significance of Distinctiveness: A Proposal for Rethinking Organizational Knowledge. Organization 14(1): 77-100. Google Scholar

74. Schuh, P. (2005) Integrating Agile Development in the Real World. USA: Charles River Media, Inc.

75. Serrador, P.,Pinto, J.K.(2015). Does Agile work? — A quantitative analysis of agile project success, International Journal of Project Management.

76. Sharifi, H., and Zhang, Z. (2001). Agile Manufacturing in Practice – Application of a Methodology. International Journal of Operations & Production Management, Vol. 21(5), pp 772-794.

77. Shenhar, A.J. (2004). Strategic Project Leaderships Toward a strategic approach to project management. R&D Management Vol. 34(5), pp. 569-578)

78. Starbuck, W. H. (1992). Learning by knowledge intensive firms. Journal of Management Studies, 29:713-40.

79. Turner, J.R. (1999). The Handbook of Project-Based Management, (2nd Edition). United Kingdom: McGraw-Hill, pp 4-24.

80. Michaelides D.(2007). The art of innovation – integrating creativity in organizations. Nicosia: Performa Productions.

81. Amabile, T. M., Kramer, S. J. The Progress Principle: Using Small Wins to Ignite Joy, Engagement, and Creativity at Work (2011), Harvard Business Review Press, Boston, MA

APPENDIX-A

```
classdef dashboard_sefa_final < matlab.apps.AppBase
    % Properties that correspond to app components
    properties (Access = public)
        UIFigure                          matlab.ui.Figure
        BudgetatCompletionLabel           matlab.ui.control.Label
        BudgetatCompletionEditField       matlab.ui.control.NumericEditField
        TeamSizeEditFieldLabel            matlab.ui.control.Label
        TeamSizeEditField                 matlab.ui.control.NumericEditField
        ProjectManagementDashboardLabel   matlab.ui.control.Label
        UIAxes                            matlab.ui.control.UIAxes
        UIAxes_2                          matlab.ui.control.UIAxes
        ClicktoCalculateButton            matlab.ui.control.Button
        ConsecutiveDayEditFieldLabel      matlab.ui.control.Label
        ConsecutiveDayEditField           matlab.ui.control.NumericEditField
        ActualCostEditFieldLabel          matlab.ui.control.Label
        ActualCostEditField               matlab.ui.control.NumericEditField
        DurationofProjectdaysLabel        matlab.ui.control.Label
        DurationofProjectdaysEditField    matlab.ui.control.NumericEditField
        ProjectStatusEditFieldLabel       matlab.ui.control.Label
        ProjectStatusEditField            matlab.ui.control.NumericEditField
        CPITextAreaLabel                  matlab.ui.control.Label
        CPITextArea                       matlab.ui.control.TextArea
        SPITextAreaLabel                  matlab.ui.control.Label
        SPITextArea                       matlab.ui.control.TextArea
        madebySefaOguzSaglamPolitechnicUniversityofMilanLabel  matlab.ui.control.Label
        UIAxes_3                          matlab.ui.control.UIAxes
        EstimateatCompletionEditFieldLabel  matlab.ui.control.Label
        EstimateatCompletionEditField     matlab.ui.control.NumericEditField
        EstimatetoCompletionEditFieldLabel  matlab.ui.control.Label
        EstimatetoCompletionEditField     matlab.ui.control.NumericEditField
        TCPITextAreaLabel                 matlab.ui.control.Label
        TCPITextArea                      matlab.ui.control.TextArea
