On Best Practices for Risk Management in Complex Projects

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Risk management shall be proactive. This is one of the key preliminaries to cope with the challenges of complex projects. An overarching and consistent view on project risks and uncertainties is necessary to follow a holistic approach in project risk management. Uncertainty is inevitable since projects are unique and temporary undertakings based on assumptions and constraints, delivering project results to multiple stakeholders with different requirements. Project management can be seen as an attempt to control this 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 elements of project management 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 within projects. A number of associations (e.g., Project Management Institute – PMI®, International Project Management Association – IPMA,or Network of Nordic Project Management Associations - NORDNET) work constantly in acquiring, improving, and standardizing best practices in project management.Based on the industrial practice, this paper outlines strategies to identify, prioritize, and mitigate risks for achievement of project' or organizational objectives.
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1 Introduction

As integral part of project management, effective risk management is a critical success factor for delivering projects in predefined cost, time, and quality. Project risk management provides benefits when it is implemented according to good practice principles and with organizational commitment to taking the decisions and performing actions in an open and unbiased manner. Starting with the definition, risksare uncertain events which when occur have negative effect on at least one project goal – e.g., time, costs, contents or quality. Contrasting, the positive variability is desired and is called opportunity.

Despite the simple explanation, the project managers often include into risksarea the problems and technical or organizational issues. It is well to note: the risks are potential events in future which did not occur yet (while problems are risks that occurred). Risks are characterized by probability, always less than 100%; and impact measured in changes of the objectives. Risks may be measured in costs (monetary risks) in time (delay risks for time management) or quality (usually affecting contracts thru monetary cost of improvement).

Interests in risk management are not new and in the late 90s, authors state that risk management was a significant step in most organizations [7] [9]. While risk management is a critical activity in construction project management, existing industry practices involve tools like risk registers, risk management spreadsheets, brain storming sessions etc. As a result, many risks remain unidentified, and proper risk management becomes impossible [4]. Useful acknowledged techniques for identifying risks, as presented in [9], include brainstorming and SWOT analysis (Strengths, Weaknesses, Opportunities and Threats). Whereas external consultants may be used, the effectiveness of the systems will

depend on a comprehensive understanding of how the business operates in practice, and any 'standard solutions' should be approached with caution.

2 Role of risk management in project lifecycle

In a multidimensional space of the project objectives (or expectations), during project phases and based on the stakeholders evaluation, the project passes a trajectory. Risk may be described as the distance between the objectives (or stakeholder expectations) and the current situation (or the perceived current situation) in the upper described multidimensional space. For this reason, targets require to be well defined, well known, and well documented for project.

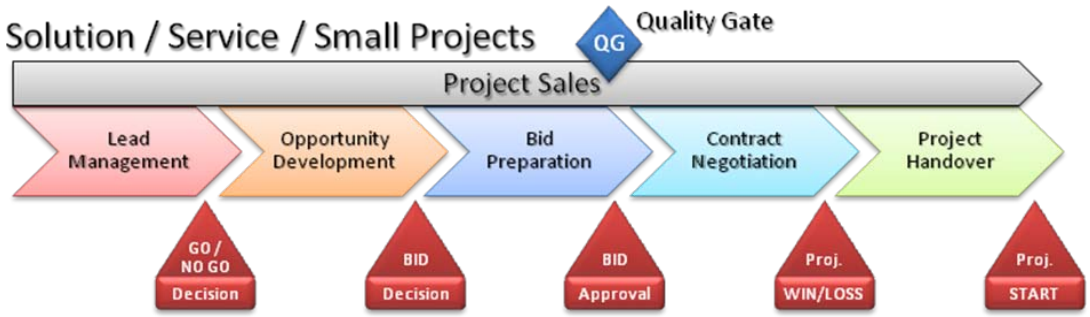

Fig. 1. Processes in the sales (acquisition) phase of projects

In the sales phase of projects, each large project crosses several phases that are relevant in terms of project risk management. The team of project sales (called sometimes acquisition) is distinct to the team of execution. Some complex sales create a project-like team with a designated project manager of sales.

