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Acknowledgements

This master thesis completes my education for a M.Sc. degree in Industrial Economics at the University of Stavanger (UiS). The main objective for the thesis was to evaluate the Adaptive Project Frameworks ability to manage fuzziness.

The subject of project management and risk has been of interest to me for a long time. This thesis offered me an opportunity to combine these and utilize a variety of the subjects from my education. Furthermore it provided me with a chance to learn more about project- and risk management, applying these in a study of the Adaptive Project Framework. The process of writing this thesis has been both challenging and time consuming, but also interesting. I am sure I will benefit from this knowledge and experience in my future career.

I am thankful to my instructor at the University of Stavanger Frank Asche, for his advice, guidance and discussions during the process of writing this paper.

Bjarne Skeisvoll Jakobsen

Stavanger, December 2015.

Abstract

The field of project management is more complex than ever due to an accelerating development in technology, competitive climate, rapid-changing customer wants, needs and internationalization. As technology and customer wants are continually changing, new business opportunities opens which firms try identifying and take advantage of. Some of these opportunities result in projects of a more innovative nature, associated with higher uncertainty and risk. These factors along with others have contributed to that the field of project management must manage an increasing degree of fuzziness. It would be fair to state that it is affecting the risk picture. As such there are high demands for project managers to manage fuzziness. Studies and experience have shown that companies struggle to manage projects associated with higher level of fuzziness. Too many project fail or do not meet their requirements, resulting in loss of billions of dollars every year. As a result, new methods and tools are continuously researched and developed.

Traditional project management models are suited to manage repetitious project that have been done before, such a developer building houses. Typically these have a lower degree of fuzziness and fewer changes are expected. The traditional methods are not suited to manage projects of a more innovative nature with more expected changes. Other methods are better suited for this such as the agile project management methods, which are becoming increasing popular. The Agile Project Framework (APF) developed by Wisocki in 2003-04 is one of these. Developed and proposed by the author to aid in managing some of these challenges. The framework is still young, but it has shown promise. The method is suited to manage all types of projects. It is characterized by being customer focused and driven. Supporters of the method argue that it provides the client with maximum value on limited resources. Despite the methods strengths, it has some weaknesses. The method is used to manage projects with a higher degree of fuzziness and it still has some of challenges related to this.

Some argue that unk unks are a major reason for project failures, but they are not the only reason. Fuzziness consists of several componenets with different roots, all affecting the level of fuzziness. The main purpose of this thesis was to evaluate the Agile Project Framework (APF) ability to manage fuzziness. Three sub-objectives were added to supplement the main purpose and clarify evaluation focus. The first sub-objective was to study advantages and disadvantages with the APF. The second sub-objective was to study how APF manage fuzziness. The third sub-objective was related to assess if the method utilizing Aven`s (A,C,U) perspective can improve APFs ability to manage fuzziness. In addition the strengths and weaknesses of the proposition was evaluated.

The study found that the APF has tools to manage projects for a high degree of fuzziness where changes are expected. Despite this the method has some weaknesses. It can be vulnerable to aspects such as unk unks, poor communication, bad quality of personell/project manager and poor feedback. Due to its small project teams it is more exposed to personell challenges than larger teams. This may be sickess, sick children, personell leaving or other reasons that result in personell not completing their work packages. The APF is most stuited for smaller project and not ideal for managing large-scale projects. One of the reasons for this is that it is highly unlikely they will get funding of millions of dollars based on the argument “it will provide maximum value on the given resources and works 100% of the time”. The study found that the presented (A,C,U) approach has some interesting ideas that may complement the APF if it is implemented effectively. To do this the assessment should be crude and focus on critical elements. Still, there is no practical data and experience to show to. Therefore at the current stage, the method presents a theoretical approach that can at best provide discussion or inspiration for new tools, rather than a viable tool. There is a reason for why the current methods are used. Despite many projects failing or not meeting their requirements, the currently used tools are the best alternatives.

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1 Introduction

This chapter introduces the background and purpose. Further, it presents the motivation and provides an overview of the structure. It is assumed that the reader has a fundamental understanding of risk and project management.

1.1 Background

Project management is a tool set with roots stretching far back in history. Great structures such as the Great Wall of China, the Egyptian pyramids or the Coliseum in Rome are examples of how project management has been used to manage complex projects. Even today when great technological progress has been made, these structures invoke admiration from visitors around the world. One can only imagine the amount of information the project managers had to take into consideration developing these structures. In addition, having much more primitive tools.

Today, great technological progress has been made in many areas. The field of project management is more complex than ever due to an accelerating development in technology, competitive climate, rapid-changing customer wants and internationalization. These factors along with others have contributed to more pressure and competition on firms to provide products and services to customers. There is a continuous race to develope and market new products and services ahead of competitors. In the last 30 years there has been a revolutionary development in technology. Complex tools such as computers and phones are now available to the common public, which was not the case 30 years ago. There is a continuous development in technology for most areas. Every year new improved products and services are introduced to the market such as televisions, computers, software and cars. This progress has been made because an increasing number of innovative projects are launched to take advantage of potential business opportunities. As technology is continuously developed, customer need and requirements change. The customer requirements for a phone today are not the same as it was 10 years ago. A phone is considered more than a simple device to call people; it is a personal computer, capable of performing advanced tasks. As such, firms must adapt and anticipate the customer wants and requirements for the future. The consequences of not developing and updating their product portfolio can be catastrophic. Not staying competitive or making wrong decisions in major product development can result in bankruptcy. New product development has become a major factor in business, this is illustrated by the fact that an estimated 50% of sales derive from products introduced within the last 5-year span. In the race to develop products and services, project managers must manage an increasing amount of complex challenges in a shorter amount of time. The characteristics of these projects are a higher degree of fuzziness and risk.

Companies have the goal to provide value to their shareholders by developing and

producing products and services. To do this projects are launched, and risks must be taken. Paul Getty made this statement about capital and risk: *"where there is money, there is risk!".* This is an accepted view of how the financial markets work, and it can be translated into project portfolio management. Markowitz laid much of the foundation of the Capital Asset Pricing Model, (CAPM), in his work on Modern Portfolio Theory (Markowitz, 1952). Markowitz argued that investors should be compensated for taking on additional risk, and introduced a framework for measuring risk (Jakobsen, 2013b). In this generally accepted theory, it is assumed that with sufficient diversification, taking on higher risk has the potential to create higher gains.

Project management is an essential part of the process to develop products and services to the community. One can argue that companies are important contributors in society for employment, value, growth and innovation. As such one should avoid wasting resources. It is therefore necessary to ensure that the risk and fuzziness are managed.

Traditional project management models are suited to manage repetitious project such as a developer building houses. These projects typically have a lower degree of fuzziness and few changes are expected. The traditional project management models are not suited to manage situations with a higher degree of fuzziness and where changes are expected. Several methods and tools have been developed to keep up with the changing market conditions. Despite the fact that the discipline has been greatly studied and developed, a surprising large amount of projects are failing (Institute, 2001). This can be releated to aspects such as projects not completed within schedule, budget or do not meet some established requirements. Studies and research have illustrated that too many projects fail or do not meet their requirements. In a study of 60 large engineering projects, Miller and Lessard found that only 45% met most of the objectives, 19% were below target, 16% had to be restructured and 20% were cancelled (Donald Lessard, 2001). The Agile Project Framework developed by Wisocki in 2003-04 is a method proposed to aid in managing some of these challenges. The framework is still young, but it has shown promise. The method is suited to manage all types of projects. It is characterized by being customer focused and driven. Supporters of the method argues that it provide the client with maximum business value on limited resources. Despite the method strengths, it also has some weaknesses. The method is used to manage projects with a higher degree of fuzziness and has some of challenges related to this. The existing project risk management methods do not seem to address unk unks satisfactory. This seems to limit firm's capability of managing unexpected outcomes and their impact.

1.2 Purpose

The purpose of the thesis is to evaluate the Agile Project Management Framework and study the methods suitability in managing fuzziness. Firms seem to struggle with challenges related to managing fuzziness in more innovative projects, and this triggered the initial interest for the thesis. There was a wish to study the background related to these challenges and evaluate them.

The main purpose was to:

« Evaluate the Adaptive Project Framework ability to manage fuzziness »

In order to aid in the evaluation of the Adaptive Project Framework and to clarify evaluation focus, three sub-objectives are added. These objectives are structured to support the main purpose.

1.2.1 Objective 1

The first objective is to study the advantages and disadvantages of the Adaptive Project Framework.

1.2.2 Objective 2

The second objective is to study Adaptive Project Frameworks ability to manage fuzziness.

1.2.3 Objective 3

The third objective is to present an approach based on Aven`s (A,C,U) perspective and adapt it to the APF. Then evaluate if it has tools that can improve the methods capability to manage fuzziness. In addition, evaluate the strengths and weaknesses of this proposition.

1.3 Structure

This thesis consists of six chapters, in addition to the bibliography.

- Chapter 1 presents the introduction, purpose, background and structure.
- Chapter 2 presents the concepts of risk and fuzziness.
- Chapter 3 presents some project management theory that provides the backbone for the thesis with central subjects such as project definition, project management models and the Adaptive Project Framework.
- Chapter 4 presents the discussion, which is divided in three parts. The first sub-chapter presents the advantages and disadvantages of the Adaptive Project Framework. The second sub-chapter studies the Adaptive Project Framework in greater detail, studying its characteristics and process to evaluate the tools ability to manage

fuzziness. The third sub-chapter presents a tool inspired by Aven´s (A,C,U) perspective, adapting it to the Adaptive Project Framwork. Evaluating if it has tools that can improve the method further.

- Chapter 5 presents the conclusion.

- Chapter 6 presents the reference list.

2 Risk and fuzziness

This chapter introduces risk and fuzziness; terminology that will be used extensively throughout the discussion. The terms uncertainty, ambiguity, complexity and equivocality are collected under the terminology fuzziness. In addition, uncertainty is divided into sub-components to adapt it to the tool inspired by Aven`s (A,C,U) perspective.

2.1 Risk

The term risk is familiar by most, but can be perceived different. In the literature there exist numerous definitions of risk and how to view it depending on arena. There seem to be little consensus on how to define risk, at least an overall definition. The most common definition in ingeneering and finance is defining risk as Probability x Consequence. That is risk is regarded as having two components, the probability of events occurring and the impacts if the events occur.

Chapman and Ward defines risk related to project as ”the implications of the existence of significant uncertainty about the level of project performance achievable” (Ward, 1997).
Many typically associate risk with statistics and determine it based on historical data. One may ask if historical data provide the assessor with enough information to say something about the risk in the future. This concept is discussed in greater detail in the discussion presenting Aven`s (A,C,U) perspective. Some associate risk with something negative, that is negative outcomes. There are divided opinions if one should restrict the concept to negative consequences. According to Aven restricting the concept of risk to only negative consequences is problematic as it may be difficult to distinguish what a negative and positive outcome is (Aven, 2010). The risk management standard COSO, regard risk indicators as events that can lead to sources resulting in consequences. These events can affect the goals positively or negatively. A positive event is considered an opportunity, while a negative event is something unwanted.