        notesTextAreaLabel                matlab.ui.control.Label
        notesTextArea                     matlab.ui.control.TextArea
        PlannedValueEditFieldLabel        matlab.ui.control.Label
        PlannedValueEditField             matlab.ui.control.NumericEditField
        Label                             matlab.ui.control.Label
        Slider                            matlab.ui.control.Slider
        CommunicationChannelsEditFieldLabel  matlab.ui.control.Label
        CommunicationChannelsEditField    matlab.ui.control.NumericEditField
    end

    methods (Access = private)

        function results = func(app)

        end

    end

    methods (Access = private)
        % Code that executes after component creation
        function startupFcn(app)

        end
        % Button pushed function: ClicktoCalculateButton
        function ClicktoCalculateButtonPushed(app, event)
            BAC=app.BudgetatCompletionEditField.Value;
            AC=app.ActualCostEditField.Value;
            NP=app.TeamSizeEditField.Value;
            CC=(NP*(NP-1))/2
```

```
            DRT=app.DurationofProjectdaysEditField.Value;
            Day=app.ConsecutiveDayEditField.Value;
            app.CommunicationChannelsEditField.Value=CC;
            PV=Day*(BAC/app.DurationofProjectdaysEditField.Value);
            app.PlannedValueEditField.Value=PV;
            EV=app.ProjectStatusEditField.Value*BAC;
            EAC=AC+((BAC-EV)/((EV^2)/(AC*PV)))
            app.EstimateatCompletionEditField.Value=EAC;
            ETC=EAC-AC
            app.EstimatetoCompletionEditField.Value=ETC;

            for i=1:Day

                CPI(i)=EV/AC;
                SPI(i)=EV/PV;
                TCPI(i)= (BAC-EV)/(BAC-AC);
            end;
            plot(app.UIAxes, Day , CPI , 'rx' );
            plot(app.UIAxes_2, Day , SPI , 'ro');
            plot(app.UIAxes_3, Day , TCPI ,'r+')
        end
        % Close request function: UIFigure
        function UIFigureCloseRequest(app, event)
            delete(app);

        end
        % Value changed function: ProjectStatusEditField, Slider
        function SliderValueChanged(app, event)
            value = app.Slider.Value;
            app.ProjectStatusEditField.Value=value/100
        end
    end
    % App initialization and construction
    methods (Access = private)
        % Create UIFigure and components
        function createComponents(app)
            % Create UIFigure
            app.UIFigure = uifigure;
            app.UIFigure.Color = [0.9373 0.9373 0.9373];
            app.UIFigure.Position = [100 100 750 593];
            app.UIFigure.Name = 'UI Figure';
            app.UIFigure.CloseRequestFcn = createCallbackFcn(app, @UIFigureCloseRequest,
true);
            setAutoResize(app, app.UIFigure, false)
            % Create BudgetatCompletionLabel
            app.BudgetatCompletionLabel = uilabel(app.UIFigure);
            app.BudgetatCompletionLabel.HorizontalAlignment = 'right';
            app.BudgetatCompletionLabel.FontName = 'Leelawadee UI Semilight';
            app.BudgetatCompletionLabel.Position = [25.03125 453 141 15];
            app.BudgetatCompletionLabel.Text = 'Budget at Completion ($)';
            % Create BudgetatCompletionEditField
            app.BudgetatCompletionEditField = uieditfield(app.UIFigure, 'numeric');
            app.BudgetatCompletionEditField.ValueDisplayFormat = '%11.10g';
            app.BudgetatCompletionEditField.FontName = 'Leelawadee UI Semilight';