The concept of risk management has become important and central to corporate management andessential to successful project management in complex setting. Risk management should be applied at major project milestones and hence be included in project plans and operational documents becoming integral part of every aspect of managing the project, in every phase and in every process group.Because of the financial impact it may bring, risk management shall be performed from the acquisition phase (i.e., project sales) so that the organization may find easier decisions on the project path. An initial risk assessment at acquisition phase improves correctness of the earnings before interest and taxes(or operating profit) calculations and adjusts expectation of the project itself. Later as the project develops, especiallyat handover and further in execution phase, risks shall be detailed and regularly updated.

In lower figures (see Figure 2 and Figure 3) we depict typical project life-cycles. We make a difference of solutions or large industrial projects vs. small project or services projects. A re-evaluation of risks is advised at major milestones, especially at "order receipt" phase and before "dispatching".In complex projects that involve warranties/service operation – some of risks extend during this phase. It is important to recognize them and actively maintain risk management in warranty/service operation phase. Project Management Institute PMI® in the *PMBOK® Guide* – Fourth Edition defines Risk Management as processes concerned with conducting *identification* of risks, analysis of impact (*evaluation*), responses (*mitigation* process), and *monitoring & control* of risks. Project Risk Management as integrant part of management aims to increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project. In advance of their occurrence, risk managementprioritizes risks and provides action-oriented information to project

managers. This orientation requires consideration of events that may or may not occur and are therefore described in terms of likelihood or probability of occurrence in addition to other dimensions such as their impact on objectives [5] [6].

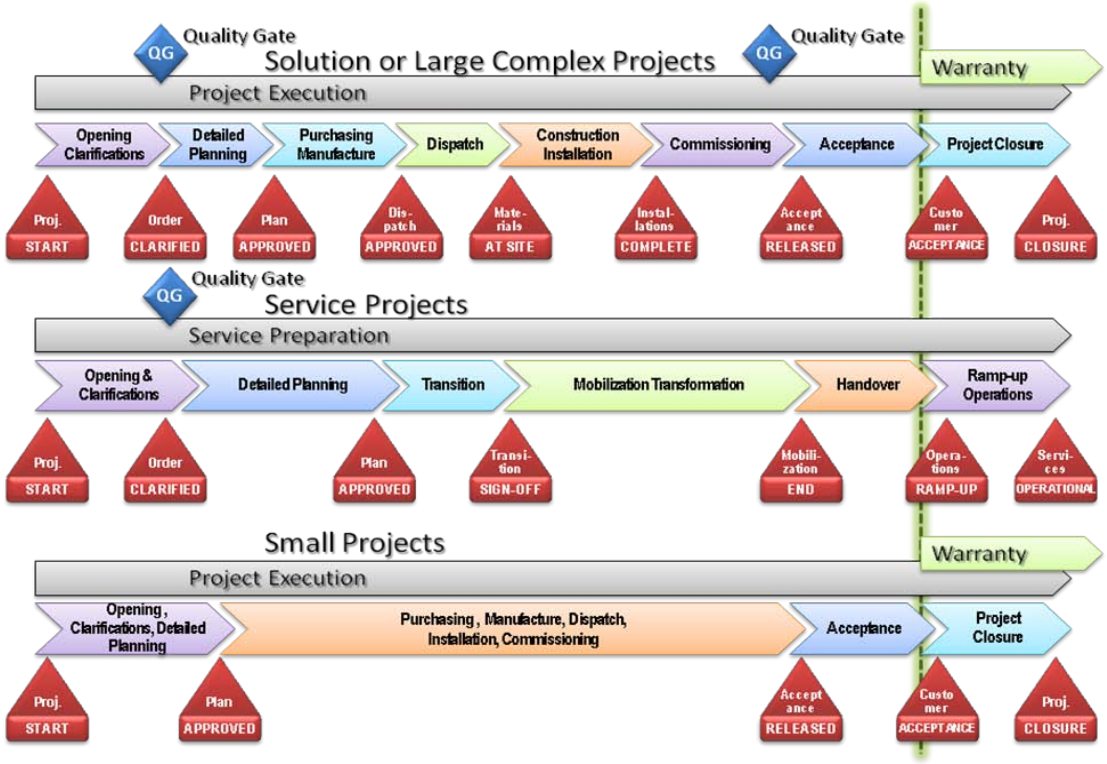

Fig. 2. Project execution orservice preparation differentiated for large projects, small projects or service projects