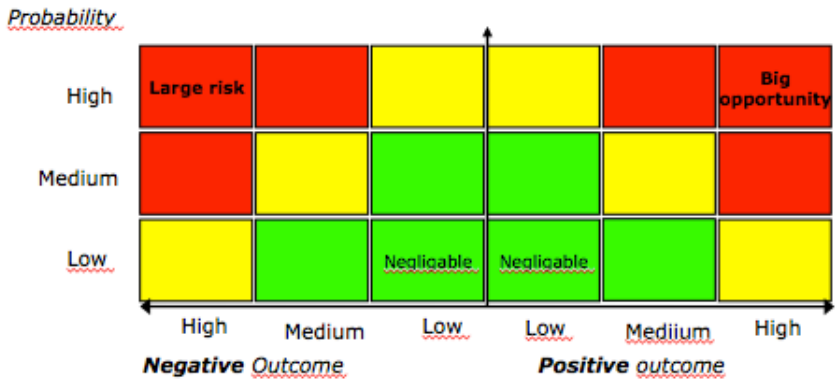

Figure 1: Events can lead to negative and positive outcomes (Jakobsen, 2013b).

2.2 Fuzziness

Fuzziness is a term associated with uncertainty and a lack of knowledge. There have been a number of studies on this subject, but there does not seem to be an exact definition of what fuzziness is. Authors and scholars use different terminology to describe fuzziness or the unknown. Output from these imply that fuzziness it associated with a lack of accurate knowledge about something or the unknown (Loch, 2006). Other studies used the following characteristics to describe the term; uncertainty (Moenaert, 1995, Zhang, 2001), ambiguity (Kim, 2002) and complexity (Khurana, 1998).

Michael Zacks (Zack, 2001) presents an intuitive and useful approach to distinguish between various aspects of knowledge management. These aspects capture much of the content in the terminology fuzziness. He distinguishes between four problems of interpreting knowledge: uncertainty, ambiguity, complexity and equivocality. In this work when discussing fuzziness it is assumed to be a collective term for the terms presented in figure 2.

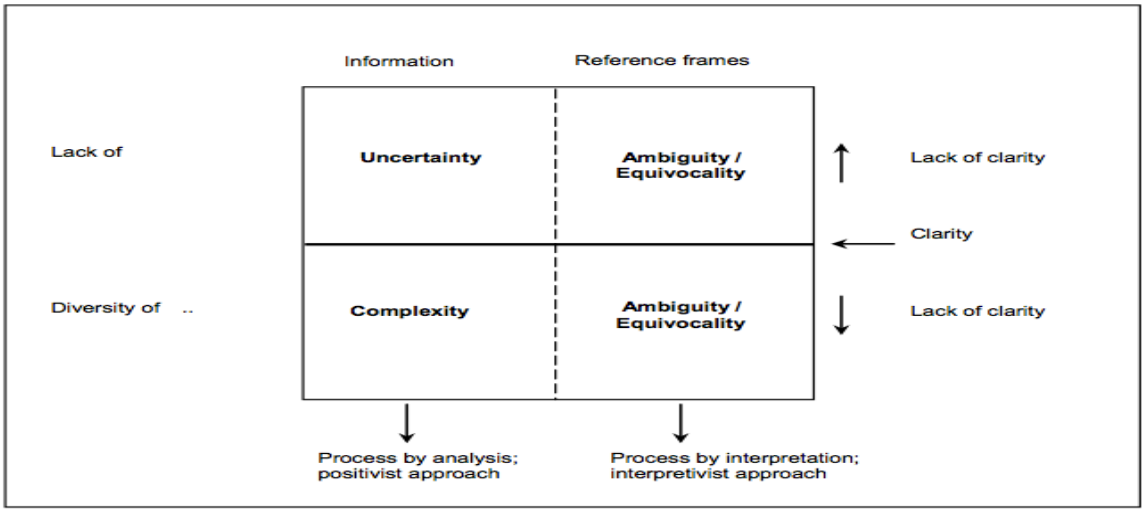

Figure 2: Illustrates the knowledge aspects and captures alot of the term fuzziness (Zack, 2001).

Zack argues that the problems of knowledge can be a result of lack of information or references frames, as seen at the top two boxes. It may also be a result of diversity of information and references frames, as illustrated by the two lower boxes. The thick horizontal line seperating the figure represents situation`s of clarity. All deviations from this represents lack of clarity (Brun, 2011). The following sub-chapters will present the terms illustrated in the figure.

2.2.1 Uncertainty

There are various definitions of uncertainty in the literature. Businessdictionary (Dictionary, 2013) defines uncertainty as:

Decision making: Situations where the current state of knowledge is such that (1) the order or nature of things is unknown, (2) the consequences, extent, or magnitude of circumstances, conditions, or events is unpredictable, and (3) credible probabilities to possible outcomes cannot be assigned.

Zack (Zack, 2001) defines uncertainty as:

Uncertainty represents lack of information or factual knowledge about current and future states, preferences, and actions. Hence uncertainty can be reduced by acquiring additional information or improving one`s ability to redict or estimate.

Both definitions captures lack of information about current and possible future outcomes. Zack (Zack, 1999) argues that uncertainty can be reduced or managaged by:

- Acquiring additional information.
- Acquiring, developing or improving knowledge and ability to predict, infer or estimate sufficiently using incomplete information.
- Using existing situational knowledge to predict, infer, estimate, or assume facts instead of missing information, with some level of confidence and reliability.

Uncertainty can result from two main causes, natural variation and lack of knowledge. In literature these caterogies of uncertainty are referred to as aleatory and epistemic uncertainty. Aleatory uncertainty is the uncertainty arising from, or associated with the inherent, irreducible, and natural randomness of a system or process. Epistemic uncertainty is the uncertain arising from the lack of knowledge about the performance of a system or process. The epistemic uncertainty will be reduced when new knowledge comes available, while the aleatory uncertainty cannot, in principle be reduced (Rausand, 2014). The nuclear industry divides the epistemic uncertainty into three sources of uncertainty:

I. Completeness uncertainty
II. Parameter uncertainty
III. Data uncertainty

2.2.1.1 Completeness uncertainty

Completeness uncertainty covers factors that are not included in an analysis. If one is not able to include all relevant factors in an analysis, one will get incorrect estimates even if the data and model selection is sufficient. Completeness uncertainty are categorized as known uncertainty, but not included in the analysis, or unknown uncertainty. Known uncertainties could have a significant impact on to the predictions.

- Known completeness is uncertainty from factors that are known, but deliberately not included in the analysis. There may be different reasons for this such as time, cost constraints, lack of relevant data, lack of competence in using models and other reasons. The known completeness uncertainty should reflect simplifications and assumptions were made in a trade-off of competence of analyst, background knowledge, available time, cost, technology, methods and operating environment.

- Unknown completeness uncertainty is uncertainty from factors that are not known or have been identified. These factors are considered to be unknown and can be difficult to determine and assess. The unknown completeness is a challenging to assesss as its impact is not visible to the assessors. Indirect factors can be studied, that is factors that may occur that one do not know the impact of. Use of expert knowledge, existing technology or new technology in new areas can help shed light on the impact of the unknown completeness (Jin et al., 2012).

2.2.1.2 Parameter uncertainty

Parameter uncertainty is related to the uncertainty in calculating the input parameter values used in methods and models. If one put garbage in some methods and models, one will get garbage out. Examples of paramater values can be component failure rates, expected values, variance, probabilities or frequencies. These values are determined by an analyst, often done by an expert within the field. There are uncertainties related to the analyst degree of belief in the values that was used. Mathematical models are either parametric or non-parametric. The non-parametric models are more flexible and less biased, but often give poor predictions as they are highly volatile (Lindstrøm, 2010). The parameter models are less flexible and has a lower variance. They are often more biased and vulnerable to the input used in methods and models.

2.2.1.3 Model uncertainty

Model uncertainty arises from the fact that any model, conceptual or mathematical, will inevitably be a simplification of the reality it is designed to represent (Jin, Lundteigen et al. 2012). Model uncertainty is related to situations for which no consensus approach or model exist. In addition, where the approach or model chosen is known to affect the models

results. Model uncertainty may occur as a result of lack of knowledge about technology, systems, processes, structures or componenets. Model uncertainty can result because:

- The situation modelled is not completely understood. This may be because one is using new technology, processes or utilizing technology in a new arena.
- For some phenomena, data or information exist, however one is not sure how it will react under different operating conditions than those the existing data were collected in.
- The nature of the failure modes is not completely understood or is considered to be unknown (M. Drouin, 2009).

2.2.2 Ambiguity

Ambiguity arises as a result of that humans have different interpretations of the same information. This is because people have different experiences, background information, and ability to interpret information. Ambiguity can result in both positive and negative effects.

According to Zack (Zack, 1999) ambiguity represents an individuals inability to interpret or make sense of something, despite available information. This information may be unclear or not clearly understandable. Ambiguity can as such not be reduced by collecting additional information, instead gain or create explanatory knowledge. A situation may be reframed into something more understandable or by learning and gaining experience. This requires repetitive cycles of interpretation, explanation and collective agreement. Rich media such as face-to-face discussions is a useful tool for these situations.

2.2.3 Complexity

Although complexity is regarded as a knowledge problem, it can increase as a result of more information. Simon defines complexity as:

"a large number of parts that interact in a non-simple way (Simon, 1999) *"*

Complexity does not necessarily have to be an unclear or unpredictable situation. It can be clearly defined and predictable, but the amount of elements, interdependencies and relations are so large that it can be a challenging to manage them. Projects complexity is not limited to technical factors. There may be other interactions just as important, such as stakeholders' interests, desires and needs. This increase complexity, but also uncertainty. It is worth to note that complexity can have both positive and negative effects. To manage and reduce complexity one can break the problem into smaller, more manageable units. Another option is to increase capacity to manage them by acquiring more effective machines, computers, software or improving routines, processes and rules.

2.2.4 Equivocality

According to Zack (Zack, 2001) equivocality refers to multiple meanings or interpretations of the same thing. The reason is that individuals have different background information, experiences and ability to interpret. Interpretations can therefore vary and may be mutually exclusive or in conflict with eachother. Equivocality can also arise from unreliable or conflicting information. To resolve equivocality, rich media is typically used to discuss interpretations and converge towards an acceptable interpretation.

2.3 Summary fuzziness components

Table 1 provide a short summary of the four knowledge problems that constitute the term fuzziness. The figure provie a short explanation of the terms and how one can respond to reduce them.

Table 1: Summary fuzziness componenets, explanation and response.

Knowledge problem	Explanation	Response
Uncertainty	Lack of information about goal and situation.	Collect information and certify
Ambiguity	Inadequate knowledge or understanding of something	Clarify
Complexity	Large number of parts that interact in a non-simple way	Simplify
Equivocality	Multiple interpretations of the same information	Unify

3 Project management theory

3.1 Introduction

In this section some fundamental project mangement theory is presented. Some Project Management Life Cycle (PMLC) models are presented, before a more in-depth section on agile models. These will provide a foundation for the discussion.

3.2 Project definition

There are several definitions for a project, as there is a broad interpretation in the literature of what a project is. The British Standards Institution defines project as: ”A project is a unique set of coordinated activities, with a definite starting and finishing point, undertaken by an individual or organisation to meet specific objectives within defined schedule, cost and performance parameters”.

