Chapter 6

Risk Management in Collaborative Systems

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Additional information is available at the end of the chapter

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1. Introduction

Many domains reached a point in which the knowledge required for skillful, professional practice can no longer be acquired in a decade, factor that generates increased specialization [2]. This increased specialization makes collaboration crucial because complex problems require more knowledge than any particular person possesses. The relevant information required to solve complex problems is normally distributed among different persons or stakeholders. In order to create insight, new ideas or new artifacts it is considered a prerequisite to bring different and often controversial points of view together, and create a shared understanding among stakeholders. It is generally considered that insight moments for creative individuals are the result of working in isolation, but it has been proven that the role of interaction and collaboration is critical [19].

Collaboration is a very dynamic process that combines functionality that supports communication, management and involves content handling. During the execution of a project team members are not always collaborating and their work alternates with cooperation, when a greater emphasis is placed on a value-chain model of producing results. Project management is a tool used to provide a team the capabilities required to produce the benefits defined by vision [24]. Risk management is a critical element in defining the relationship between risks, uncertainty and objectives thus contributing to the chances of success in the execution of a project [9]. In the present context of information society both project and risk management should reconsider collaboration by thoroughly understanding its mechanisms and adapting its tools in order to fully harness it. In this study we will present some of the main aspects regarding collaboration that are relevant in order to build an efficient project and risk management strategy. This will be followed by some approaches from software development that we consider relevant for the context and present our risk management approach for similar projects.

2. Collaboration

The term collaboration is used often when one refers to quite different aspects of working together, like cooperation or even communication [33]. Focusing on national programs that

involve agencies, David Osher [30] identifies collaboration as being the most sophisticated level of relationship because it requires efforts to unite people and organizations in order to achieve common goals that could not be achieved by any single individual or organization acting alone.

On the other hand, in [15] collaboration is regarded from a more project management oriented point of view focusing on the elements required to achieve this level of relationship. Collaboration is identified as a process in which entities share information, resources and responsibilities to jointly plan, implement, and evaluate a program of activities to achieve a common goal. Following this author, collaboration is a process of shared creation that involves mutual engagement of participants to solve a problem together and implies sharing risks, resources, responsibilities, and rewards. Sharing risks, resources, responsibilities, and rewards can also give the group to an outside observer the image of a joint identity.

This approach implies that collaboration is more than what will later see that is identified as cooperation by adding joint identity and novelty to the goal. Michael Schrange in his Shared Minds [37] focuses especially on this novelty of the group's goal. Schrange considers collaboration as a process of shared creation: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own.

Collaboration is often confused with cooperation. Because for many people the two terms are indistinguishable [15], in the following we will take a closer look at what collaboration is and how can it be attained. One general accepted model that describes what is collaboration and what are its main components is the 3C Collaboration Model [15]. This model states that collaboration is attainable by implementing three main processes: communication (networking), coordination and cooperation.

Communication [22] is the starting process in each collaborative process. It is a general belief that efficient or so to say "ideal" communication will provide better common understanding or agreement but when people communicate accurately they realize more precisely the differences that exist on their perspectives of the concepts in use [18]. Different types of agreement tend to mask the differences in perception that accurate communication would uncover.

The second process required by the 3C model is coordination. Coordination refers to [22] the management of people, their activities and resources. Coordination allows team members to manage conflicts and activities in order to increase the efficiency of communication and cooperation efforts. Networking or communication is used as a foundation [45] but involves also altering activities for mutual benefit and for a common goal. It also increases resource usage efficiency and the ability to meet the targets.

Cooperation refers to the interaction among group members in order to produce, manipulate, and organize information, or build and refine cooperation objects like documents, spreadsheets etc. [22] This process requires a shared workspace that should provide the required tools in order to manage these artifacts, tools like version and access control and authorization. The shared workspace is very important because it allows group members to count on group memory and it provides also some basic awareness mechanisms.

Cooperation, coordination and collaboration are often used interchangeably, but they should be describing different stages in the transformation of the relationship between groups and organizations [30].

The backbone of collaboration is not the process of relationship but the strict following of a specific result [18]. We consider that an extra element must be added to the 3C model of collaboration, namely "Creativity". In order to support creativity in collaborative systems we consider that *a)* integrated light-weight project and risk management, and *b)* flexible content management tools have to be implemented [33].

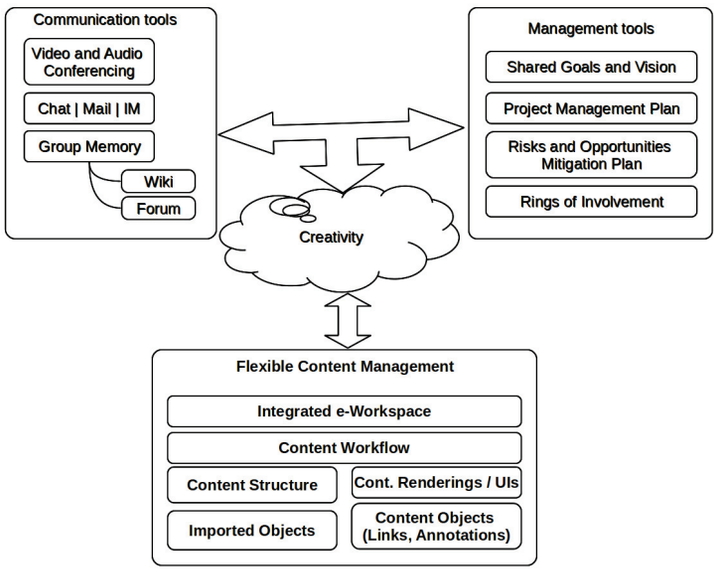

Figure 1. The 4C Collaboration model [33].