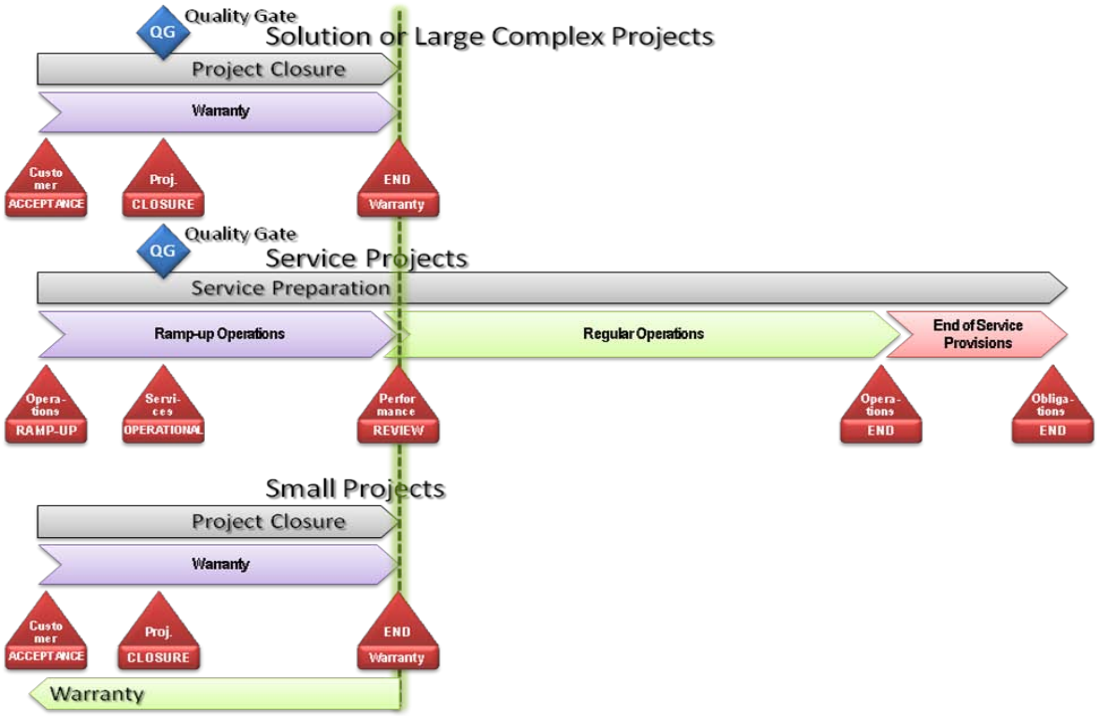

Fig. 3. Project closure and service preparation

The philosophical treatment of causality extends over millennia. In the Western philosophical tradition, discussion stretches back at least to Aristotle, and the topic remains a staple in contemporary philosophy. Concerning risks in project management, a risk is considered to have at least one cause and at least one effect.

Fig. 4. Relationship between cause, uncertain event which is risk if may produces an effect

Specialists in decision theory, statistics and other quantitative fields have defined uncertainty and risk more specifically.Authors in [1]distinguish uncertainty and risk according to their possible outcome: uncertainty as the lack of certainty, being the state of having limited knowledge where it is impossible to exactly describe future outcome; and risk as the state of uncertainty where some possible outcomes have an undesired effect or significant loss. Proposed measurement of uncertainty may include the application of a probability density function to continuous variables, while measurement of risk include correlation of this possible outcomes (uncertainties) with the magnitudes of those losses – this also includes loss functions over continuous variables.

Further, the article [2] distinguishes between causes, risks and effectsof the respective risks for the project (see Figure 4):

- *Causes* are definite events, or sets of circumstances, which exist in the project or its environment, and which give rise to uncertainty. Examples include the requirement to implement a project in a developing country, the need to use an unproven new technology, the lack of skilled personnel, or the fact that the organization has never done a similar project before.
- *Risks* are uncertainties which, if they occur, would affect achievement of the objectives negatively (threats). Similar, opportunities are uncertainties which, if they occur would affectpositively 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.
- *Effects* are unplanned variations from objectives, either positive or negative, which would arise as a result of risks occurring.Examples include being early/late for a milestone, increased/decreased operating profit, exceeding the authorized budget/being on budget, failing to meet contractually agreed targets etc. Effects are contingent events, unplanned potential future variations which will not occur unless risks happen.