The Project Management Institutes project definition is ”a temporary endeavor undertaken to create a unique product or sevice” (Institute, 2015). There are many examples of what a project can be. There are some characteristics of projects that set them apart from other activities. Projects are:

i. Temporary
ii. Unique
iii. Requires progressive elaboration

- With temporary, it means a project exist for a limited period. This does not mean the project will have a short duration, but a starting and finishing point. Project can have shorter or longer periods, ranging from a few days till several years. The length can be based on the complexity and scale of the endeavor. The duration is said to be partly depending on how the starting and ending points are determined. Ideally, a project should have a clearly defined start and finish to ensure that they do not become too fuzzy.
- The second characteristic requires that projects are unique. In one way or another one can argue all projects are different to a varying degree, be it size, area, design, features, functions or other aspects.
- The third characteristic is that projects require progressive elaboration. As a project gets under way the work is gradually defined. Increased level of details is added over time, this ican be particularly noticeable in larger and more complex projects (Gardiner, 2005).

A client wants to maximize his deliverable by getting it to market as quick as possible with as much functionality, features as possible. At the same time he wish to get this done at the

lowest possible cost. This is not possible in practice as a project manager has scarce resources. Therefore priorities are made with respect to cost, time and quality as illustrated by the project management triangle in figure 3.

Figure 3: Project management triangle (Minkiewicz, 2015).

Project managers must manage the resources as best as possible based on these constraints. It is important they understand where the priorities lie as tough choices and priorities must be made. Project managers are judged by how they perform with respect to cost, time and quality. Failing to deliver according to these can result in project failure. A solid communication process is key so project managers can communicate with stakeholders and understand where the priorities lie.

3.3 Project phases

To simplify the project management process it is divided into a set of phases called a project life cycle. These phases break the process into more managable parts simplifying the project managers work.

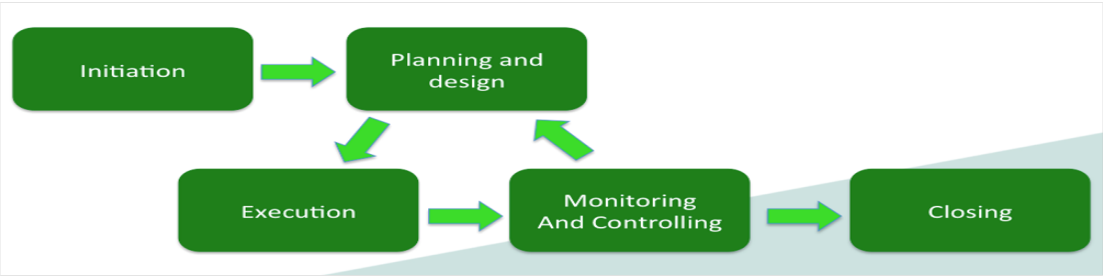

Figure 4: Project life cycle phases (Zolda, 2013).

I. Scoping and definition: Develop and gain approval of a general statement of the goal and business value. One should do a need analysis to identify and document the client's true needs.
II. Planning: Plan and identify the work to be done. Estimate cost, time and resource requirements. Gain approval to launch project.

III. Execution: Recruit team and establish team operating rules. Establish scope change management process and team communication. Write work packages and finish project schedule.

IV. Monitor and control: Monitor projects status and resolve any problems and change requests. There exist several methods to keep track of performed work, costs and time. One can use CPI, SPI, BCWP, ACWP, BCWS, EAC. Uncertainties must be continually monitored, identified, followed up and reported. If problems occur, these must be managed.

V. Closing: Gain clients approval of having met the projects requirements, hand over and and install the deliverables. All outstanding payments should be finalized and project accounts closed. Finalize all project documentation and perform post-implementation audit (Wysocki, 2012).

All projects will in principle got through these phases, independent of size and complexity. The breakdown can be done in different ways dependent of the level of detail required. Projects with a higher degree of uncertainty can make use of a more thorough breakdown planning (Rolstadås, 2006).

3.4 Uncertainty in project phases

In the earliest phases of a project life there is less certainty about constraints and opportunities. Since the project is still in an early phase much planning is left. Therefore fuzziness and uncertainty is the highest at the early project phase. As figure 5 illustrate, when more planning is done and work gets under way, uncertainty is reduced.

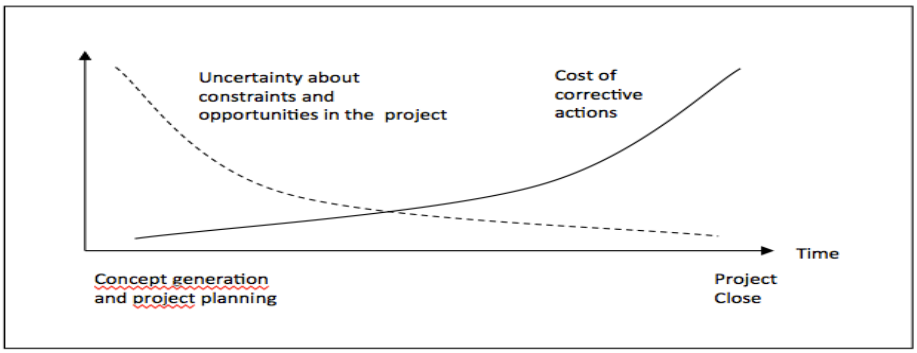

Figure 5: Uncertainty and cost of corrective actions versus time (Brun, 2014b).

The figure shows that uncertainty is highest at project start, in the concept generation and planning phase. As the project gets under way things become more clear and uncertainty is reduced. The cost of corrective action is lowest at the start, but increase as a function of time. This is natural as fundamental choices are made in the start and changing these will increase as time pass. This can be related to aspects such as process, concept, materials, functions and features. It is therefore useful to do some upfront planning as it may not only

reduce uncertainty, but also the possibility of having to launch expensive corrective actions at a later stage. If corrective actions are set in motion, it may not only lead to higher costs, but also delays.

3.5 Communication

Communication is a key topic for managing fuzziness, especially for higher degree of fuzziness. The importance of a solid communication process cannot be understated. Careful communication planning can go a long way to provide a better platform for succeeding in project management. PMI's 2013 Pulse of the Profession (Institute, 2013b) report revealed that the most crucial success factor in project management is effective communications to stakeholders. It also reported that effective communication can result in more successful projects and attribute to firms becoming more competitive. On average two in five projects do not meet project's original goal or intent, and one-half of those unsuccessful projects are related to ineffective communications. See figure 6.

Other studies have also illustrated the importance of this topic. Forbes Insight 2010 Strategic Initiatives Study found that nine out of ten CEOs think communication is a critical component of the strategic initiatives (Benedict, 2010). According to Project Management Institutes (PMI) (Institute, 2013a) research 55 percent of project managers agree that effective communication to all stakeholders is the most critical success factor in project management. The PMI´s Pulse of Profession report showed valuable insight into the importance of communication. The research found that effective communication leads to more successful projects. It aids organizations performing better, completing an average of 80 percent of projects on time, budget and meeting project goals. It showed that organizations with effective communication risk fourteen times less dollards than the low-performing competitors. Figure 6 illustrate that one out of five projects were unsuccessful due to ineffective communication and 56 percent of the capital was at risk due to this.

Figure 6: Consequences of ineffective communication in projects (Institute, 2013a)

Stakeholders expectations, needs and wants must be uncovered and communicated effectively to ensure that the project team understands what is expected. If these are not effectively communicated and understood by all stakeholders, the project can incur unneccessary risk.

In project management there exist a range of tools, techniques to monitor and control project performance and progress. The output of these can contribute to identifying changes or variance from original plan. These can signal potential problems that should be adressed. The agile method is suited to adapt to change requests and if neccessary take corrective action. It can also has tools to adapt to changing customer needs and requirements. Communication is key when making changes, to inform projects stakeholders regarding change and status.

	Unambiguous Task	Ambiguous Task
Rich Media	***Communication failure.*** Data glut. Rich media used for routine tasks. Excess cues cause confusion and surplus meaning.	***Effective communication.*** Communication success because rich media match ambiguous tasks.
Lean Media	***Effective communication.*** Communication success because media low in richness match routine messages.	***Communication failure.*** Data starvation. Lean media used for ambiguous messages. Too few cues to capture message complexity.

Figure 7: Explanation of rich and lean media use (Brun, 2014b).

Having a solid project and risk management process can help identify problems early, assess impact and communicate it to the right personell. One should ensure not to do unmeaningful risk analysis as this may give stakeholders a false perception that all risks have been identified and planned for. The role of communication is of vital importance to able to meet the respective stakeholders with a requirements. It has been said that communication is the lifeblood of projects. Establishing solid communication channels can help everyone involved manage uncertainty and ambiguity.

3.5.1 The media richness theory

In 1984 Richard Daft and Robert Lengel introduced the media richness theory to describe and evaluate communication mediums in organizations (Lengel, 1984). The aim of the media richness theory was to aid in managing communication challenges and equivocality. The theory states that all communication media has a varying degree of ability to communicate information to an individual and change their understanding. The communication media must be adapted to the fuzziness one is facing. Daft and Lengel (Lengel, 1984) defined information richness as ”the ability of information to change understanding within a time interval”.

One can divide information into information richness, the capacity it has of carrying data. Low or lean information are aspects as text and numbers. High or rich information is face-to-face dialogue, visual signs, tone and body language.

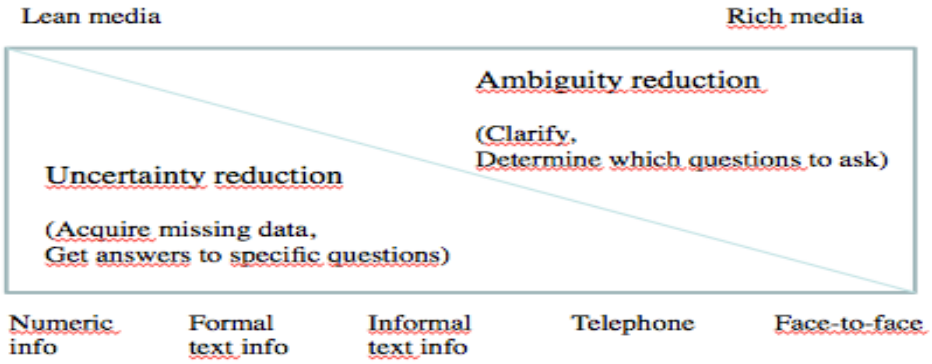

Figure 8: Lean and rich media (Lengel, 1984)

The axes are streching from a low to high degree of uncertainty, and from a low to high degree of equivocality. There are different requirements for different situations of fuzziness. Low uncertainty and equivocality will result in more clearly defined situations. For this case it might be enough to collect lean information such as numeric or text. to reduce uncertainty. Other situations might have higher equivocality and uncertainty. For these cases when there is a greater need to clarify, rich media is a better suited tool.

When establishing communication channels one should take care to find suited media. The main aim of selecting communication media is to make better utilization of scarce resources and to reduce equivocality. This will help a receiver to more easily decode information. Note that rich media is not always the best option, as it is resource consuming. Effective communication involves sending and receiving the same message. If communication is not clear the fuzziness can increase. One of the main points with communication is that it is interactive, because it can reduce fuzziness. The communication process can be divided in smaller pieces. It includes the message, source, encoding, media channel, decoding, recivers interpretation, feedback, tone, context, body language (Mehta, 2002).