            app.BudgetatCompletionEditField.Position = [178.03125 449 100 22];
            % Create TeamSizeEditFieldLabel
            app.TeamSizeEditFieldLabel = uilabel(app.UIFigure);
            app.TeamSizeEditFieldLabel.HorizontalAlignment = 'right';
            app.TeamSizeEditFieldLabel.FontName = 'Leelawadee UI Semilight';
            app.TeamSizeEditFieldLabel.Position = [99.703125 426 63 15];
            app.TeamSizeEditFieldLabel.Text = 'Team Size';
            % Create TeamSizeEditField
            app.TeamSizeEditField = uieditfield(app.UIFigure, 'numeric');
            app.TeamSizeEditField.ValueDisplayFormat = '%11.10g';
            app.TeamSizeEditField.FontName = 'Leelawadee UI Semilight';
            app.TeamSizeEditField.Position = [178.03125 422 100 22];
            % Create ProjectManagementDashboardLabel
            app.ProjectManagementDashboardLabel = uilabel(app.UIFigure);
            app.ProjectManagementDashboardLabel.FontName = 'Elephant';
            app.ProjectManagementDashboardLabel.FontSize = 18;
```

```
            app.ProjectManagementDashboardLabel.Position = [20 555 301 24];
            app.ProjectManagementDashboardLabel.Text = 'Project Management Dashboard';
            % Create UIAxes
            app.UIAxes = uiaxes(app.UIFigure);
            title(app.UIAxes, 'CPI today');
            xlabel(app.UIAxes, 'Day');
            ylabel(app.UIAxes, 'CPI ');
            app.UIAxes.FontName = 'Leelawadee UI';
            app.UIAxes.Box = 'on';
            app.UIAxes.XGrid = 'on';
            app.UIAxes.YGrid = 'on';
            app.UIAxes.Position = [63 127 176 147];
            % Create UIAxes_2
            app.UIAxes_2 = uiaxes(app.UIFigure);
            title(app.UIAxes_2, 'SPI today');
            xlabel(app.UIAxes_2, 'Day');
            ylabel(app.UIAxes_2, 'Spi');
            app.UIAxes_2.FontName = 'Leelawadee UI';
            app.UIAxes_2.Box = 'on';
            app.UIAxes_2.XGrid = 'on';
            app.UIAxes_2.YGrid = 'on';
            app.UIAxes_2.Position = [304 127 176 147];
            % Create ClicktoCalculateButton
            app.ClicktoCalculateButton = uibutton(app.UIFigure, 'push');
            app.ClicktoCalculateButton.ButtonPushedFcn      =      createCallbackFcn(app,
@ClicktoCalculateButtonPushed, true);
            app.ClicktoCalculateButton.BackgroundColor = [0.6745 0.5255 0.5255];
            app.ClicktoCalculateButton.FontName = 'Leelawadee UI';
            app.ClicktoCalculateButton.FontSize = 16;
            app.ClicktoCalculateButton.FontWeight = 'bold';
            app.ClicktoCalculateButton.Position = [347 545 174 34];
            app.ClicktoCalculateButton.Text = 'Click to Calculate';
            % Create ConsecutiveDayEditFieldLabel
            app.ConsecutiveDayEditFieldLabel = uilabel(app.UIFigure);
            app.ConsecutiveDayEditFieldLabel.HorizontalAlignment = 'right';
            app.ConsecutiveDayEditFieldLabel.FontName = 'Leelawadee UI Semilight';
            app.ConsecutiveDayEditFieldLabel.Position = [282 452 98 15];
            app.ConsecutiveDayEditFieldLabel.Text = 'Consecutive Day';
            % Create ConsecutiveDayEditField
            app.ConsecutiveDayEditField = uieditfield(app.UIFigure, 'numeric');
            app.ConsecutiveDayEditField.ValueDisplayFormat = '%11.10g';
            app.ConsecutiveDayEditField.FontName = 'Leelawadee UI Semilight';