In order to discuss about collaboration, a key prerequisite must be satisfied, namely having a joint/ compatible goal or problem to solve (it is not enough that parties have their own individual goals) [15]. A vision specifies the scope and extent of these benefits but does not provide the means to attain them. Project management is a tool used to provide a team the capabilities required to produce the benefits defined by vision [24]. Vision delineates a *strategy* and project management sets the *tactics* by detailing the steps required to put it in practice. Teams can successfully implement their vision if they can bind it with the tactics.

Hilson [24] identified that a "zero risk" zone not also that it does not exist, but it is not even desirable because the available benefits are determined by the degree of risk it is confronted. Risk is defined as [35] "any uncertain event or set of circumstances that, should it occur, would have an effect on one or more objectives". Thus an uncertainty that does not effect the objectives is not a risk, but it can even be an opportunity. Risk management it is an important component in defining the relationship between risks, uncertainty and objectives thus contributing to the chances of success in the execution of a project.

Project management is about making complexity manageable and it is important to collaboration because it provides teams an organized way of keeping in touch with their goals. As defined by The Project Management Institute (PMI) [35], project management is "the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements".

Project risk management provides approaches by which uncertainty can be understood, assessed, and managed within projects. One of the key prerequisites of success in implementing risk management is to have a proactive approach. This process must supplement project management and must follow a holistic approach. Risk management will not provide great benefits to the teams using it if their practices fall under two limitations: focus on tactics and focus on threats [24].

3. Creativity

The rationality behind collaboration is creativity. Creativity, and especially scientific creativity, is a process of achieving an outcome that is recognized as innovative by the relevant community. As defined in [16], this process does not occur in one person's head, but in the interaction between that person's thoughts and a sociocultural context.

Creativity can refer to the work of artists, but can also refer to every-day problem-solving abilities. This type of creativity is essentially, equally significant because enables people to become more productive and make better results. Support for divergent and convergent thinking, development of shared objectives and reflexivity[20] are identified as key requirements for creativity.

Divergent thinking represents the ability to return in response to a challenge or undertaking an extensive set of alternatives, responses, ideas or opinions [20]. On the other hand, convergent thinking represents the ability to narrow down to one set of alternatives and is comparable with consensus building. If a group manages to build trust, uninhibited exchange of ideas and mutual support, each member can use the mind of the other as an extension of his own. At this stage, each person acts as a critic for the other and ideas are reworked into components of a shared vision. Cognitive conflicts within groups that use brainstorming effectively can alleviate divergent thinking. This stimulates thoughtful consideration of new and innovative ideas during brainstorming in a collaborative interaction[20]. Colleagues disagreement can result in evolutionary thinking, viewed as a series of small alterations that cause substantial changes in a concept.

Minority dissent [20] stimulates a reappraisal of a situation manifested in the search for further information and the use of thoughts and strategies about the issue. Some studies have shown that arguments can stimulate creative solutions even when wrong. Dissent stimulates both divergent and convergent thinking; the minority's consistency in advocating his opposition during convergent thinking may cause questions about the majority position, resulting therefore in making better decisions.

Clarity of goals is a necessary requirement for creativity flow [16] but team members have to take in consideration how they express these goals. Having clear objectives helps convergent thinking filter with greater precision. Developing shared objectives is a necessary condition for creativity because it requires group members to share their domain-specific knowledge and generates less resistance to change.

Upgrading from 3C to collaboration starts with the development of shared goals. Shared goals are more that common or compatible goals because they provide the team a joint identity by eliminating the value-chain model of building a common understanding or result. A component that supports the definition of a shared vision and a description of this vision

in terms of shared goals is essential. This must allow users to (re)adjust their goals according to the changes in the environment [31].

Obtaining immediate feedback is essential in having complete participation in the task at hand [17, p. 54]. In the context of a group, this refers to the extent to which members collectively reflect on the group's objectives. This process is known as reflexivity and consists of three elements: reflection, planning and action or adaptation [20].

In order to allow creativity to develop in a group, requirements like support for reflexivity must be implemented [20]. Reflexivity is built on processes like:

1. reflection: consists in evaluating, filtering and selection of ideas that will be further taken in consideration.
2. planning: is one the main subprocesses of project management and its main relevance for creativity is that it guides member's attention towards action and means of accomplishing their goals. Good planning reveals hidden aspects of the task at hand and is a good support in motivating team members.
3. action or adaptation: adaptation is actually a simple process of risk management because it represents a continuous adaptation of tasks and objectives in concordance with the changes in the environment. Integrated risk management tools are a must in order to identify, mitigate and define action plans that cover decisions at both strategic and tactics level and include not only threats but opportunities also [24].