3.6 Project management Models

There are four main groups of Project Management Life Cycle (PMLC) Models:

I. Traditional Project Management Model (TPM)
II. Agile Project Management Model (APM)
III. Extreme Project Management Model (xPM)
IV. Emertxe Project Management Model (MPx)

The traditional project management assumes goals and tasks are well-defined. For situations as this there is less fuzziness and changes expected. Situations that are more unclear with respect to goals and solutions has is a higher degree of fuzziness. Figure 9 illustrate which situations the PMLC models are suited for. They are divided in two parts:

i. Fuzziness about project goals
ii. Fuzziness about project solutions

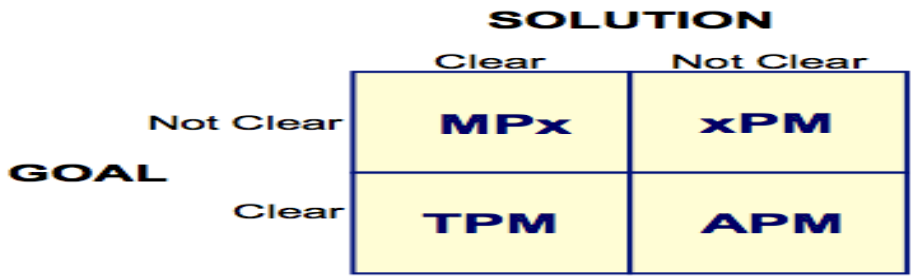

Figure 9: PMLC models with respect to goal and solution (Brun, 2014a).

Based on the projects fuzziness profile, one should choose the most appropriate PMLC model. Figure 9 illustrated that the TPM model is suited for projects with clear goal and solution. The APM model for projects with clear goal, but not clear solution. The MPx model for projects with a clear solution, but not a clear goal. The xPM model for projects with not clear goal and not clear solution. Each model has its strengths and weaknesses and should be selected appropriately. Figure 10 show that the level of fuzziness increase as a consequence of decreasing clarity for goal and solution.

Figure 10: Project fuzziness correlation related to goal and solution situation (Brun, 2014a).

Less up-front planning is done for situations with a higher degree of fuzziness, as less information about goal and solution is available at the start. Rather it is replaced by a learn-as you go where more decision-making is delayed until things become clearer. For projects such as these there is a greater need for client involvement.

3.7 Agile Project Management

There does not seem to be a generally accepted definition for agile project management. However there are some common characteristics. They have a high degree of fuzziness at the start, iterative development, adaptability and focus on interactions. There are two main groups of agile PMLC models, the Iterative and the Adaptive. Figure 9 illustrated that agile models are suited for projects with clear goal and not clear solution. Within these two groups of agile PMLC models there are several methods to choose from. The Agile models are quite popular for software development and the four most popular choices for this are:

-Rational Unified Process (RUP)
-Scrum
-Adaptive Software Development (ASD)
-Dynamic Systems Development Method (DSDM)

The Adaptive Project Framework (APF) is another popular agile method. It is different to the others due to the fact it was developed for both software and non-software development. This has been successfully utilized for product development, process improvements and process design (Wysocki, 2012).

3.7.1 The Agile Manifesto

In 2001 as the industry were struggling to manage software and development projects, a group of project managers met at a ski resort to exchange experiences. This was the birth of the "Agile Manifesto". The Agile Manifesto has been the guiding principle of APM models and states that some items should be prioriticed over others. The result of the Agile Manifesto were the following four core values:

"*We are uncovering better ways of developing by doing it and helping others do it. Through this work we have come to value*:

i. Individuals and interactions over processes and tools
ii. Working software over comprehensive documentation
iii. Customer collaboration over contract negotiation
iv. Responding to change over following a plan

While there is value in the items in the right, we value the items on the left more."(Beck et al., 2001)

The core values are built on the following twelve main principles (Beck et al., 2001):

I. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
II. Welcome changing requirements, even late in development. Agile processes harness

change for the customer's competitive advantage.

III. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

IV. Business people and developers must work together daily throughout the project.

V. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.

VI. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.

VII. Working software is the primary measure of progress.

VIII. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.

IX. Continuous attention to technical excellence and good design enhances agility.

X. Simplicity the art of maximizing the amount of work not done is essential.

XI. The best architectures, requirements, and designs emerge from self-organizing teams.

XII. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

3.7.1.1 Iterative PMLC Model

The characteristics of an Iterative PMLC model is medium to high uncertainty regarding project deliverable. The solution is only partially known at the start and without a clear goal. The main functions are known, but not in depth and detail. The development process is known, but only after the features have been clarified. An iterative PMLC model consists of a number of process groups, repeated sequentially within an iteration by a feedback loop. This process continuous until an acceptable solution is found. Prototypes such as models and simulation are often used as to discover the final product solution.

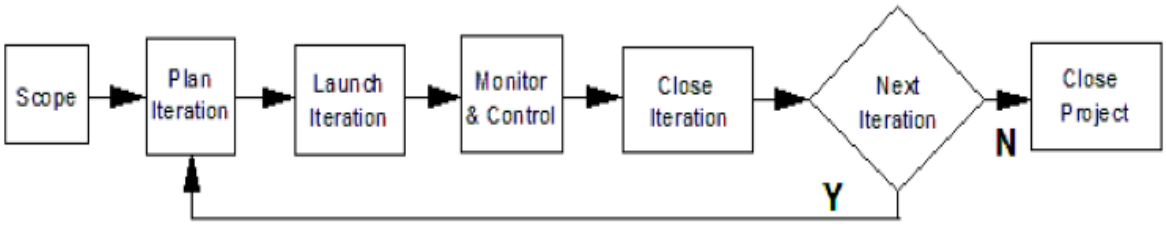

Figure 11: The Iterative PMLC model (Brun, 2014a).

The model is suited for projects when one have considered using incremental PMLC model, but believe more scope change requests can occur. Also when one have considered Adaptive PMLC, but want more client involvement. The strengths of the model is that the client can review the current solution for improvements, by using a production prototype.

Scope changes can be prosessed between iterations to adapt to changing business and market conditions.

The model does have some weaknesses. It requires a more actively involved client than for Linear and Incremental PMLC models. It has a greater need for co-located teams. The implementation of intermediate solutions can be problematic. The final solution cannot be defined at the start, something a client may worry about (Wysocki, 2012).

3.7.1.2 Adaptive PMLC Model

The characteristic of an Adaptive PMLC model are that there is high uncertainty regarding projects solution and uncertainty regarding developing a deliverable. It is used for projects with a higher degree of uncertainty and complexity than for Iterative models. There is also high uncertainty about functions and features. The model proceeds from cycle to cycle based on limited information about the solution. Each cycle aims to learn from the proceeding, to redirect the next cycle in an attempt to coverge on an acceptable solution. This is illustrated by figure 12. When a solution is found that satisfies the clients need, the last cycle is completed and the project is closed.

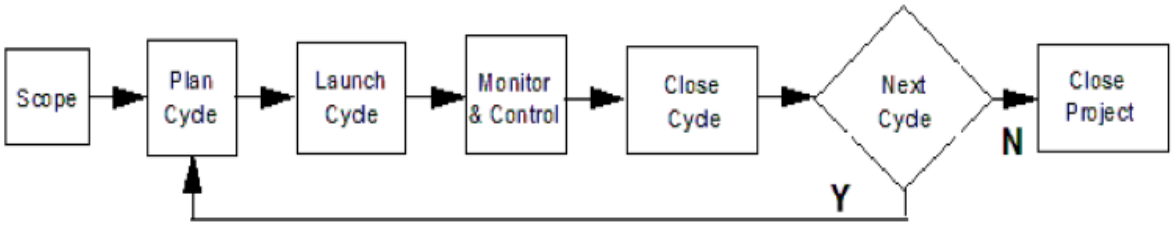

Figure 12: The Adaptive PMLC model (Brun, 2014a).

When less is known about a solution and process, more uncertainty, risk and complexity is present. As the project gets under way, there is a gradual and continuous process from cycle to cycle. The closer one get to a solution; the more the fuzziness and risks are reduced.

The characteristics of an effective Adaptive PMLC model is:

- An iterative structure
- Just-in-time planning
- Emphasize change and adaption through discovery and learning
- Cyclical structure

The strength of an Adaptive PMLC model is that it use minimum amount of time on non-value-added work. It does not have any formal scope change management request. Rather than wasting time on this it places it in the Scope Bank. It does not waste time planning for

uncertainty, instead concentrate on more certain parts. This can create maximum value for a client within the given time and cost constraints.
The weakness is that it requires meaningful client involvement. Clients must be fully involved in the development process and share responsibility. In addition, one cannot identify exactly what will be delivered at the end. This might not be what a client wants to hear when they are investing in projects (Wysocki, 2012).

3.8 Adaptive Project Framework

The APF was developed by Wisocki in 2003-04 (Wysocki, 2012), but unlike most Agile methods it is not limited to software development. It is suited to manage all kinds of projects from product developement, R&D projects to software development. It is characterized by being customer focused and customer driven. The fundamental concept behind the APF is that the scope varies and one must adapt by making choices within the resource constraints. APF provides the client with maximum business value on limited resources, by adjusting to the scope at each iteration. The method requires meaningful client involvement as the client plays a central role in the decision process. At each iteration there is a possibility to change the direction, to make use of new information.

3.8.1 APF Core Values

The APF is more than a framework, it is a way of thinking about clients. How to best provide value for a client and add maximum business value. Through a set of six core values the APF has established a new way of thinking to help the client and development team.

I. Client-focused
II. Client-driven
III. Incremental results early and often
IV. Continuous questioning and introspection
V. Change is progress to a better solution
VI. Do not speculate on the future

3.8.2 The APF process

The APF is an adaptive development process that consist of the five phases illustrated in figure 13.