            app.ConsecutiveDayEditField.Position = [388 449 100 22];
            % Create ActualCostEditFieldLabel
            app.ActualCostEditFieldLabel = uilabel(app.UIFigure);
            app.ActualCostEditFieldLabel.HorizontalAlignment = 'right';
            app.ActualCostEditFieldLabel.FontName = 'Leelawadee UI Semilight';
            app.ActualCostEditFieldLabel.Position = [313 426 67 15];
            app.ActualCostEditFieldLabel.Text = 'Actual Cost';
            % Create ActualCostEditField
            app.ActualCostEditField = uieditfield(app.UIFigure, 'numeric');
            app.ActualCostEditField.ValueDisplayFormat = '%11.10g';
            app.ActualCostEditField.FontName = 'Leelawadee UI Semilight';
            app.ActualCostEditField.Position = [388 422 100 22];
            % Create DurationofProjectdaysLabel
            app.DurationofProjectdaysLabel = uilabel(app.UIFigure);
            app.DurationofProjectdaysLabel.HorizontalAlignment = 'right';
            app.DurationofProjectdaysLabel.FontName = 'Leelawadee UI Semilight';
            app.DurationofProjectdaysLabel.Position = [20.03125 399 143 15];
            app.DurationofProjectdaysLabel.Text = 'Duration of Project (days)';
            % Create DurationofProjectdaysEditField
            app.DurationofProjectdaysEditField = uieditfield(app.UIFigure, 'numeric');
            app.DurationofProjectdaysEditField.ValueDisplayFormat = '%11.10g';
            app.DurationofProjectdaysEditField.FontName = 'Leelawadee UI Semilight';
            app.DurationofProjectdaysEditField.Position = [178.03125 395 100 22];
            % Create ProjectStatusEditFieldLabel
            app.ProjectStatusEditFieldLabel = uilabel(app.UIFigure);
            app.ProjectStatusEditFieldLabel.HorizontalAlignment = 'right';
            app.ProjectStatusEditFieldLabel.FontName = 'Leelawadee UI Semilight';
            app.ProjectStatusEditFieldLabel.FontWeight = 'bold';
```

```
            app.ProjectStatusEditFieldLabel.Position = [531 555 86 15];
            app.ProjectStatusEditFieldLabel.Text = 'Project Status';
            % Create ProjectStatusEditField
            app.ProjectStatusEditField = uieditfield(app.UIFigure, 'numeric');
            app.ProjectStatusEditField.ValueChangedFcn      =      createCallbackFcn(app,
@SliderValueChanged, true);
            app.ProjectStatusEditField.ValueDisplayFormat = '%5.2f';
            app.ProjectStatusEditField.Editable = 'off';
            app.ProjectStatusEditField.FontName = 'Leelawadee UI Semilight';
            app.ProjectStatusEditField.Position = [627 551 100 22];
            % Create CPITextAreaLabel
            app.CPITextAreaLabel = uilabel(app.UIFigure);
            app.CPITextAreaLabel.BackgroundColor = [0.9373 0.9373 0.9373];
            app.CPITextAreaLabel.HorizontalAlignment = 'right';
            app.CPITextAreaLabel.FontName = 'Segoe UI Light';
            app.CPITextAreaLabel.FontWeight = 'bold';
            app.CPITextAreaLabel.Position = [53 322 25 16];
            app.CPITextAreaLabel.Text = 'CPI';
            % Create CPITextArea
            app.CPITextArea = uitextarea(app.UIFigure);
            app.CPITextArea.FontName = 'Segoe UI Light';
            app.CPITextArea.FontWeight = 'bold';
            app.CPITextArea.BackgroundColor = [0.9373 0.9373 0.9373];
            app.CPITextArea.Position = [91 273 148 77];
            app.CPITextArea.Value = {'<1 Over Budget'; '=1 On Budget'; '>1 Under Budget'};