In order to make planning more accessible and easy to access process maps are identified as a solution [40]. The process map should be derived from the project management and risk mitigation plan. It's main purpose it to *i)* provide an clear understanding of the hole workflow involved in reaching a goal, and *ii)* to supply a open delineation of the responsibility distribution. This is particularly useful in avoiding responsibility overlapping or uncovered responsibility areas. A mechanism that can manage the sequence of tasks and their execution for a particular process is required in order to enable the coordination process.

Reflection [20] is based on critical thinking, which is a form of thinking that is focused, disciplined, consistent and constrained. Critical thinking can be associated with convergent thinking because it implies evaluating what divergent thinking offers, filters it using acceptability criteria and selects the ideas that will be also taken in consideration.

Planning [20] creates conceptual readiness for relevant opportunities and guides group member' attention towards actions and means to achieve goals. Planning generates high reflexivity if during the process factors like potential problems, hierarchical ordering and short/ long term planning are taken in consideration.

Action or adaptation [20] refers to the continuous renegotiation of group's reality during interaction between group members, and members and the environment. Adaptation consists in goal-directed behaviors that are relevant to achieving the desired changes in group objectives, strategies and processes identified by the group during the stage of reflection. Risk management is used to identify, mitigate and define action plans for the full range of uncertainty, including both risks and opportunities.

Serendipity represents the possibility of making unexpected and fortunate discoveries and consists in *a)* discovering new pieces of information that can lead thinking to new ideas,

and *b)* the sagacity needed to make the connections between different pieces of information [1]. Computers can help develop serendipity by *i)* revealing stimulating connections, and *ii)* supporting either the growth or the sharing of an idea.

Creative activities are the result of the relationship between an individual [2] and the realm of his or her work, and other human beings. The resolution of complex problems is based on different aspects of knowledge that reside in the minds of individual stakeholders as tacit knowledge [2]. Full agreement may not always be achievable but what is decisive is to make informed compromises. This can be achieved by using the so called symmetry of ignorance [2]. Symmetry of ignorance is also highly valuable in identifying risks that may affect the team's goal negatively. Stakeholders bring perspectives to the collaborative process, perspectives that are of considerable importance in framing the problem. This concept requires externalizations or boundary objects that capture distinct domains of human knowledge.

At the core of intelligent human performance, is not the individual human mind in isolation, but the interaction [2] of the mind with *(i)* tools and artifacts, and *(ii)* groups of minds in interaction with each other. In the first case, the interaction with externalization objects is straightforward, the knowledge an individual needs is distributed between his head and the world - an address book, a file system, etc. In the second one, the need for such objects becomes more critical because the distribution of knowledge has to be available to all members implicitly.

Externalization objects are essential to collaboration [2] because they *a*) create and store mental effort records, evidence that is outside the memory; and *b*) represent artifacts that provide information and form the basis for critique and debate. Very valuable assets for a group or organization are not only the results but also the way people think, the way they get to god results. It is a significant challenge to try to capture the thinking process in tools that are remarkably easy and intuitive to use.[31]

4. Agile team management

Concerns about principles and practices of agile development approaches are well examined in many works as [28] where authors offer several answers to area. Agile is a people-focused approach [27] and considered effective in terms of team work and collaboration of small teams. People factors that can affect the performance of the team from an agile perspective are analyzed. The ability of adapting to changes efficiently and cost-effectively influenced in a radical way the path to success and survival in business environments [38]. As business processes become more complex, interconnected, interdependent, and interrelated than ever before, traditional approaches [4, 6] are no longer used and are characterized as reflecting linear and sequential processes. Even seemingly minor changes can produce unanticipated effects, as systems become more complex and their components more interdependent. Agile development methodologies were developed in response to this complexity, with a focus on rapid iterative delivery, flexibility and working code [4, 5]. However, for this migration to be successful, organizations must channel the bulk of their change efforts to the development team. The reason is that, the development team serves as a "fulcrum" on which the organization's efforts are applied and through which these efforts are turned into software products for customers [4].

Although agile development methodologies are viewed as an improvement to the traditional methodologies several key considerations need to be taken into account when deciding to migrate to Agile. In order for this migration to be successful we must take into account several variables such as the organizational culture, resistance to change, accepting the new roles by the members, the use of self-organizing teams, the insurance of face to face communication on behalf of the organization and the motivation of the members composing the team.