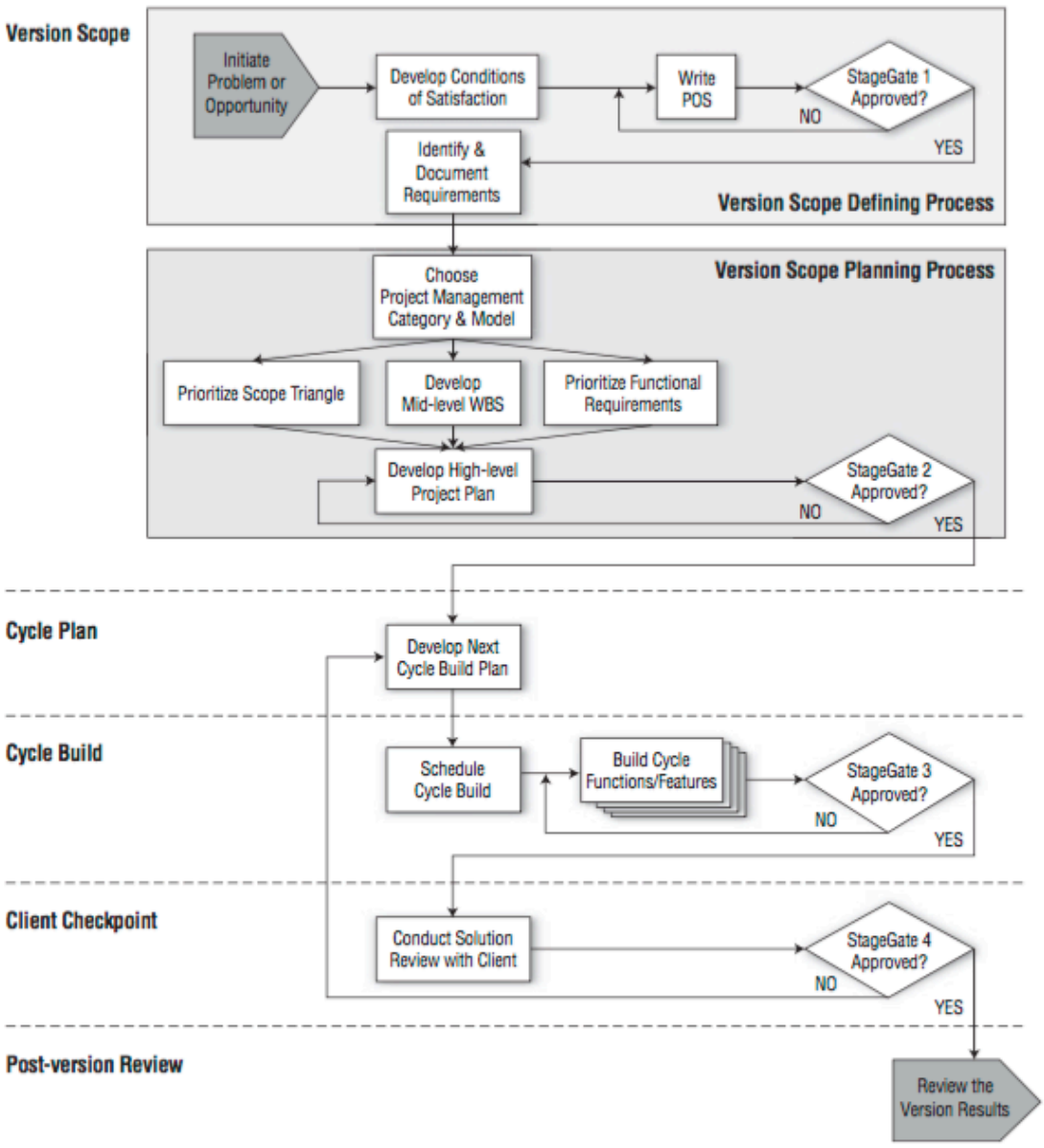

Figure 13: The APF life cycle (Wysocki, 2012).

I. Version Scope: The first phase contains the following eight deliverables:
Condition of Satisfaction (COS), Project Overview Statement (POS), Requirement Breakdown Structure (RBS), prioritized functions, number of cycles, prioritized scope triangle, cycle timebox and mid-level Work Breakdown Structure (WBS).

II. Cycle Plan: The second phase contains the following deliverables:
Low-level WBS on detail level, partitioning functionality, dependency diagram and dividing work betweeen team members.

III. Cycle Build: In the third phase a detailed planning is performed and the cycle starts. The deliverable is whatever functionality that can be built before the cycle expires. Monitoring progress for cycle, risk and reporting of project status. The cycle is finalized when time expires. Work not completed in the cycle is transferred to the next. All issues and challenges are registered in the Scope Bank.

IV. Client Checkpoint: The deliverables are verified and the client is involved by providing continuous feedback. The next cycle is adjusted if changes in functionality must be done.

V. Post-Version Review: The deliverables are evaluated. Lessons learned are registered to improve the next version and the Framework.

The APF is an adaptable tool and can be embedded in other PMLC models. If a solution is completely known apart from in one module, the APF can be used for the remaining module. The value of the method is a reduction in costs and time. It also ensures the best solution is found based on the given constraints.

4 Discussion

4.1 Introduction

To deliver a successful project, fuzziness must be managed sufficiently. Studies have shown that a high level of projects fail or do not meet their requirements. In a study of 60 large engineering projects, Miller and Lessard found that only 45% met most of the objectives, 19% were below target, 16% had to be restructured and 20% were cancelled (Donald Lessard, 2001). For more balanced range of projects over 70% in large organizations fail to meet their stated objectives (Institute, 2001). Different studies give different numbers, but they do illustrate that the industry is facing some challenges managing fuzziness. One can state that these are unacceptable high numbers and cannot be explained simply by poor management. While it might be a contributing factor, it is unlikely to be the sole cause. Some argue that an essential cause for project failure is novelty, unknown unknowns or unk unks. One can wonder why project managers seem unable to manage them. By definition unk unks are not known. They are unrecognized uncertainties not uncovered or prepared for in plans. When unk unks occur, one can risk experience negative and extreme outcomes. That is not to say it is not possible to prepare for them. Knowing there are unk unks can provide motivation to uncover them. Unk unks can be divided into two sub-categories, unknowable and knowable unk unks. Unknowable are events and outcomes one is unable to anticipate, while knowable are events possible to uncover.

Case studies have shown that the established traditional risk management methods can identify and manage the mainly foreseeable risks and residual risk (Loch, 2006). They use a so-called instructionalist approach were contingency plans are made. If events occur these contingencies are triggered. This approach can work as long as all risks have been identified and their impact correctly predicted. In practice this is not always realistic, particularly for projects of a more novel character. Many interactions among factors can result in events that one could not have foreseen. The severity and consequences of events may also vary significantly. Basic unk unks or risks may be overlooked or forgotten. There may be a number of reasons for this, but it is especially prevalent in more innovative projects were less data and experience are available. The existing methods do not look beyond this approach and as such do not address the unk unks. The current framework can limit company's possibility to understand and uncover the true fuzziness level. As such they are less robust and more vulnerable to "surprises".

Figure 14 illustrates limitations in the existing risk management methods. Planning can identify critical factors and aid in reducing fuzziness before launching a project. However one can only do so much planning before a project is launched. Trying to identify all knowable risks and unk unks is not good utilization of scarce resources. One must try to find a balance for uncovering fuzziness and unk unks. As such one must accept that not all

fuzziness and risk can be removed. At the end of the day one must take risk to have a chance to get the potential rewards.

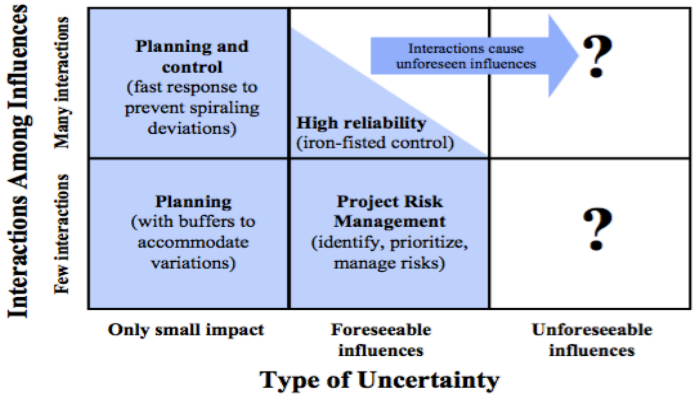

Figure 14: Limitations of established risk management methods.

Because traditional project management method uses an instruction follow approach it is not ideal to manage projects with higher degree of fuzziness. The APF method is more suited at managing fuzziness than the TPM models. It is part of the APM models and one of the "new kids on the block" with respect to tools. The method was introduced in 2004 and has shown promising signs. Despite this an alarmingly high percentage of failed project illustrate that there is a weakness in the existing tools and methods. Despite the APF being more suited to manage fuzziness it is also vulnerable, especially for innovative projects.

4.2 Advantages and disadvangates of using the Adaptive Project Framework

The APF is more than a framework, it is a new way of thinking were the client is central. How can a client be best served and at the same time gain maximum business value. This way of thinking is encorporated into its six core values presented in chapter 3. This sub-chapter presents some arguments provided by Wysocki why one should utilize APF, before studying some disadvantages.

The agile method is suited for situations with clear goal, but not clear solution. Since it is in agile projects nature to have an unclear solution it is not uncommon to have higher uncertainties related to different factors. The APF are due to its characteristics more robust and adapt to handle change than the TPM. With cycles going back to the planning phase it has a tools to adjust to change. For each iteration new knowledge, information and changes can be adjusted and updated. If the delivery does not satisfy the customer requirements, changes can be planned in next cycle.

Table 2 presents 15 reasons provided by Wisocky for why one should use the APF (Wysocki, 2010). Obviously with Wysocki being an author and one of the greatest supporters of the method, it must be mentioned he has his own agenda and is considered biased. That does not mean the arguments are invalid. Despite being biased the arguments provide insight into what the method can offer. These arguments are discussed in greater detail in the next sub-chapter. Thereafter, the disadvantages of the APF is studied to illustrate that the method is not suited for all purposes.

Table 2: 15 reasons to utilize APF for projects (Wysocki, 2010).

Reasons to use the APF	Argument
I. The approach thrives on change rather than avoiding it.	The APF is used for projects were the solution is not known at the start, but must be determined. Through the methods iterations, the project team can learn and determine the best solution that will provide maximum business value for the client.
II. The approach is not a ”one size fits all” approach.	Since projects are characterized as being unique, why not use an approach to manage them that is unique. The APF adapts to a projects characteristics.
III. The approach utilizes just-in-time planning.	Developing a complete plan makes little sence since changes are expected. When in doubt leave it out and focus on planning

		things one knows will be part of the final deliverable.
IV.	**The approach is based on the principle that you learn by doing.**	The real value of the APF is gained from learning and discovering the solution. The method utilizes the swim lanes and cycles to learn and discover the solution.
V.	**The approach guarantees "If we build it, they will come".**	The APF delivers the best possible solution at completion of each iteration given some time and money constraints. The solution is continuously aligned with the client needs.
VI.	**The approach seek to get it right every time.**	When a client has decided that a function or feature is going to be part of the final solution, it is integreated into the current one. At completion of each iteration, the current solution is implemented to align with the clients needs.
VII.	**The approach adjusts immediately to changing business conditions.**	Between iterations, the business analyst and project manager review what has been done and reflect how the business climate has changed. Adjustments are made if necessary.
VIII.	**The approach is client-focused and client-driven.**	Since the framework is centered on a client, meaningful client involvement is essential. The design creates client ownership and interest in the project.
IX.	**The approach is grounded in a set of immutable core values**	a) Client-focused b) Client-driven c) Incremental results early and often d) Continuous questioning and introspection e) Change is progress to a better solution f) Do not speculate on the future
X.	**The approach assures maximum business value.**	A client has the final say on which features and functions that go into the solution. This allows them to choose what they believe will create maximum business value.
XI.	**The approach squeezes out all of**	APF does not waste time or unneccesary

	the non-value-added work.	resources speculating on the future. If there is any doubt about a function or feature being part of the final solution, it is not integrated into the current one.
XII.	**The approach fully engages the client as the primary decision maker.**	As the primary decision maker the client is responsible for successful project completion. The role of the PM is to inform the client of which directions to go and feasible alternatives.
XIII.	**The approach creates a shares partnership with shared responsibility.**	The approach aids in attaining and maintaining client involvement and ownership. These are key topics to achieve success.
XIV.	**The approach empowers the team.**	By challenging the personell the approach is suited to motivate them to succed where other may have failed.
XV.	**The approach works 100 percent of the time, no exceptions!**	If APF is closed early it is because it is not converging towards an acceptable solution, or a different approach is discovered during iteration. Closing it may free resources to use for more viable projects.

Wysocki`s reasons and arguments for choosing the APF illustrate some of the methods strengths. There is no doubt the arguments are onesided presenting a selling point. To illustrate that the method is not perfect the models weaknesses are also presented.