            % Create SPITextAreaLabel
            app.SPITextAreaLabel = uilabel(app.UIFigure);
            app.SPITextAreaLabel.BackgroundColor = [0.9373 0.9373 0.9373];
            app.SPITextAreaLabel.HorizontalAlignment = 'right';
            app.SPITextAreaLabel.FontName = 'Segoe UI Light';
            app.SPITextAreaLabel.FontWeight = 'bold';
            app.SPITextAreaLabel.Position = [282 322 25 16];
            app.SPITextAreaLabel.Text = 'SPI';
            % Create SPITextArea
            app.SPITextArea = uitextarea(app.UIFigure);
            app.SPITextArea.FontName = 'Segoe UI Light';
            app.SPITextArea.FontWeight = 'bold';
            app.SPITextArea.BackgroundColor = [0.9373 0.9373 0.9373];
            app.SPITextArea.Position = [332 273 148 77];
            app.SPITextArea.Value = {'<1 Behind Schedule'; '=1 On Schedule'; '>1 Ahead of
Schedule'};
            % Create madebySefaOguzSaglamPolitechnicUniversityofMilanLabel
            app.madebySefaOguzSaglamPolitechnicUniversityofMilanLabel                  =
uilabel(app.UIFigure);
            app.madebySefaOguzSaglamPolitechnicUniversityofMilanLabel.FontName   =   'Gill
Sans MT';
            app.madebySefaOguzSaglamPolitechnicUniversityofMilanLabel.Position = [30 541
291 15];
            app.madebySefaOguzSaglamPolitechnicUniversityofMilanLabel.Text = 'made by Sefa
Oguz Saglam, Politechnic University of Milan';
            % Create UIAxes_3
            app.UIAxes_3 = uiaxes(app.UIFigure);
            title(app.UIAxes_3, 'TCPI today');
            xlabel(app.UIAxes_3, 'Day');
            ylabel(app.UIAxes_3, 'TCPI');
            app.UIAxes_3.FontName = 'Leelawadee UI';
            app.UIAxes_3.Box = 'on';
            app.UIAxes_3.XGrid = 'on';
            app.UIAxes_3.YGrid = 'on';
            app.UIAxes_3.Position = [544 127 176 147];
            % Create EstimateatCompletionEditFieldLabel
            app.EstimateatCompletionEditFieldLabel = uilabel(app.UIFigure);
            app.EstimateatCompletionEditFieldLabel.BackgroundColor   =   [0.9373   0.9373
0.9373];
            app.EstimateatCompletionEditFieldLabel.HorizontalAlignment = 'right';
            app.EstimateatCompletionEditFieldLabel.FontColor = [0.4196 0.2314 0.2314];
            app.EstimateatCompletionEditFieldLabel.Position = [506 453 131 15];
            app.EstimateatCompletionEditFieldLabel.Text = 'Estimate at Completion';
            % Create EstimateatCompletionEditField
            app.EstimateatCompletionEditField = uieditfield(app.UIFigure, 'numeric');
```

```
            app.EstimateatCompletionEditField.ValueDisplayFormat = '%5.1f';
            app.EstimateatCompletionEditField.Editable = 'off';
            app.EstimateatCompletionEditField.BackgroundColor = [0.5843 0.6471 0.651];
            app.EstimateatCompletionEditField.Position = [642 449 100 22];
            % Create EstimatetoCompletionEditFieldLabel
            app.EstimatetoCompletionEditFieldLabel = uilabel(app.UIFigure);
            app.EstimatetoCompletionEditFieldLabel.BackgroundColor   =   [0.9373   0.9373
0.9373];
            app.EstimatetoCompletionEditFieldLabel.HorizontalAlignment = 'right';
            app.EstimatetoCompletionEditFieldLabel.FontColor = [0.4196 0.2314 0.2314];
            app.EstimatetoCompletionEditFieldLabel.Position = [506 426 131 15];
            app.EstimatetoCompletionEditFieldLabel.Text = 'Estimate to Completion';