Traditional teams are characterized as command and control teams while agile ones are characterized as self-organizing teams. From this view, agile teams have a number of key advantages over traditional ones. For this reason, agile teams succeed to deliver products at better quality in less amount of time. A main problem in adopting agile is represented by human resources and their resistance to change. For example the manager might be afraid of losing his power over the members of the group, or becoming "role-less". Although the roles might change the manager is still needed not for planning and controlling ability, but for the important job of interfacing on the team's behalf with the rest of the organization [4]. Project managers pass from planning, controlling, directing, and managing, to new roles like building trust, facilitating and supporting team decisions, expanding team capabilities, anticipating and influencing change. They become facilitators, liaisons and network builders, boundary managers, "resource allocators", team champions and advocates, and in most cases, still have responsibility to watch the project budget. The roles of team members also change, as the group takes on increasing ownership of work processes and the agile practices. They become decision makers, conflict managers, innovators and conveners of standup meetings. These new and unique roles of the project manager and team members engender a more co-operative team with rapid results [4].

The agile methods focus on each team member and offers motivations to achieve a common goal of the team and the project. Building projects around motivated individuals, giving them the environment and support they need, and trusting them to get the job done; is central to the success of an agile team [42]. Different agile methods have different approaches for encouraging motivated individuals in development teams. For example, Extreme Programming, XP [7] has the concept of "collective ownership", while Scrum [41] has "scrum teams".

Communication represents a crucial factor on agile methods and treated in a different manner as traditional methods do. Face-to-face communication is preferred rather than written documents and this new mentality increases the quality of coordination and communication. This is in line with one of its core principles that states that, the most efficient and effective method of conveying information to and within a development team is face-to-face conversation [42].

It is well known that organizational culture influences the project trajectory and its implementation environment. Therefore, the only way to succeed in such a change is through a conscious programme of continual reinforcement of the desired behaviors until they become a natural and automatic part of the daily business of the organization [4].

To sum up, although agile development might be an improvement on the traditional development methodologies, an organization looking to migrate to agile needs to take into consideration several aspects regarding organizational culture and other variables that may prevent performance during this transition.

5. Proactive risk management

Project risk management is an essential and determinant step towards successful projects. A detailed analysis and a precise definition of risk can lead to achievement of objectives. PMI states [35] that "the objectives of Project Risk Management are to increase the probability and impact of positive events, and reduce the likelihood and consequences of negative events in the project".

One of the key prerequisites of success in implementing risk management is to have a proactive approach [11]. Risk management must supplement project management and must follow a holistic approach. Project management can be seen as an attempt to control the uncertain environment, through the use of structured and disciplined techniques such as estimating, planning, cost control, task allocation, earned value analysis, monitoring, and review meetings. Each of these project management elements has a role in defining or controlling inherent variability in projects. Project risk management provides approaches by which uncertainty can be understood, assessed, and managed [12, 13].

According to PMI [35], risk management can be implemented using the following sub-processes: plan risk management, identify risks, perform quality and quantitative risk analysis, plan risk responses and monitor and control. Based on the description provided by PMI, we will outline the main aspects involved by these processes.

Planning risk management [35] consists in agreeing on how to conduct risk management activities. This implies that the process should start at the beginning of the project and evaluate the extent and type of risk management with the project's importance and scope. This is essential in order to avoid performing extensive risk analysis on small projects that might not require such a considerable extent. Planning risk management uses as inputs documents like the project scope statement, cost plan, and schedule and will produce documentation that describes risk categories (a clear understanding on the types of risks - technical, external, organizational or project management related) and risk probability and impact (in order to have a common understanding of the terms used in identifying the risks a glossary of terms must be defined).

Identifying risks is an initiative that requires the identification and documentation of the risks that may affect the project. This sub-process should be regarded as an iterative one because new risks may evolve or emerge as the project progresses. Identifying risk requires that all the relevant stakeholders should be involved. Identifying risks is the most complex sub-process, and uses techniques like documentation review, information gathering (tools like brainstorming, interviewing, root cause analysis and Delphi technique[1] can be used), checklist analysis, assumptions analysis, diagramming techniques or SWOT analysis[2]. This subprocess should have as output the list of identified risks and possible responses.

Performing quality risk analysis consists in prioritizing risks by combining their likelihood and impact [32]. Performing quantitative risk analysis requires a numerical analysis of the effects of identified risks on the project objectives. Planing risk responses requires that options

[1] The Delphi technique consists in reaching consensus of experts by requesting ideas about relevant project risks anonymously using questionnaires. The results are summarized and recirculated to the experts for further analysis. This approach reduces bias in the data and restricts a person from having excessive weight on the outcome.

[2] Other techniques for risk assessment can be consulted in [29, p. 41-46]

are developed in order to increase opportunities and reduce threats. In order to determine the appropriate alternatives, strategies like avoidance (changing the project management plan in such a way that the identified risk does not affect it anymore), transfer (requires shifting all or part of the negative effect along with the responsibility to a third party), mitigation (consists in reducing the chances and/or impact of a risk in order to be in satisfactory threshold limits) and compliance. Monitoring and controlling is an ongoing process and consists in implementing risk responses, tracking identified risks and identify new ones.

As we have seen in Section Creativity, identified as an essential requirement for creativity was reflexivity support. Reflexivity consists in the group's focus on its objectives and the actions identified as required in order to reach them. Adaptation, as one subcomponent of reflexivity, consists in goal-directed behaviors that are relevant to achieving the desired changes in group objectives, strategies and processes identified by the group during the stage of reflection. Risk management can be used as a tool by team members in order to respond to changes in the environment.