Many factors can contribute to fuzziness. Alistair Cockburn and Jim Highsmith (Jim Highsmith, 2001) argue that there exist several critical people factors for agile methods such as talent, skill and independent assessment. Not managed correctly, these factors can potentially cause problems. Having a quality project manager will often help, but it might not be enough. Quality staff is another important factor. Without a solid and complementary team to perform, a project is vulnerable. That is not to state agile methods are more sensitive to people factors than other methods, or that they only require highly capable personell. Many agile projects perform well with a mix of experience. The method derives much of its ability from team knowledge instead of individual knowledge. Still there is always the risk than an individual or team makes irrecoverable fundamental decisions that can lead to increased time, cost or project failure. This may have a large impact, especially if the decisions are related to fundamental aspects at the start and are not uncovered until a later stage (Boehm, 2002).

Perhaps the most challenging factor to manage are the unk unks, which are unpredictable events that can occur. Given the APF nature of less up-front planning, projects using this method might experience more surprises than those managed by the traditional. The question is how vulnerable they are to these surprises? This question is discussed in the following sub-chapter. Another weakness of the APF is the methods vulnerability to meaningful client involvement. With the client being central, poor client involvement will result in that the project is vulnerable. Another potential weakness is that the method also has a lot of flexibility, perhaps too much flexibility. This may result in that a clients is constantly changing requirements because they know there is a framework in place suited for this. In a client checkpoint a client can ask to change features and functions, then in the next checkpoint change to its original design. Constantly changing requirements may lead to a higher degree of redone work. Another potential weakness is that it can lead to higher and maybe unrealistic expectations. This is due to its selling points, claiming the method can provide maximum business value on limited resources and works 100 percent of the time.

Project management is about managing and controlling projects. For APF the control and final decision-making is left to a client, which gives a project manages less control. It should be noted that this does not necessarily have to be negative. Other disadvantages are that it is difficult to determine resource requirements and get funding, since do not know what the final deliverable will be at the start. To get a client to invest millions of dollars without being able to tell them what the final deliverable will be, is a hard selling point.

4.3 Managing fuzziness with Adaptive Project Framework

Having studied some advantages and disadvantages of the APF, the attention turns to the methods processes and characteristics. These are evaluated in greater detail to assess the methods ability to manage fuzziness. Preliminary in the discussion the operating climate is presented. Thereafter, the methods advantages and disadvantages are discussed by going through APFs processess and characteristics.

The APF is often used for innovative projects associated with high uncertainty regarding the solution. Projects with many interactions and high uncertainty can be challenging to manage. They can contribute to a higher degree of fuzziness as its componenets complexity, uncertainty, ambiguity and equivocality can all be high. Another aspect affecting fuzziness are the unk unks, which may be particularly challenging to manage.
At times the APF operate in situations with a lack of information and/or conflicting data. For these situations, there can be a higher degree of equivocality and ambiguity. Ambiguity arise when information is unclear or not understandable, a common feature in novel projects. To reduce ambiguity, information must be simplified to help stakeholders and project team get a better understanding. With different and conflicting interpretations one may also experience a higher degree of equivocality. To manage this fuzziness component, it is important to ensure that the team members and stakeholders interpretations are unified. An example of this can be situations were a project team and client have different interpretations of the deliverable. As such the project team can be in the process of developing something different from what the client is expecting and wants. There may also be different and unclear interpretations within a project team, which may result in that personell are not all working towards the a common solution. Situations as these can be avoided or reduced by having a solid communication process. Rich media a common suited tool to help reduce fuzziness related to these components. Other aspects associated with a higher degree of equivocality and ambiguity, is that it may be difficult for projects participants to interpret information, assess probability types and understand what they express. When dealing with situations as these, expert knowledge can be used. Experts can contribute with their subjective assessment to simplify and make things more clear. The assessment can be quantitative or qualitative. Tools such as confidence intervals can shed light on events and their risks. For higher degree of equivocality and ambiguity it is important that experts communicate to decision makers and project participants the background for choosing values. Tools as rich media can for this such as face-to-face meetings or video conferences. Information considered to be relevant and redundant should be clarified. Complexity is another fuzziness component. With many interactions or poor capacity to manage them complexity may be high. Simplifying, improving processes or increase capacity to manage them are ways to reduce it.

Unk unks is considered the most challenging fuzziness componenet. It is interesting to assess how the APF is adapted to manage them. One the methods core values is ”do not speculate on the future”. The APF focuses on what is known about a solution and does not waste resources planning things that may change. All non-value added work are avoided and planning done ”just in time”. If new functions or features are identified during the development they can be integrated at a later stage. This is done to utilize available resources more effectively. Wysocki argued the method provides a client with maximum business value based on limited resources (Wysocki, 2010). Being a bit critical one may ask the question ”will doing less planning result in that a project will be more vulnerable to unk unks?”. When planning is done, information is collected. This reduce uncertainty, make things more clear and as such reduce fuzziness. The argument for doing less up-front planning is that the APF is structured to use resources more efficiently and avoiding unneccessary up-front planning does this. There is little doubt that projects using this approach is more exposed to fuzziness. The question is how vulnerable the method is to new events and changes? To answer the question one can study figure 15 which illustrate how the cycle plan process is structured. Looking at this, give a better understanding of why the method can ”get away” with less planning than the traditional methods. When discussing vulnerability one must study the consequence and magnitude of the events.

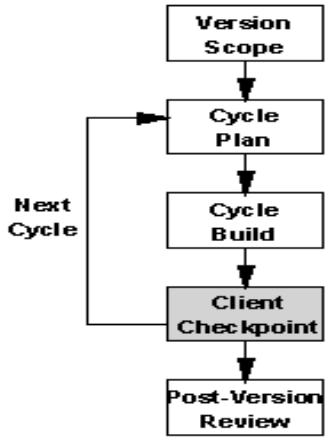

Figure 15: Adaptive Project Management process (Wysocki, 2012).

One of the main characteristics of the APF is its adaptability to continuously changing demands. The methods cycle box consist of three cycle boxes; cycle plan, cycle build and client checkpoint. There is a continuous flow of cycles until a project has met its deliverables or is closed for another reason. Every day a project team spends a short amount of time to assess project status, that is where they are compared to plans. With a short time period and controlled cycle length, the method can quickly discover and correct things. The method does not allow for change within a current cycle. Instead the team must focus on meeting the planned deliverables. After the cycle is finalized, the next step is the

Client Checkpoint. At the heart of APF it spends time looking back at what was discovered and learned in the previous cycle. The output is used as input for planning the next cycle and if deemed necessary changes are made. It is this process where the core values and short cycle length allow the APF getting away with less planning. These make the method highly adaptable to changes. So to answer the question ”how vulnerable the method is if new events and changes occur?”; one can argue that for most cases the APF seems to have tools to identify and respond to changes. Still events can occur that may have catastrophic consequences. So despite that APF has tools to adapt to change, some events may be of such magnitude it may be challanging to do something about. Consequences may be delays, increased costs, reduced quality or cancelling a project. Overall for most cases, it would be fair to argue the method is equipped to handle changes due to its characteristics, values and process.

4.3.1 Project team, roles and responsibility in APF

Project teams typically consists of smaller groups with less than 8 personell. These are often assigned to a project full-time resulting in less schedule problems. The team members can and are capable of taking responsibility for tasks. However they are not so-called ”self-driving”, as this is the project managers job. His role can be divided between two teamleaders; a development manager and a customer manager. The authority is divided between the two, each responsible for his team. Having this responsiibility role has its strengths and weaknesses. The strength being that development can in principle be more effective as each manager focuses on using his main competence and toolset to develop his teams deliverable. The weakness become more clear when team managers disagree or have conflicting opinions. This may lead to deterioration in communication lines, trust and loss in development time. There should always be an individual with authority to solve potential disagreements and unite the teams.

The size of a project team also affects the degree of fuzziness. With more personell there is higher fuzziness and as such a higher demand for effective communication lines. Everyone must be kept updated on progress, challenges, development and changes. It is therefore recommended having smaller project teams in agile projects. A project manager should give team members responsibility, believe they can do the work and trust that there is a solid development process in place. The daily 15-minute status update, weekly meeting for customer status, client checkpoint and problem solving sessions, ensure that stakeholders are updated regarding status, progress and potential challenges. The communication is typically rich media such as face-to-face interactions. It is an effective method for open discussions to uncover potential risks and opportunities. The process is only as good as the personell using it, so it can be vulnerable if team members do not use it peroperly. Examples of this can be lack of sharing potential problems, lack of informing regarding status or discoveries. However the APF does have the tools to limit the consequences of these aspects. With shorter cycle lengths to the client checkpoint, one do not have to wait

long before lack of sharing information can be identified. This may motivate personell to share information at an earlier stage to avoid someone discovering they were not providing or hiding away information. Motivated personell contribute to a more robust process.

There are some disadvantages having smaller project teams. They can be vulnerable to aspects such as personell leaving, sickness, sick children or other personell challenges affecting them. This can result in that work packages are not completed within a cycle plans and must be postponed. When things as these occur one must adapt and the plans changed. Aspects such as these may be difficult to avoid as they are part of business and happens every now and again. Contingency plans could be made for personell performing critical tasks. They might not be easy to replace on short notice, as more critical tasks are often performed by personell having some kind of expertice. In addition, new personell must spend time updating on the project status and work performed. Due to the short cycle time at least one does not have to wait long to make changes. It should be mentioned that these challenges are not only associated with the APF, but for all project management methods. Still, smaller teams will be more vulnerable than larger teams, as they are more dependent on each teammember completing their work packages.

4.3.2 Client checkpoint and customer responsibility

In the client checkpoint a project team and client get together to reflect on what was discovered and learned during the previous cycle. Challenges and possibilities are discussed and used as input for planning the next cycle. One must ensure there in meaningful client involvement as this is one of the greatest benefits of the APF approach. Allowing customer involvement can contribute to higher level of successful projects. The customer need is highest priority, making it a client-focused and client-driven method. Having a client-driven method means that the client share project responsibility. It is essential that the customer takes this serious and allocate personell to aid in developing the deliverable. It is up to a client to decide what direction a project should take. The project team will work to identify the best options, but it is up to the client to choose which they believe will provide maximum value. This approach creates a sence of ownership that may motivate a client. It is important the client communicate their needs and opinions in a clear manner. It is recommended that a client provide personell with solid knowledge and understanding of the technology. With two parties expressing perspectives and opinions, great synergy can be derived.

A client is informed regarding status, deliverables, challenges and potential change. This give them a foundation to make decisions regarding changes in functionality, features or other aspects. The checkpoint should provide the project team with feedback regarding were business value lie and what aspects are considered most important for them. Communication and meaningful client involvement are key words. Short cycle length

ensures that less time pass until a client and project manager can evaluate if the deliverable are truly what the customer wants. If features, functions or others aspects have been misunderstood, these can quickly be corrected. This reduces fuzziness and ensures less resources are wasted.

Ideas, challenges, changes in competitive climate, suggestions for features and functions, that were uncovered in the previous cycle are placed in the Scope Bank. During the client checkpoint the updated Scope Bank is used to identify contents for the next cycle. This is a useful tool to adapt to new knowledge, changes and information. It helps the method manage and reduce fuzziness. The following elements are typically recommended to work on for the next cycle:

i. Review the COS and make adjustement to solution requirement if neccessary.
ii. Prioritize items in the Scope Bank by using prioritation techniques.
iii. Identify and prioritize Swim Lane contents.
iv. Determine the next cycle timebox.
v. Select items to be developed in the next cycle.