3 Best practices for risk management

Until 80's,only event-risks were considered typicallyas risks. In addition to these isolated risks occurring from undesired events, the intrinsic variability of the activities may generate as well risks. With preponderance in development projectsthat employ novel technologies –solutions may come after long search efforts, which require appropriate financing.Novel technology correlates often with delays, which aretaxed by customers in form of liquidated/nonperformance damages.

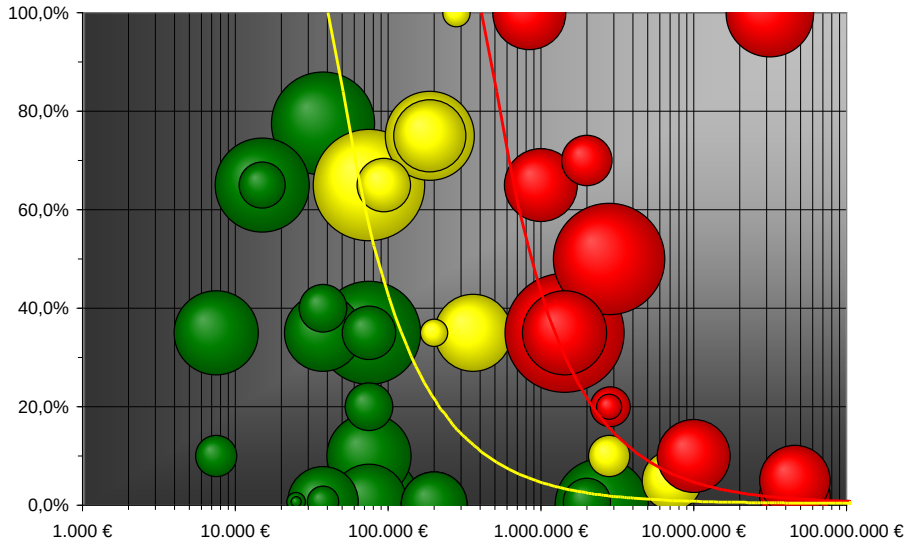

Fig. 5. Classical risk representation of occurrence probability vs. impact

Risk is typically represented based on probability vs. impact. The risks calculated for contingencies shall be the product of risk's probability and the impact. When risks own a probability higher than 80% a full impact shall be considered into the contingencies.

Correlations of independent events and/or variability are other sources of major risks. While the probability of independent events is the product of individual probabilities; the impact may increase by order of magnitude difference. Apart, complex/large projects span during long time. For such projects, the environmental changes – e.g., change in stakeholders, buy/merges, customer financial capability, economic trends and disruptive technologies – may influence the projects and be decisive for the risk spectrum. Here is the summary of our recommendations where to look for sources of variability in risk management:

- Event- Risks which infers with the project;
- Intrinsic variability in terms of costs/duration;
- Correlations on events and variability;
- Environmental changes during the project.

Project risk management requires that all other management processes as planning, resource allocation, budgeting, to be performed at the level of the best practices available. Risk management adds the perspective of project risk to the outputs of those other processes and adds to their value by taking risk into consideration.

Many of the project management processes address planning the project, from concept to final design and from procurement through daily management of execution and close-out. These processes often assume *an unrealistic degree of certainty* about the project and, therefore, they need to include treatment of project risks.Project Risk Management addresses this uncertainty in project estimates and assumptions; it builds upon, and extends other project management processes. For instance, project scheduling provides dates and critical paths based on activity durations and resource availability assumed to be known with certainty. *Quantitative risk analysis* explores the uncertainty in the estimated durations and may provide alternative dates and critical paths that are more realistic given the risks to the project. In addition to quantitative measurements and contrasting to numbers, corporations may consider the *qualitative risk analysis*, where the "feeling about risks" and the team-awareness in relation to respective risks is evaluated.