The Practice Standard for Project Risk Management [36] identifies the following factors as critical for a successful risk management:

1. individual commitment and responsibility (risk management is the responsibility of all team members)
2. open and honest communication. All team members must participate at risk management and avoid actions or attitudes that can hinder communication because it can lead to ineffective risk management
3. risk effort scaled to project (the costs of risk management should be appropriate to its potential value)
4. integration with project management. Risk management can be performed only in strict correlation with project management.

Risk management will not produce substantial benefits to the teams using it if their practices fall under two limitations: focus on tactics and focus on threats [24]. Focusing only on project related issues (like risks related to project processes or performance) or technical functionality and not considering strategic sources of risk that menace the vision a decoupling between objectives and project deliverables will appear. On the other hand, focusing only on the negative side of uncertainty (threats, risks) will lead to ignorance towards opportunities, situations that should be integrated in the risk management plan in order to maximize benefits. This shift requires minor changes in the typical process, but the greatest challenge is to produce the change in people's approach which is centered on the threat aspect of uncertainty.

In [35] the following strategies for handling opportunities are identified:

a) exploitation (eliminate the uncertainty factor and ensure that the opportunity definitely happens);

b) sharing (requires allocation of some or all of the ownership of the opportunity to a third party so that all parties gain from their actions);

c) enhancing (identifying the key driving factors and enhancing their probability and/or positive impact); and

d) accepting (take advantage of an opportunity if it comes, but not actually pursuing it).

An integrated risk management [24] approach is required in order to cover both strategy and tactics, and opportunities and threats. Such an approach can provide increased benefits not available to a limited scope risk management. According to the aforementioned author, these benefits consist in:

- project deliverables become more concordant with the group's needs and vision by reducing the strategy - tactics gap,
- taking in consideration that projects as a tool are used to *a)* produce results that meet specific needs, and *b)* provide benefits, a focus on these aspects is necessary in order to avoid simply producing a series of deliverables,
- avoid having a poor or to late response to opportunities by enabling a proactive management of opportunities at both strategic and tactical level,
- support the best possible decision approach in an uncertain environment by providing relevant information to decision-makers,
- reduce waste and stress and increase productivity and effectiveness by managing uncertainty in advance with planed responses to known risks,
- increase the chances of achieving both strategic and tactical objectives by minimizing threats and maximizing opportunities,
- safe risk-taking leads increased rewards and that requires an appropriate level of risk to be taken with full awareness of the degree of uncertainty and its potential effects on objectives, and
- develop a risk-mature culture that is aware that risks exists at all levels and they can and should be managed proactively.

As we have seen in this section, risk management is a key factor for all teams, regardless of size and work domain, to help them make more informed decisions and take a proactive approach in regard to risks and opportunities.

5.1. Risk mitigation

A project driven organization represents a main approach for most medium and large sized institutions to successful deliver projects. Projects are more often used to transfer all personnel focus and involvement in day to day work, tasks and activities. Thus, concerns as respecting predefined terms become their main objectives. A proper project risk management approach deals with a set of techniques by which inevitable uncertainty can be understood, assessed, and managed within projects. Its main objective is to deliver projects in predefined costs, time and quality respecting customer specifications.

A main problem in project management and project risk management is represented by optimism bias and by human behavior to underweight outcomes that are merely probable and to overweight outcomes with a low probability to happen. This problem was clearly identified and presented by Daniel Kahneman and Amos Tversky [25, 26] in prospect theory

with origins in decision making under risk. Prospect theory is based on some well-observed deviations from rationality and helped Kahneman win the 2002 Nobel Prize in Economics.

As a first experiment, they used a group to choose between two options. For first problem (Figure 2), the group had to choose between option A (to win 2500 with a probability of 33% or 2400 with a probability of 66% or there were a 1% chance to win nothing) and option B (to win 2400 certainly). For this first problem, 18% of respondents chose option A, while 82% of respondents chose option B.

*Problem #1: Choose between A or B	
A	B
Win 2500 with a probability of 33% Win 2400 with a probability of 66% Win 0 with a probability of 1%	Win 2400 with a probability of 100%

Figure 2. Problem 1 from prospect theory

Their choice was influenced by the 1% probability to win nothing even if in option A they had 66% chance to win more than option B and 33% chance to win equally to option B (a 99% chance for option A to win more or equally to option B). Events with low probability (1% chance to win nothing) influence their decision.

According to results (18% for option A and 82% for option B), utility function means: 33% utility to win 2500 plus 66% utility to win 2400 is lower than 100% utility to win 2400.

$$33\%u(2500)+66\%u(2400) < 100\%u(2400)$$

$$33\%u(2500) < 100\%u(2400)-66\%u(2400)$$

$$\mathbf{33\%u(2500) < 34\%u(2400)}$$

For second problem (Figure 3), the group had to choose between option C (to win 2500 with a probability of 33% or there were a 67% chance to win nothing) and option D (to win 2400 with a probability of 34% or there were a 66% chance to win nothing). For this first problem, 83% of respondents chose option C, while 17% of respondents chose option D.