According to Wisocki, the outcome of the client checkpoint lead to four important questions that should be answered before the project continues (Wysocki, 2012).

Table 3: Questions that should be answered in the client checkpoint (Wysocki, 2012).

Questions	Comment
Do the cumulative deliverables meet expectations?	There are two characteristics that provide essential feedback about the project; momentum and convergence. Is the project team gaining momentum as they discover and learn more about the solution. Is the project converging towards an acceptable solution? Are there signs that fuzziness is reduced and things are becoming more clear?
Should the project continue to the next cycle?	If the project is gaining momentum and converging towards an acceptable solution continue developing. There might be exceptions to this such as a competitor having launched a superior product, there is not sufficient funding or a client wish to concentrate on other strategic projects. If

	the project is struggling or not converging towards an acceptable solution, it should be cancelled.
What is the priority order of the remaining functionality?	During the previous cycle information was collected, things discovered and lessons learned. Changes may result in different prioritization of remaining functionality. The Scope Bank is used as input to the prioritization tools.
What should be built in the next cycle?	After next cycle length has been determined, updated prioritization list of functions and features. One must determine how much work can be done during the cycle. Balancing the work to make sure it is reasonable and viable.

These questions not a strict follow guide, rather questions Wisocki feels are useful. They are presented as a tool to help answer important aspects. They are based from the outcome of the client checkpoint. A firm may use a different approach if they another would better suit their needs.

4.3.3 Communication

APF understands the importance of communication and emphasize establishing effective communication among project stakeholders. The communication lines should allow participants to exchange information in both formal and informal ways. The APF have four main tools to manage communication; the Condition of Satisfaction (COS), daily meetings, weekly client meeting and the Client Checkpoint. The COS is developed in the start phase. This can be a short meeting between a client and customer, represented by a manager and a client representative. Other times a more formal meeting with additional participants and stakeholders present. One of the important aspects of the meeting is to establishing a communication strategy. Roles, responsibility, decision-making and communication process is discussed and documented. Rich media is highly favored. This is illustrated by the daily meetings were each team member has an opportunity to participate in open discussions. Project status, challenges, new development and more are discussed. It should be noted that problem solving or decision making are not part of this.

APF typically divides personell into a customer- and development team. Because of different background and experiences they may have different opinions and views. Both teams have daily meetings to coordinate and work collectively towards a common solution.

Information is exchanged between the teams. Simple more straightforward information and updates can be shared by using lean media such as internal Mails. Situations that are more unclear or have diversity of referance frames require use of rich media. This can be team leaders participating in open discussions. A dedicated customer team is a tool for more effective communication between a client and other stakeholders. Knowledge gaps, need of additional information can be identified and solved.

Based on the discussion it would be fair to argue that the APF has tools to manage fuzziness at least for smaller projects. How would this approach fare with large projects? As noted project teams with more personell will have a higher degree of fuzziness and higher requirements for the communication lines. For large project there will be different challenges. Maybe one of the first things one can ask is how realistic it is to get financing for large projects? One can argue that it would be very difficult to get a company to make higher investments when they do not know what the final deliverable will look like. The argument that they will get maximum business value out of the given resources, is not a good enough argument to convince a firm to make major investments.

4.4 Can an approach based on Aven`s (A,C,U) perspective improve the APF?

In this section an approach inspired by Aven`s (A,C,U) perspective is presented. It will be discussed with respect to APF to assess if it has ideas that can improve the method. Before presenting the approach, the theory behind Aven´s (A,C,U) is introduced.

Studies have shown time and time again that the industry is struggling to manage fuzziness. APF is a method developed to manage projects with a higher degree of fuzziness. Despite this and the fact that APF has shown encouraging signs, a surprising large amount of projects are still failing. To aid in managing these challenges it is proposed to use Aven`s (A,C,U) perspective as a tool to uncorporate a more complete fuzziness.

4.4.1 Aven´s (A,C,U) perspective

Many typically associate risk with statistics and determine it based on historical data. The question is if historical data provide the assessor with enough information to say something about the risk in the future. Aven (2010) argues that historical data can provide a good insight of what to expect in the future, but the prediction one make can turn out to be poor. When using historic data to predict the future, one is assuming the future will be like the past. According to Aven (2010) there is a huge step from using history of risk as an assumption for transforming the data to the future. To fully express risk one need to look beyond historic-based data. The traditional probability-based perspective defines risk using probabilities and probability distributions. The assigned numbers or data are conditioned on a set of assumptions and simplifications, which depend on the background knowledge. Aven (2010) argues that uncertainties are often hidden in the background knowledge. One must take care not to restrict attention just to the assigned probabilities as they could hide factors that could result in surprising outcomes. This is sometimes refered to as unknown unknowns, or so-called unk unks. It represents situations where one cannot determine some events or consequences because there is no prior experience or theoretical basis for expecting the phenomena. He argues that risk is more than calculated probabilities and expected values. Aven (2008) argues that the uncertainty should be the pillar of risk, instead of only using probability distributions. Based on this argument, a risk-definition is introduced based on the knowledge-based uncertainty perspective. In this the risk does not exist independently of the assessor, as the uncertainties are based on the assessors' background knowledge.

Aven (2008) defines risk as:

By risk we understand the two-dimensional combination of

(i) events A and the consequences of these events C, and

(ii) the associated uncertainties U (whether A will occur and what value C will take).

This is referred to as the (A,C,U) perspective (Aven 2008).

Risk is related to future events A and their consequences (outcomes) C. Today, we do not know if these events will occur or not, and if they occur, what the consequences will be. In other words, there is uncertainty U associated with both A and C. How likely it is that an event A will occur and that specific consequences will result, can be expressed by means of probabilities p, based on our knowledge (Aven 2008).

This definition introduces a new risk perspective, adding the uncertainty dimension to the traditional risk perspective. The features of the new risk perspective are presented in figure 16.

Figure 16: The new risk perspective (Aven, 2013)

Aven argues that risk is associated with uncertainty, but this does not mean risk is uncertainty. Uncertainty isolated from the consequences and impact cannot be used as a general definition of risk. It fails to capture an essential aspect of risk, the consequence dimention. Uncertainty cannot be isolated from size, extension and severity of the consequences (Aven, 2010). For innovative projects one may be in situations with less available data and technological knowledge. A project may be vulnerable as many aspects can have a higher degree of fuzziness.

4.4.2 Approach to assess the uncertainty

This section presents an approach that can be used for assessing the uncertainty. One will see that the approach captures much of the term fuzziness. During the process it is emphasized keeping the assessment crude and not going in too great detail. The reason is that the APF does not do much up-front planning and any approach should be adapted to this characteristic. It is recomended to use a qualitative approach. For situation with factors of critical importance and regarded as having higher fuzziness, a semi-quantitative appriach may be used. Used sufficient the approach has tools than can offer practicality and make an impact.

Figure 17 can be used as a basis to do the qualitative evaluation. The layout of uncertainty factors were collected by Janbu (Janbu, 2009) and idea is inspired by previous work performed for mutual funds by Skeisvoll (Jakobsen, 2013a). It can allow for a more systematic approach to uncover aspects of fuzziness and make the APF more robust. Aven`s (A,C,U) perspective is considered to be epistemic uncertainty. This uncertainty discussion can be built around the following three uncertainty factors:

i. Model uncertainty
ii. Parameter uncertainty
iii. Completeness uncertainty

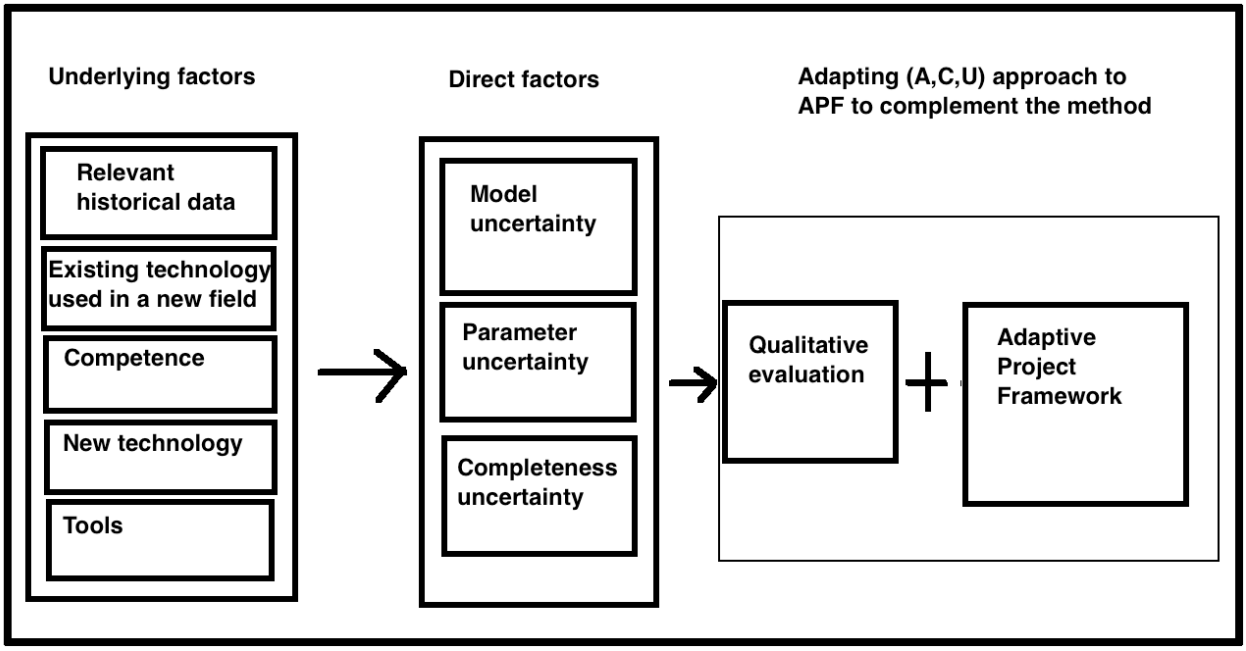

Figure 17: Approach for applying Aven´s (A,C,U) perspective in APF projects (Jakobsen, 2013a).

Many underlying factors can affect a project with a varying degree of probability of occurring and impact. Some are independent, oUnderlying factorsthers more correlated. When planning, these factors are used as input for the start phase in the "version scope" and "new cycle build plans". See figure 18. Expected values are determined and calculated to represent these factors. These values are affected by a set of assumptions, simplifications and background knowledge. One should keep in mind that the determined values represent a simplification of the situation. These predictions may turn out to be poor, especially if less data is available from similar projects and technology. The main idea with this approach is to do a quick evaluation of the uncertainty surrounding these factors. This can allow the decision maker to gain a better understanding of the fuzziness and what is behind the numbers, as apposed to only focusing on expected values. The next sub-chapter presents

the approach used to classify these.

4.4.3 Approach to classify uncertainty

To classify the uncertainty surrounding the factors one can use a method developed by Flage and Aven (Flage and Aven, 2009). It considers both risk and vulnerability, depending of two dimensions:

i. Degree of uncertainty
ii. Sensitivity of the relevant risk and/or vulnerability to changes in the uncertainty quantitites.

The uncertainty classification is divided into three categories: minor, moderate and significant uncertainty. A description of each category is provided that can be used as a guideline. The uncertainty classification is presented in table 4, followed by a sensitivity classification in table 5.