For meaningful results it is imperative that risk management to be applicable throughout a project's life cycle. The earlier in the

project life cycle that the risks are recognized, the more realistic the project plans and expectations of results will be. An early identification of a risk allows to minimize it and to reduce the negative effect it can have on achieving the initially set of objectives. More, to certain risks one may apply a set of mitigations. Often, mitigations address processes of the organizations, which may require time from implementation to fruitful results. As example, if the risk is the poor communication between two teams, one of mitigations may be "weekly meetings". The risk of poor communication decreases after a number of "weekly meetings" when (part of) communication barrier is removed.

Several authors describes that the nature of risk management and the challenges generated by its theoreticaland practice have been in a state of evolution over the past 10 years [8]. This process of evolution has created a number of difficulties for those involved in the management of risk, who now increasingly find lacking the necessary capabilities to cope with this nature of this change – not least because of the increased volume of information around the various sources of threat and the trans– disciplinary nature of the problems.

A project risk can be identified as individual risk to one of activity inside the projector asoverall- project risk. Individual risks/opportunities are those risks that might positively or negatively affect one or more of the project tasks objectives. Defining and understanding individual risks can help to decide and make a strategy about how to apply efforts and resources to enhance the chances of project success. Overall project risk refers to the effect of uncertainty on the project as a whole;it applies to the whole project. To lead to successful achievement of objectives is necessary to set realistic targets for the cost and duration of a project.

Other authorsidentified three processes of risk management [10] based on the ownership of the process:

1) *risk assessment* process, which includes identification and evaluation of risks and risk impacts, and recommendation of risk-reducing measures – performed by experts in risk analysis and moderation;

2) a *risk mitigation* process, which refers to prioritizing, implementing, and maintaining the appropriate risk-reducing measures recommended from the risk assessment process – owned by technical project manager;

3) *continual evaluation* process and keys for implementing a successful risk management program – owned by project manager and/or quality management.

This risk analysis methodology can be tailored to the specific phase of a project ranging from project acquisition to customer acceptance and ensures a common understanding of project inherent risks and uncertainties due to the involvement of project experts from different disciplines. Major part of effort is at the beginning, when setting the risks, updates are then less demanding while some of risks close during execution phase. In all phases, the project manager/head of the bid commission is the owner of the risk management process. Specialized, the effort may be delegated to the risk manager or a team of specialist that perform the risk assessments.

Risk Identification Step

A risk cannot be managed unless it is first identified. The first step in the iterative project risk management aims to identify all knowable risk to project objectives (see Figure 6). The fact that some risks are unknown or emergent requires the risk identification to be an iterative process. It is also important to achieve a full understanding of the present conditions in which the organization operates. A careful risk management framework must base on identification of the key risk factors inherent in each single investment, and the interdependencies among these factors [3]. Early risk identification enables key project decisions to take maximum account of risks inherent to the project. Also, as early as possible in the project lifecycle shall be documented the conditions and events that represent material threats to the organization's achievement of its objectives

or represent areas to exploit for competitive advantage.
One of the most common failings in the risk management process is for the risk identification step to identify incoherent issues or irrelevant aspects that are not risks [2]. Subsequent steps will tend to not close and maintain the confusion state, while risk management cannot be effective. It is therefore essential to ensure that risk identification identifies risks.

Fig. 6. Steps to DO in risk identification and risk management

There are two key requirements for effective risk identification: the first is a clear understanding of what is meant by the term 'risk'; the second is to be able to distinguish risks from non-risks, particularly from their causes and effects.
Not all risk can be identified from beginning. More, some are not quantifiable. Environment changes and the risks close during project lifecycle. A periodical, iterative risk identification preserve information to the required level. Risk identification should be defined in the Quality Plan, useful to repeat at major milestones. Additionally, iterative identification of risks has a low cost after a risk workshop was performed.
Project and the organization should provide the processes and the capability to invoke the identification of the risks. The project risk management process shall permit emergent risks to be identified and reported at any time, not limited to the risk identification events or the regular reviews.
Defined the aim of the project, the broad sources of risk should be taken into consideration. The event-risks should be corroborated with correlations and project environment conditions. It is necessary to determinate the contribution of each risk to the aggregate risk profile, and prioritizing accordingly.
Risk management process should identify the opportunities and maximize conditions to profitably achieve higher probability and higher impact.The risk identification process should take into account a broad range of project stakeholders to ensure that all perspectives are correctly represented. Limiting the identifications of risks to the immediate project team decrease chances to evaluate all knowable risks.
It should be the task of the risk identification to link the risks and opportunities to one

project objective (time, cost, quality, scope etc.). This implies that project was evaluated and project' objectives are clearly defined. When the risks relate with several objectives, it should be noted.