*Problem #2: Choose between C or D	
C	D
Win 2500 with a probability of 33% Win 0 with a probability of 67%	Win 2400 with a probability of 34% Win 0 with a probability of 66%

Figure 3. Problem 2 from prospect theory

Their choice was influenced by the +100 win and 1% probability difference. The 1% probability difference is now ignored and they chose higher win. Probability difference (1% as difference between 67% and 66%) influence their decision.

According to results (83% for option C and 17% for option D), utility function means: 33% utility to win 2500 is higher than 34% utility to win 2400.

$$\mathbf{33\%u(2500) > 34\%u(2400)}$$

This is exactly the reverse inequality from first problem. This is a clear example how human behavior tends to underweight outcomes that are merely probable and to overweight outcomes with a low probability to happen. As can be observed, second problem is derived from first problem (Figure 4) by elimination of Win 2400 with a probability of 66% option.

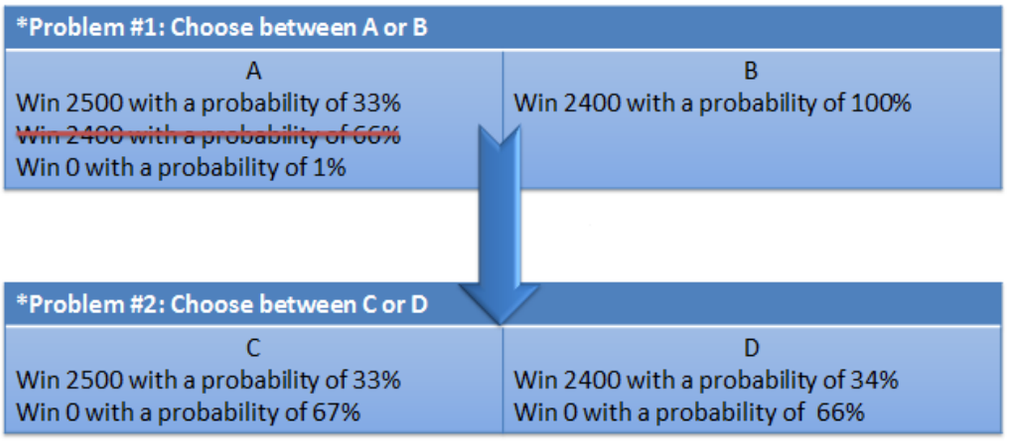

Figure 4. Problem 2 is derived from Problem 1 (from prospect theory)

This theory is main root for Reference Class Forecasting, which for a particular project, aims to identify a relevant reference class of similar projects from the past, to establishing a probability distribution for the selected reference class and to compare the specific project with the reference class distribution for establishing the most likely outcome for the specific project [21]. Another concern specifies that "to eliminate intentional or unintentional planning mistakes leading to time and cost overrun, current project management theories prescribe the eradication of any bias leading to overly optimistic forecasts. In an effort to hamper optimism bias, normative project management theory and practice introduce further tools and processes to eradicate the causes of optimism bias" [44].

According to [23], risks are defined as uncertainties which, if they occur, would affect achievement of the objectives negatively (threats). Similar, opportunities are uncertainties which, if they occur would affect positively the project. Examples include the possibility that planned productivity targets might not be met, interest or exchange rates might fluctuate, the chance that client expectations may be misunderstood, or whether a contractor might deliver earlier than planned. These uncertainties should be proactively managed through the risk management process. Changes in the business environment, project evolution and percent of completion, will continue to affect the risk situation inside projects. As each project is unique and has its own trajectory, project risk management should be a proactive approach for efficient and effective decision-making.

Projects continue to fail because of a proper project risk management lack and the management problem is getting bigger. A large number of organizations and institutes spend a lot of time and resources to develop and improve standards and methodologies for project risk management. Among these, the most common are:

- AS/NZS 4360:2004, The Australian and New Zealand Standard on risk management, [14] developed by Broadleaf Capital International PTY LTD;
- IRM Standard, jointly developed by The Institute of Risk Management (IRM) [43], The Association of Insurance and Risk Managers (AIRMIC) and by ALARM The National

Forum for Risk Management in the Public Sector (widespread in the United Kingdom) – adopted by the Federation of European Risk Management Associates (FERMA);

- PMBOK Guide developed Project Management Institute [35] (widespread in the U.S.A);
- PRAM (Project Risk Analysis and Management) Guide developed by Association for Project Management[3] (widespread in United Kingdom).

Adapted after PMBOK Guide, developed by Project Management Institute in a Practice Standard for Project Risk Management [35, 36], and by improving planning tools and techniques, a framework for project risk management can be derived, as presented in Figure 5.