Table 4: Uncertainty classification (Flage and Aven, 2009).

Minor uncertainty	**Moderate uncertainty**	**Significant uncertainty**
All the following conditions are meet:	*Conditions between those characterizing significant and minor uncertain, e.g.:*	*One or more of the following conditions are meet:*
The phenomena involved are well understood; the models used are known to give predictions with the required accuracy.	The phenomena involved are well understood, but the models used are considered crude.	The phenomena involved are not well understood; models are non-existent or known/believed to give poor predictions.
The assumptions made are regarded as very reasonable.	Some reliable data are available.	The assumptions made represents strong simplifications.
Much reliable data are available.		Data are not available, or are unreliable.
There is a broad agreement among experts.		There is a lack of agreement/consensus among experts.

The sensitivity classification is divided into a similar approach with categories; minor, moderate and significant sensitivity. Explanations are provided as a guideline for users.

Table 5: Sensitivity classification (Aven flage)

Minor sensitivity	Moderate sensitivity	Significant sensitivity
Unrealistic large changes in base case values needed to bring changes in conclusions.	Relatively large changes in base values needed to bring changes in conclusions.	Relatively small changes in base values needed to bring changes in conclusions.

Studying the explanations in table 4 and 5, one see similarities between the contents and Zack`s knowledge aspects in figure 3. As such one get the feeling that this approach capture much of the terminology fuzziness. Studying figure 17 show that the underlying factors are used as input for the direct factors of model, completeness and data uncertainty. When performing the uncertainty assessment one should work from the direct factors; model, completeness and data uncertainty. This can simplify the evaluation process, to ensure a crude analysis with less detail.

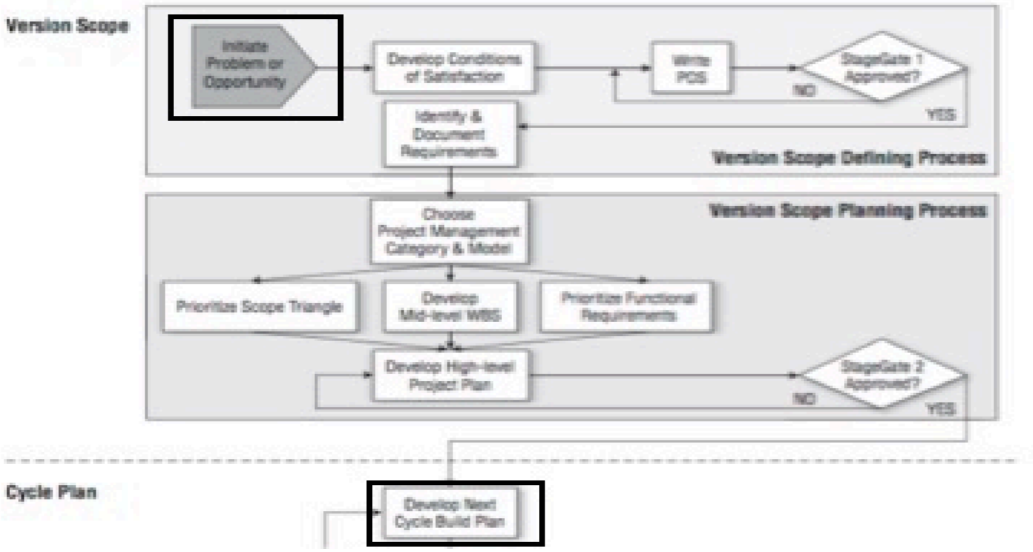

Figure 18: Suggested focus areas for the (A,C,U) approach adapting it to the APF.

For practical purposes one can identify objectives, features, functions, sub-functions and other relevant aspects one believe are critical to a project. These aspects are then evaluated for the three direct uncertainty componenets. A practical example of how this can be done is presented in the following sub-chapter. The assessor can do this assessment when he determines expected values. Typically for the planning in “version scope” and the continuous process “new cycle plan build” see figure 18. The approach may be used other places in the process if a project manager feels it is useful. One should always ensure the

process is adapted to the APF, so the tools compliment each other.

4.4.4 Practical example of how an uncertainty assessment can be made

This sub-chapter presents a practical example of how the assessment can be done. It is by no means a blind follow approach. The main point is to ensure an approach that is practical and complements the APF. The left column in table 6 presents elements one wish to evaluate. These elements may be objectives, functions, features or other chosen factors. They are evaluated with respect to the three uncertainty factors; model, parameter and completeness uncertainty. Each element are assessed with respect to both risk and vulnerability to get a more complete evaluation. The guideline in table 4 and 5 provide the background for the chosen categories in the assessment.

Table 6: Assessment of parameter uncertainty.

Elements	Effect on risk	Effect on vulnerability
Objective 1	Minor	Moderate
Function 1	Moderate	Moderate
Sub-function 1	Moderate	Moderate
Feature 1	Moderate	Moderate

Table 7: Assessment of data uncertainty.

Elements	Effect on risk	Effect on vulnerability
Objective 1	Minor	Moderate
Objective 2	Moderate	Significiant
Sub-function 1	Moderate	Moderate
Feature 1	Moderate	Moderate

Table 8: Assessment of completeness uncertainty

Elements	Known uncertainty level		Unknown uncertainty level	
	Effect on risk	*Effect on vulnerability*	*Effect on risk*	*Effect on vulnerability*
Objective 1	Minor	Moderate	Moderate	Minor
Function 1	Minor	Moderate	Moderate	Significant
Feature 1	Moderate	Moderate	Minor	Moderate

One could look at more elements than presented here. This is just presented as an example of how it can be done. One should be careful not looking at too many elements, as this may be counterproductive. It can result in less benefits and using too much scarce resources.

The values are focusing on the most critical elements, keeping the qualitative assessment crude.

Assessments such as this can theoretically provide a better platform for decision-making by complementing the expected values with additional information. Using qualitative assessment may in some cases not be enough to provide the decision maker with a simple more straightforward answer for situations with high fuzziness. However it will provide more insight and background than mere expected values. As elements considered to be critical are studied and can be discussed with a client or other experts. The approach can and should be used with other tools as long as they complement eachother.
A question one may have related to this approach is will the assessment of the factors not also be subject to an assessors background knowledge? The answer is yes to a certain extent it will. However the approach will provide more information than expected values, which as we know may turn out to be poor. Having an established guideline to perform and read an evaluation will simplify the process. It is recommended that it is done by some specialist in colaboration with a project manager and perhaps a client representative. Having more than one individual performing it can help to gain a broader perspective, vital angels and discussions around important aspects. It should not be done by too many people as the main point was to keep it simple and not wasting resources. It can be argued the guideline provide a tool aid in to capturing much of the term fuzziness and shed light on unk unks. Though it does not necessarily uncover the unk unks themselves, it can provide a valuable insight to which areas, functions, features are most vulnerable.

There are some disadvantages with this tool. As noted it will shed light into the fuzziness surrounding expected values, but it will not necessarily provide the decision-maker with simple yes/no answers. This does not mean it is without value as it provides critical information when operating in an environment with high fuzziness. Another aspect is the approach practical and viable? There are already many factors that must be managed in project; will this approach complicate things? The answer to this is if one can utilize the tool effectively it can provide value. To do this one should keep the assessment crude for most cases and focus on the critical aspects. It is important that it compliments the APF, rather than going into too much detail. Another question is, does the industry need another tool? There are already so many available. Looking at the number of projects that fail and how much resources are wasted, one can argue that the industry should keep developing new tools to improve. If some value can come out of using this approach it should be utilized. As for replacing the industries current tools, it is highly unrealistic. There is a reason for why they are used today and that is because they are currently the best available. Still, one should continuously seek for new and improved ideas, tools and methods.

5 Conclusion

The fuzziness and risk in the project management industry is continuously changing due to rapid changes in technology, customer requirements, wishes and competive international business climate. These along with other factors have contributed to an increased level of fuzziness associated with some projects. Studies and experience have shown that companies struggle to manage projects associated with higher level of fuzziness. Too many project fail or do not meet their requirements, resulting in loss of billions of dollars every year. It is therefore important that the industry is continually working on developing and incorporating better tools.

The main purpose of the thesis was to evaluate APF and the methods ability to manage fuzziness. Three sub-objectives were added to clarify evaluation focus. These were added and structured to support the main porpose. The first sub-chapter studied the advantages and disadvantages of the APF. The second presented a more thorough evaluation of the APF, studying both its characteristics and process to evaluate the models ability to manage fuzziness. The third sub-chapter presented a tool inspired by Aven´S (A,C,U) perspective, adapting it to the APF. Then evaluated if it had ideas that could improve the APF. The result of the discussion was that there are a number of advantages and disadvantages of APF. Used properly and for the right climate it can provide value. It is a method typically used for smaller projects were one expects more changes and a higher degree of fuzziness. One of the main reasons for why it is not used in larger projects is because its highly unlikely a client will provide funding for such projects. Arguments such as the APF will ”provide maximum value based on the given resources and it works 100% of the time” is not enough. Personell managing resources within a firm will require something much more concrete than this to allocate millions of dollars for funding. The result from the second evaluation focus was that APF is a tool suited to manage projects were changes are expected and for a higher degree of fuzziness. The model seems to be gaining an increasing degree of foothold in the industry and its due to its tools to manage these.
The method does have its weaknesses. Since it has smaller project teams with few personell it is vulnerable to aspects such as poor communication, poor feedback and a lack of quality personell. These factors are not only associated with APF and affects all project management methods. However since he APF has small teams they are more exposed to these factors than larger teams. Since the method is used for smaller or medium projects, it is more vulnerable to personell challenges. This can other aspects such as sickness, personell leaving, sick children and others reasons affecting personell from doing their job. These are difficult to avoid as they are a natural part of a business environment and will occur every now and again. Contingency plans can be made for personell performing critical tasks. However they may not always be easy to replace, especially on short notice. The reason is that personell performing more critical tasks often have some expertice. In addition, the new personell would need time to get updated on the project and its status.

After studying the methods structure, process and values, it was determined the method has tools to identify potential challenges early and limit their concequences. As such the method is considered to be less vulnerable than the traditional methods. The APF is most suited for smaller project and not ideal to manage mega or large-scale projects. One of the reasons for this is that it is highly unlikely that it will get funding for millions of dollars based on the argument "it will provide maximum value on the given resources and works 100% of the time". The conclusion is therefore that the APF is satisfactory for most projects with clear goal and not clear solution. Despite this the method should be improved and made more robust.

The method inspired by Aven`s (A,C,U) perspective was presented as a method that would ideally do this, by improving APFs ability to manage fuzziness. It was argued it theoretically had tools that could make method more robust and limit its vulnerability to fuzziness and unk unks. In the approach, an assessment was presented that can provide a better platform for decision-making by providing complimentary information on critical elements. Only using a qualitative assessment will in some cases not be enough to provide a decision maker with a sufficient feedback to get a straight yes/no answer. Yet it provide more insight and background than mere expected values. As such it can be argued it can complement the APF operating under high fuzziness. As to the question "is the approach is considered practical and viable?" critics may argue that with so many factors that must be managed, the approach can result in complicating things. One can argue that if one manages to keep the assessment crude and focus on the most critical aspects, it can in theory compliment the APF. Yet has no practical data and experience to show to. Therefore at the current stage, the method presents a theoretical approach that can at best provide discussion or inspiration for new tools, rather than a viable tool.

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