Risks statements should provide enough information so that any of team members is able to unambiguously describe. Single phrases as "resources" or "logistics" are inadequate.Each risk should be described to a level of detail that permits assignment to a single risk owner (one individual) with clear responsibility and accountability for its management. Moderator should aim to preserve the discussions neutral and unbiased.

After the risk analysis process is complete, it is necessary to compare the estimated risks against risk criteria which the organization has established. The risk criteria may include associated costs and benefits, legal requirements, socioeconomic and environmental factors, concerns of stakeholders etc. Risk evaluation therefore, is used to make decisions about the significance of risks to the organization and whether each specific risk should be accepted or treated.

Mitigations

Risk management shall advise on strategies to manage the risk. Because the project manager is the owner of the risks in the project, he/she will decide on the method of mitigation and the priorities.

When several risks are identified, each characterized by probability of occurrence and impact, the priority shall focus on the risks with high impact and high probability. Another method to mitigate risks is to derive a root cause of several risks and apply improvements there. This method would aim to decrease the probability/impact/ probability & impact of multiple risks that are related to root cause. At end, but not least, the risks may be ranked based on mitigation costs. It is easy to early approach the "low hanging fruits" – to mitigate the risks that own a low cost mitigation. In result, the total project risk amount defined as sum of identified risks (i.e., the product of the individual impact and the individual probability) decreases.

On the basis we understand and know project risks, there are several strategies to minimize the effect of risk: first, is to *avoiding the risk* itself by not performing the activities that imply this risk. This some-how goes to the cause of risk.An example would be to select projects with low risk, i.e., to perform activities/projects belowa known threshold. Still, from economic perspective this method is not always suitable; large project/organizationprofit margin implies risks.A second method aims to*reduce the negative effect of the risk*. This mitigation acts on the impact that may be monetary costs, delay or quality.But effective technical solutions are addressing both probability and impact.For an unknown risk value, i.e. the product of risk probability and impact, when the risk has a high predictability, i.e. we may estimate the range of risk impact, and low manageability – *transferring the risk* to another party is a good solution. An example includestaking insurance for transport ofcomponents. Pooling risks would be a good solution for*accepting some or all of the consequences* of a particular risk.

After successful mitigation, risks are represented based on residual probability vs. residual impact. Not all risk can be mitigated or make sense to mitigate. 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.

Risk management continues to evolve and to develop better strategies and practices for companies to achieve their objectives. New tools and techniques are available for corporate objectives, so, the transfer of risk has expanded beyond the insurance industry. Society development and trends have increased the demand for professionals who can provide expanded risk management services. On opposite side, over-control and suppressing risks can be as damaging to business interests as the lack of controls. *Risk management does not aim to eliminate risks, but focus to actively manage risks in a*

business context [9]. Mitigation and enhancement are the most widely applicable and widely used response strategies. Here, the approach is to identify actions that will decrease the probability and/or the impact of a threat, and increase the probability and/or the impact of an opportunity.

When collecting mitigation options to actively reduce project risks, the Risk Manager (or upon case the Project Manager) shall include the comprehensive description of mitigation including costs, responsibilities and due dates and the quantitative evaluation after successfully implemented mitigations as remaining risk. 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 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.