A risk identification step where techniques and special tools are used is needed because a risk cannot be managed unless it is first identified. After identification, a risk assessment and evaluation step follows. Each risk is evaluated based on the probability of its occurrence and its impact on project objectives (in qualitative risk analysis) and a numerical estimate of the overall project risk is provided (in quantitative risk analysis). The risk analysis should be performed not only once but in iterative cycles along major. Monitoring is also recommended in continuous intervals. Monitoring is mandatory to permanently track and control identified risks and to promptly respond in case of new risks occurrence that were not previously identified. Risk management does not aim to eliminate risks, but focus to actively manage risks in a business context [39].

Back to risk mitigation step, to certain risks may apply a set of mitigations. Often, mitigations address processes of the organizations. For fruitful results, this process may require long time from implementation. The strategies to manage the risks and the method of mitigation and the priorities are mostly decided by the project manager. Each risk is identified in previous steps and each one is characterized by probability of occurrence and impact. The focus should be on risks that yield a high impact and are identified with high probability of occurrence. Figure 5 presents risks after and before mitigations. Another approach is to address risk after mitigation costs ranking. Deriving a root cause of several risks represents another method to mitigate risks; improvements may be applied there. In this way, the impact of multiple risks that are related to root cause may be decreased.

There are several strategies that can be applied in risk mitigations step. First of all, a risk can be avoided, by not performing tasks that imply risks. Despite this method is not always fruitful from economic perspective, those tasks may be replaced if suitable. A second method aims to reduce the negative effect and impact of the risk in terms of monetary costs, delay or low quality. In some cases the risk can be transferred to another party. Not all risk can be mitigated or make sense to mitigate, in some cases risks should be accepted (in an inconvenient cost/benefit analysis). After successful mitigation, risks are represented based on probability vs. impact. After mitigation, in case the probability decrease the risks are represented on a lower as a parallel shift with y-axis; in the case the impact decrease, risks shift left as Figure 6 shows.

Mitigation actions should target those risks associated with high leverage towards minimizing the residual risk afterwards or acceptable mitigation costs. The risk analysis methodology provides means of visualizing mitigation costs and expected residual risks with and without mitigation. After mitigation actions and responsibilities for the measures are agreed and

[3] http://www.apm.org.uk/

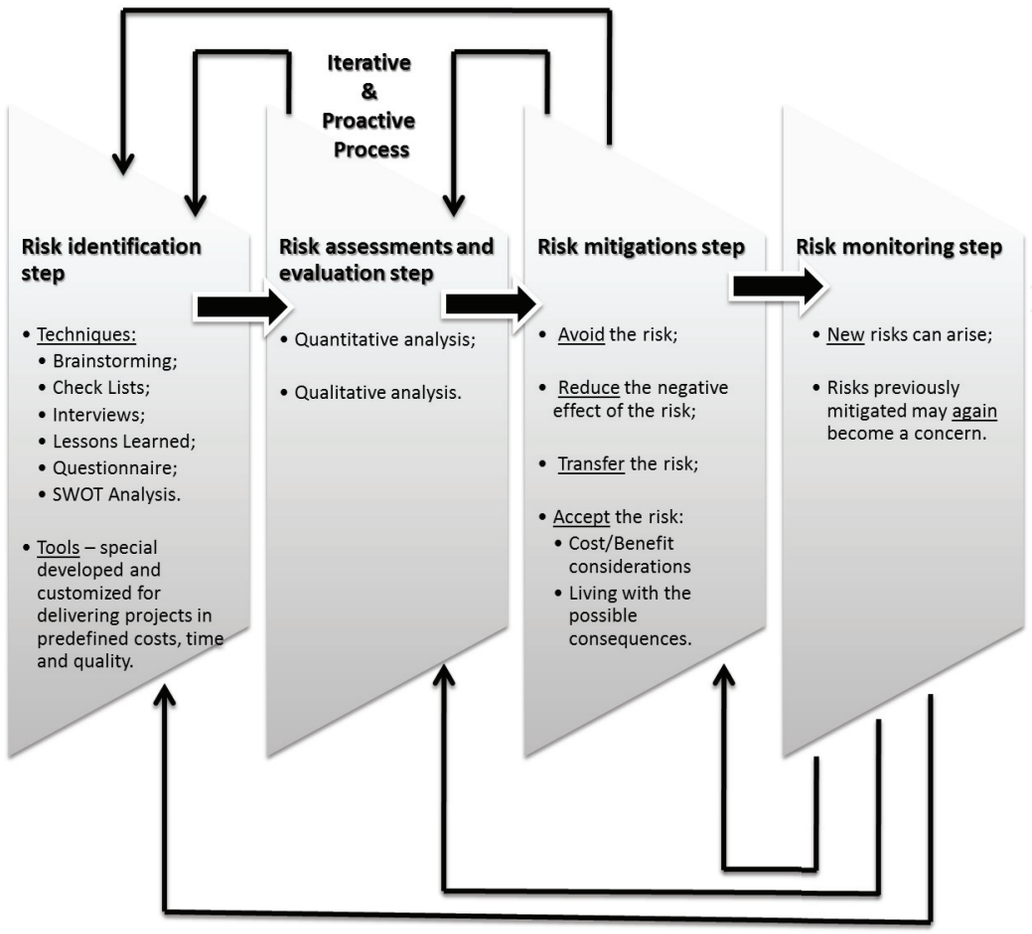

Figure 5. Risk management framework [12]

decided upon, the implementation of these actions need detailed planning and controlling. According to the findings in the risk mitigation phase the responsible action owners should be mandated by the project manager. Hence, the project manager needs to prioritize mitigation options and corresponding costs and efforts to decide whether measures will be taken or not. Performing agreed mitigation actions will contribute to reduce the risk status and create a new risk situation in the project. However, the implementation and controlling of the mitigations will be driven by the project team.