            % Create EstimatetoCompletionEditField
            app.EstimatetoCompletionEditField = uieditfield(app.UIFigure, 'numeric');
            app.EstimatetoCompletionEditField.ValueDisplayFormat = '%5.1f';
            app.EstimatetoCompletionEditField.Editable = 'off';
            app.EstimatetoCompletionEditField.BackgroundColor = [0.5843 0.6471 0.651];
            app.EstimatetoCompletionEditField.Position = [642 422 100 22];
            % Create TCPITextAreaLabel
            app.TCPITextAreaLabel = uilabel(app.UIFigure);
            app.TCPITextAreaLabel.BackgroundColor = [0.9373 0.9373 0.9373];
            app.TCPITextAreaLabel.HorizontalAlignment = 'right';
            app.TCPITextAreaLabel.FontName = 'Segoe UI Light';
            app.TCPITextAreaLabel.FontWeight = 'bold';
            app.TCPITextAreaLabel.Position = [527 322 28 16];
            app.TCPITextAreaLabel.Text = 'TCPI';
            % Create TCPITextArea
            app.TCPITextArea = uitextarea(app.UIFigure);
            app.TCPITextArea.FontName = 'Segoe UI Light';
            app.TCPITextArea.FontWeight = 'bold';
            app.TCPITextArea.BackgroundColor = [0.9373 0.9373 0.9373];
            app.TCPITextArea.Position = [572 273 148 77];
            app.TCPITextArea.Value = {'<1 Under Budget'; '=1 On Budget'; '>1 Over Budget'};
            % Create notesTextAreaLabel
            app.notesTextAreaLabel = uilabel(app.UIFigure);
            app.notesTextAreaLabel.BackgroundColor = [0.9373 0.9373 0.9373];
            app.notesTextAreaLabel.HorizontalAlignment = 'right';
            app.notesTextAreaLabel.FontSize = 10;
            app.notesTextAreaLabel.FontAngle = 'italic';
            app.notesTextAreaLabel.Position = [133 70 34 15];
            app.notesTextAreaLabel.Text = 'notes:';
            % Create notesTextArea
            app.notesTextArea = uitextarea(app.UIFigure);
            app.notesTextArea.FontSize = 10;
            app.notesTextArea.FontAngle = 'italic';
            app.notesTextArea.BackgroundColor = [0.9373 0.9373 0.9373];
            app.notesTextArea.Position = [182 52 545 35];
            app.notesTextArea.Value = {'to calculate Estimate at Completion (EAC) it is
accepted as substandard performance continues'; 'Team Size includes project manager'};
            % Create PlannedValueEditFieldLabel
            app.PlannedValueEditFieldLabel = uilabel(app.UIFigure);
            app.PlannedValueEditFieldLabel.BackgroundColor = [0.9373 0.9373 0.9373];
            app.PlannedValueEditFieldLabel.HorizontalAlignment = 'right';
            app.PlannedValueEditFieldLabel.FontName = 'Leelawadee UI Semilight';
            app.PlannedValueEditFieldLabel.FontColor = [0.4196 0.2314 0.2314];
            app.PlannedValueEditFieldLabel.Position = [294 399 86 15];
            app.PlannedValueEditFieldLabel.Text = 'Planned Value';
            % Create PlannedValueEditField
            app.PlannedValueEditField = uieditfield(app.UIFigure, 'numeric');
            app.PlannedValueEditField.ValueDisplayFormat = '%5.3f';
            app.PlannedValueEditField.Editable = 'off';
            app.PlannedValueEditField.FontName = 'Leelawadee UI Semilight';
            app.PlannedValueEditField.BackgroundColor = [0.5843 0.6471 0.651];
            app.PlannedValueEditField.Position = [388 395 100 22];
            % Create Label
            app.Label = uilabel(app.UIFigure);
            app.Label.HorizontalAlignment = 'right';