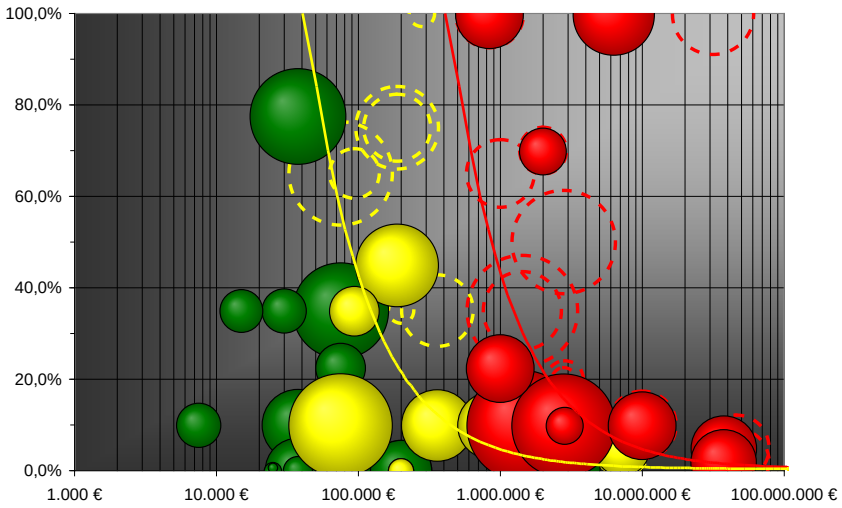

Fig. 7. Risk representation after mitigation

Evaluation and assessment of risks

Changes in the business environment, completion of the project, will continue to affect the risk situation inside projects. This is the reason for performing the risk analysis not only once but in iterative cycles along major milestones or delivery baselines for the customer project. To cope with the ever changing complexity of a long-term project and in order to measure stabilizing risk controls proactively over time, monitoring is recommended in continuous intervals. On the other hand performing the risk analysis ad hoc in a single analysis may be appropriate to quickly deep-dive into troubled projects to provide a neutral view of the project status.

The frequency of the monitoring activities depends on the projects risk exposure level and on the respective organizational unit's risk aversion/appetite.Continue development of the organizations leading to frequent internal changes. All these organizational changes mean that some old risks close, new risks will arise, and risks previously mitigated may again become a concern.

Thus, the risk management process is ongoing and evolving.

4 Conclusions

Project risk management is an essential and determinant step towards successful projects. All real risks that can affect one or more objectives of the project must be identified and managed.A detailed analysis and a precise definition of risk can lead to successful achievement of objectives. Risk management helps project organizations to achieve performance and profitability and at the same time prevents loss of resources. It provides a positive potential return on investment for organizational management, project stakeholders, project management, and team members and helps an entity get to where it wants to go and avoid pitfalls and surprises along the way.

Changes in the project management plan that result from the Project Risk Management process may require decisions at the appropriate level of management to reassign personnel, establish or modify budgets, make commitments to others outside the project, interact with regulators, and comply with the rules of accounting and law.

Project Risk Management should be conducted in compliance with these internal and external requirements. Project risk management should be conducted in a manner consistent with existing organizational practices and policies. It is a valuable component for any project management step and it adds value to all project management processes and provides benefits when it is implemented according to good practice principles and with organizational commitment to taking the decisions and performing actions in an open and unbiased manner.

Acknowledgments

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References

[1] H. Douglas,*How to Measure Anything: Finding the Value of Intangibles in Business*, John Wiley & Sons, 2007.

[2] D. Hillson, *When is a risk not a risk?*, Project Manager Today,January 2007 © Project Manager Today, 2007.

[3] R. Horwitz, *Hedge fund risk fundamentals: solving the risk management and transparency challenge*, Bloomberg Press Princeton, ISBN 1-57660-163-3, 2004.

[4] V. Kumar, N.Viswanadham, "A CBR-based Decision Support System framework for Construction Supply Chain Risk Management,"*Proceedings of the 3rd Annual IEEE Conference on Automation Science and Engineering*, Scottsdale, AZ, USA, Sept 22-25, 2007.

[5] PRM-PMI®,*Practice standard for Project Risk Management*, Project Management Institute, Inc, 2010.

[6] PMBOK® Guide – Fourth Edition, *A guide to the Project Management Body of Knowledge*, Project Management Institute, Inc, 2010.

[7] C. Smallman, "Knowledge Management as Risk Management: A Need for Open Governance?,"*Risk Management*, vol. 1, no. 4, pp. 7-20, 1999.

[8] D. Smith, M. Fischbachera, "The changing nature of risk and risk management: The challenge of borders, uncertainty and resilience,"*Risk Management*, vol. 11, pp. 1–12,2009.

[9] L. Spedding, A. Rose, *Business Risk Management Handbook*, Elsevier, ISBN: 978-0-7506-8174-2, 2008.

[10] G. Stoneburner, A. Goguen, A.Feringa,*Risk Management Guide for Information Technology Systems*, Recommendations of the National Institute of Standards and Technology, 2002.

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