High risks are represented with red, medium risks with yellow and low risks with green in both situations: after and before risk mitigations. Our focus is on high and medium risks.

Despite the enormous sums of money being spent on project planning, risks arise. A risk management oriented culture is preferred to manage risks (cost, time or quality related) in conditions that most of the big projects fall victim to significant cost overrun.

5.2. Opportunity management

In project environment, risks are considered as uncertain events that if occurs has a negative effect on a project objective. Contrasting, the positive and desired effect is considered opportunity. A proactive risk management plan should be applied to successful manage uncertainties. Threats risks and opportunities should be treated as single unit and

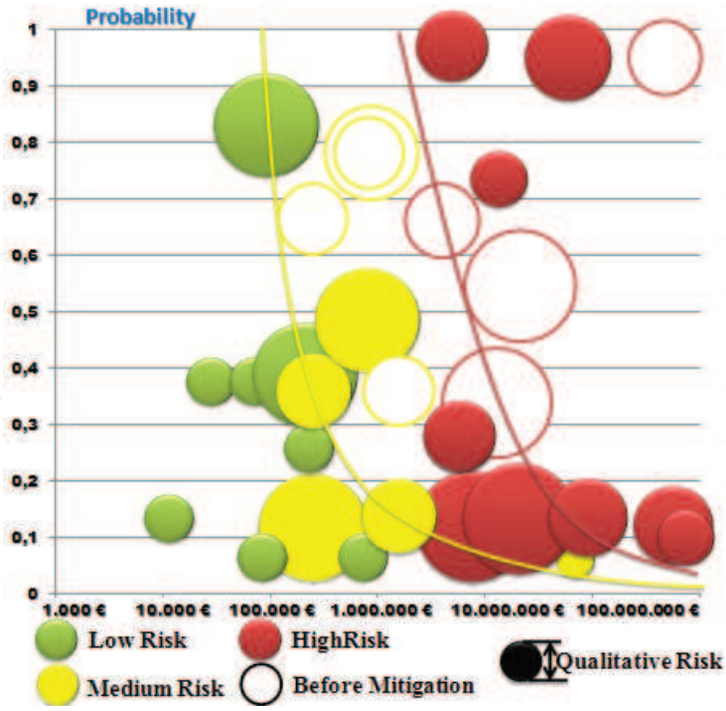

Figure 6. Risk representation Probability vs. Impact (After and Before Mitigations) [12]

individually defined in a single plan. Traditional project risk management approaches offer less attention on project opportunities. For example, check lists are considered a great technique to identify risks and captures previous experiences but most of the time this technique includes only threats and misses opportunities. Another technique is represented by Lessons Learned Reports that prevents making the same mistakes or missing the same opportunities twice. It also offers solutions and ideas where the opportunities can be unlocked. SWOT analysis addresses both threats and opportunities. As risks, opportunities are linked to one project objective (time, cost, quality, scope etc.). Some of the authors consider that companies can overlook opportunities that provide significant possibilities for organizational innovation and new competitive advantage by focusing on the downside of risk [8]. Both, risk and opportunities require attentions and should be treated. By managing risks, threats can be and also an opportunity perspective is available. Such opportunities may provide significant results in terms of innovation and project delivery at high-quality. In many situations, the opportunity is easily missed. Some strategies for identifying opportunities are listed and presented in [8]: learning from the past, customer sensitivity, learning from others, scanning, scenario planning, identifying the market gaps and change the game, idealized design and competing in advance and market sensitivity.

6. Conclusion

The rationality behind collaboration is creativity. Collaboration uses communication, coordination and cooperation as a backbone but it is seen as something more than that. It is about creating shared understanding that no member could achieve on his own and in order to generate insight, new ideas or new artifacts it is a necessity to bring together different and often controversial points of view.

Collaboration can be achieved if defined in a goal oriented framework and should use knowledge from project and risk management to increase the chances or obtaining the envisioned deliverables. These tools can lead to successful achievement of objectives, but they are not sufficient.

During the execution of a project team members are not always collaborating and their work alternates with cooperation, when a greater emphasis is placed on a value-chain model of producing results. Focus permanently switches from the flexible content approach to the management tools according to task's specific. In order to fully support the process of collaboration, the aspects that precede it or come in-between the collaboration sessions must be fully supported so that they will not represent a problem that can hinder collaboration. Both collaboration and cooperation require efficient project and risk management and this can only be achieved if collaboration prerequisites are sufficiently understood and integrated in the overall strategy.

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