            app.Label.Position = [531 528 25 15];
            app.Label.Text = ' ';
            % Create Slider
```

```
            app.Slider = uislider(app.UIFigure);
            app.Slider.ValueChangedFcn   =   createCallbackFcn(app,   @SliderValueChanged,
true);
            app.Slider.Position = [577 534 150 3];
            % Create CommunicationChannelsEditFieldLabel
            app.CommunicationChannelsEditFieldLabel = uilabel(app.UIFigure);
            app.CommunicationChannelsEditFieldLabel.BackgroundColor   =   [0.9373   0.9373
0.9373];
            app.CommunicationChannelsEditFieldLabel.HorizontalAlignment = 'right';
            app.CommunicationChannelsEditFieldLabel.FontName = 'Leelawadee UI Semilight';
            app.CommunicationChannelsEditFieldLabel.FontColor = [0.4196 0.2314 0.2314];
            app.CommunicationChannelsEditFieldLabel.Position = [506 399 147 15];
            app.CommunicationChannelsEditFieldLabel.Text = 'Communication Channels';
            % Create CommunicationChannelsEditField
            app.CommunicationChannelsEditField = uieditfield(app.UIFigure, 'numeric');
            app.CommunicationChannelsEditField.Editable = 'off';
            app.CommunicationChannelsEditField.FontName = 'Leelawadee UI Semilight';
            app.CommunicationChannelsEditField.BackgroundColor = [0.5843 0.6471 0.651];
            app.CommunicationChannelsEditField.Position = [661 395 81 22];
        end
    end
    methods (Access = public)
        % Construct app
        function app = dashboard_sefa_final()
            % Create and configure components
            createComponents(app)
            % Register the app with App Designer
            registerApp(app, app.UIFigure)
            % Execute the startup function
            runStartupFcn(app, @startupFcn)
            if nargout == 0
                clear app
            end
        end
        % Code that executes before app deletion
        function delete(app)
            % Delete UIFigure when app is deleted
            delete(app.UIFigure)
        end
    end
end
```

APPENDIX-B

Table 5-1 Dataset for neural network

EAC	CC	TEAM	TCPI	SPI	CPI	STATUS	EV	PV	AC	DURATION	BAC	DAY
50000,00	10,00	5,00	0,99	1,00	2,00	0,01	1000,00	1000,00	500,00	100,00	100000,00	**1,00**
13533,33	10,00	5,00	0,98	1,50	5,00	0,03	3000,00	2000,00	600,00	100,00	100000,00	**2,00**
20000,00	10,00	5,00	0,98	1,00	5,00	0,03	3000,00	3000,00	600,00	100,00	100000,00	**3,00**
30877,78	10,00	5,00	0,98	0,75	4,29	0,03	3000,00	4000,00	700,00	100,00	100000,00	**4,00**
43911,11	10,00	5,00	0,98	0,60	3,75	0,03	3000,00	5000,00	800,00	100,00	100000,00	**5,00**
55816,67	10,00	5,00	0,98	0,50	3,53	0,03	3000,00	6000,00	850,00	100,00	100000,00	**6,00**
4235,27	10,00	5,00	0,88	1,86	14,13	0,13	13000,00	7000,00	920,00	100,00	100000,00	**7,00**
5067,16	10,00	5,00	0,88	1,63	13,13	0,13	13000,00	8000,00	990,00	100,00	100000,00	**8,00**
5971,12	10,00	5,00	0,88	1,44	12,26	0,13	13000,00	9000,00	1060,00	100,00	100000,00	**9,00**
6947,16	10,00	5,00	0,88	1,30	11,50	0,13	13000,00	10000,00	1130,00	100,00	100000,00	**10,00**
7995,27	10,00	5,00	0,88	1,18	10,83	0,13	13000,00	11000,00	1200,00	100,00	100000,00	**11,00**
4689,50	10,00	5,00	0,82	1,58	14,96	0,19	19000,00	12000,00	1270,00	100,00	100000,00	**12,00**
5248,64	10,00	5,00	0,82	1,46	14,18	0,19	19000,00	13000,00	1340,00	100,00	100000,00	**13,00**
5839,20	10,00	5,00	0,82	1,36	13,48	0,19	19000,00	14000,00	1410,00	100,00	100000,00	**14,00**
6461,16	10,00	5,00	0,82	1,27	12,84	0,19	19000,00	15000,00	1480,00	100,00	100000,00	**15,00**
7114,54	10,00	5,00	0,82	1,19	12,26	0,19	19000,00	16000,00	1550,00	100,00	100000,00	**16,00**
4924,80	10,00	5,00	0,76	1,47	15,43	0,25	25000,00	17000,00	1620,00	100,00	100000,00	**17,00**
5340,40	10,00	5,00	0,76	1,39	14,79	0,25	25000,00	18000,00	1690,00	100,00	100000,00	**18,00**
5772,80	10,00	5,00	0,76	1,32	14,20	0,25	25000,00	19000,00	1760,00	100,00	100000,00	**19,00**
6222,00	10,00	5,00	0,76	1,25	13,66	0,25	25000,00	20000,00	1830,00	100,00	100000,00	**20,00**
6441,60	10,00	5,00	0,76	1,19	13,66	0,25	25000,00	21000,00	1830,00	100,00	100000,00	**21,00**
6661,20	10,00	5,00	0,76	1,14	13,66	0,25	25000,00	22000,00	1830,00	100,00	100000,00	**22,00**
6044,77	10,00	5,00	0,74	1,17	14,75	0,27	27000,00	23000,00	1830,00	100,00	100000,00	**23,00**
5537,87	10,00	5,00	0,72	1,21	15,85	0,29	29000,00	24000,00	1830,00	100,00	100000,00	**24,00**
5114,86	10,00	5,00	0,70	1,24	16,94	0,31	31000,00	25000,00	1830,00	100,00	100000,00	**25,00**
4757,33	10,00	5,00	0,68	1,27	18,03	0,33	33000,00	26000,00	1830,00	100,00	100000,00	**26,00**
4451,76	10,00	5,00	0,66	1,30	19,13	0,35	35000,00	27000,00	1830,00	100,00	100000,00	**27,00**
4188,01	10,00	5,00	0,64	1,32	20,22	0,37	37000,00	28000,00	1830,00	100,00	100000,00	**28,00**
3958,38	10,00	5,00	0,62	1,34	21,31	0,39	39000,00	29000,00	1830,00	100,00	100000,00	**29,00**
3321,11	10,00	5,00	0,56	1,50	24,59	0,45	45000,00	30000,00	1830,00	100,00	100000,00	**30,00**
3370,81	10,00	5,00	0,56	1,45	24,59	0,45	45000,00	31000,00	1830,00	100,00	100000,00	**31,00**
3420,52	10,00	5,00	0,56	1,41	24,59	0,45	45000,00	32000,00	1830,00	100,00	100000,00	**32,00**
3371,14	10,00	5,00	0,55	1,39	25,14	0,46	46000,00	33000,00	1830,00	100,00	100000,00	**33,00**
3631,51	10,00	5,00	0,54	1,38	23,50	0,47	47000,00	34000,00	2000,00	100,00	100000,00	**34,00**
3884,15	10,00	5,00	0,53	1,37	22,12	0,48	48000,00	35000,00	2170,00	100,00	100000,00	**35,00**
4129,35	10,00	5,00	0,52	1,36	20,94	0,49	49000,00	36000,00	2340,00	100,00	100000,00	**36,00**
4367,40	10,00	5,00	0,51	1,35	19,92	0,50	50000,00	37000,00	2510,00	100,00	100000,00	**37,00**
4598,55	10,00	5,00	0,50	1,34	19,03	0,51	51000,00	38000,00	2680,00	100,00	100000,00	**38,00**
4823,08	10,00	5,00	0,49	1,33	18,25	0,52	52000,00	39000,00	2850,00	100,00	100000,00	**39,00**
5041,22	10,00	5,00	0,48	1,33	17,55	0,53	53000,00	40000,00	3020,00	100,00	100000,00	**40,00**
5253,22	10,00	5,00	0,48	1,32	16,93	0,54	54000,00	41000,00	3190,00	100,00	100000,00	**41,00**
5459,31	10,00	5,00	0,47	1,31	16,37	0,55	55000,00	42000,00	3360,00	100,00	100000,00	**42,00**
5659,71	10,00	5,00	0,46	1,30	15,86	0,56	56000,00	43000,00	3530,00	100,00	100000,00	**43,00**
5854,63	10,00	5,00	0,45	1,30	15,41	0,57	57000,00	44000,00	3700,00	100,00	100000,00	**44,00**
6044,29	10,00	5,00	0,44	1,29	14,99	0,58	58000,00	45000,00	3870,00	100,00	100000,00	**45,00**
6228,87	10,00	5,00	0,43	1,28	14,60	0,59	59000,00	46000,00	4040,00	100,00	100000,00	**46,00**
6408,56	10,00	5,00	0,42	1,28	14,25	0,60	60000,00	47000,00	4210,00	100,00	100000,00	**47,00**
6583,54	10,00	5,00	0,41	1,27	13,93	0,61	61000,00	48000,00	4380,00	100,00	100000,00	**48,00**
6753,98	10,00	5,00	0,40	1,27	13,63	0,62	62000,00	49000,00	4550,00	100,00	100000,00	**49,00**
6920,05	10,00	5,00	0,39	1,26	13,35	0,63	63000,00	50000,00	4720,00	100,00	100000,00	**50,00**
7081,90	10,00	5,00	0,38	1,25	13,09	0,64	64000,00	51000,00	4890,00	100,00	100000,00	**51,00**