Risk Management in Space Activities
Implementation, Execution and Evaluation of Risk Management

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Abstract

Risk management is the human activity which integrates recognition of risk, risk assessment, developing strategies to manage risk, and mitigation of risk using managerial resources. It is indissolubly connected with project management. Risk management must therefore be a disciplined process of risk identification, risk analysis, risk evaluation and the implementation of risk control that protects assets and/or resources from (financial) loss or restores these after a loss. It is the goal of the risk management process to enhance the viability and value of an organization under virtually all circumstances the organization may be subject to. When the risks are known, after having performed a risk analysis, they must be dealt with. In a risk management process, to reduce the known risks, control measures are identified and implemented into the project management. This paper describes the implementation, execution and evaluation of risk control measures in risk management processes that are used in planning space projects.

Keywords: *Space-Risk-Management-Control Measures*

Introduction

In earlier papers the questions of what a risk analysis consists of and how a risk analysis can be carried out were answered.[1, 2] However, risk management is more than just the execution of a risk analysis. More than often it all ends after the execution of the risk analysis. Managers may think that by having performed a risk analysis, the risks are under control. But after having identified the risks, they have to be dealt with (reduced) and they must be managed. And, as risks are not static phenomena, risk management must be a dynamic process. This is called the risk management process. In this process the risks are controlled by implementing and executing control measures and by evaluating these measures. The implementation of control measures into a risk management process consists of choosing the appropriate measures and to incorporate them in the project planning/management. The implementation of the risk management process into the project management has a number of aims such as to continuously make explicit and control risks, to deal with risks proactively instead of reactively, to deal with them consciously and to consider the accompanying control measures. The execution of control measures is the next step in the process and may vary from taking out insurance to creating bigger margins in the project. From this point in time a control measure can be considered to be a normal part of the project management. Inseparably connected to each risk management process is the evaluation of the control measures. Although in general risk management is a normal cyclic process that can be applied to all kind of projects, there are some differences in space related projects when compared to other projects. Because of the 'one way nature' of the space business – failing launch vehicles or satellites cannot be recalled to the factory for repairs – the margins are very small and risks should be reduced to almost zero.

Scope of paper

Risk management is a rapidly developing discipline and there are many and varied views and descriptions of what risk management involves, how it should be conducted and what it is for. But, risk management in projects is a necessity. This paper describes the implementation, execution and evaluation of risk control measures in risk management processes that are used in planning space projects.

Implementation of Risk Management

Knowing the risks and having chosen control measures to mitigate these risks does not automatically imply that all is under control. Risk control must be achieved by using a predetermined hierarchy of control measures in which its primary aim is to eliminate the risk. If this is not possible the risk must be minimised by using one or more of the other control options from the hierarchy. In doing so, the risk control measure selected must be the highest possible option within the control measure hierarchy to minimise the risk to the lowest level as reasonably practicable.

Implementation of risk management changes the way an organization operates and may very well create resistance. Project team members often are sceptically about risk analysis and can even be reluctant to cooperate. It is important to recognize such inhibitions and to make it a subject of discussion. A well tuned implementation of risk management can contribute to change inhibitions into cooperation. The implementation of risk management and the introduction of control measures must be custom made for each project. Each implementation is different and depends on the size of the project and project organization, the phase in which the project is, as well as the knowledge and experience in, and the culture of the project organization. Experience learns that the most important factors for success when implementing risk management are:

– Clear goals;
– Harmonisation of management style and organization for each phase of the project;

– Recognition of the culture of the project organization;
– The place of the risk management into the project organization;
– Adequate capacity to fulfil the (upcoming) tasks;
– Adequate knowledge and experience in risk management;
– External motives (e.g. compulsory reporting).

Implementation of risk management and risk control measures into a project organization is time consuming because learning to continually think about risks and the application of control measures all cost time. Also, people have to learn a new way of working and this means that risk management cannot be implemented overnight. The following enumeration is a core set of processes that are common to implementing a risk management practice. The processes are iterative and may overlap or even may be executed in parallel. The implementation of risk management is a project in itself and a number of phases or processes can be discerned. (See Table 1, Implementation of risk management as a project).

Initiation. Careful planning and oversight is required to ensure that risk management supports the goals and (strategic) objectives of the organization. It also ensures that the resources are effectively implemented into its architecture. First of all it must be determined which goals and objectives are set for the risk management process and what has to be ready at the end of the implementation. One must be aware that goals have a price. Those that offer greater certainty have a more significant cost, thus goals (and priorities) are the driving factor in decisions taken. The goal for the organization can be: "Develop resources to build competencies in effectively handling risk management issues that may occur." The main objective that follows could than be: "Improve the organization's ability to avoid, transfer, mitigate, and/or manage the risks associated with fulfilling its mission." Sub-objectives can be stated and developed such as maintaining and enhancing risk management related training opportunities; identify, update, and/or develop risk management-related tools and resources; and monitor and report on risks and risk management strategies. Every (sub) objective must have a defined way of achievement. If the objective is that all higher employees must complete a basic course in risk management, it should be stated that this objective must have been completed by a certain date and that the risk management staff provides quarterly reports regarding compliance for new employees. In setting the goals and objectives it is necessary to clearly define the results of the implementation of risk management and to define the boundaries of the project. E.g. if the goal mentions "develop resources", than those resources must be defined in terms of time and costs. It is also important to set boundaries for the project so one will not loose itself in all kinds of side steps. It must be determined up front what will be taken into account and what not.

Definition. This phase involves the identification of the requirements the risk management process must meet. This not only concerns the desired result of the process, but also applies for the level of detail, the completeness and the correct operation procedures as well. Then it has to be determined whether these requirements are achievable and not mutually conflicting. In this phase it is also determined which resources or specialized tools are necessary for the implementation of the risk management process and what requirements these must meet.

Design. The design phase involves converting the requirements identified during the initiation and definition phases into specifications. Risk management process designs can be developed in various ways using top-down or bottom-up approaches in which programme components and interfaces are identified and linked. Contemporary design techniques often use prototyping tools that build mock-up designs. When using prototyping tools, risk management staff should be diligent to develop automated controls. Prototyping often enhances an organization's ability to design, test, and establish controls, but employees may be inclined to resist adding additional controls, even though they are needed. The list of requirements that is developed in the definition phase can be used to make design choices. In the design phase, one or more designs are developed, with which the project result can apparently be achieved. Depending on the subject of the project, the products of the design phase can include all kind of presentation material (sketches, flow charts, site trees, HTML screen designs, prototypes, photo impressions, etc.). The programme management staff uses these designs to choose the final design that will be used in the project. The design preferably has the form of a specification of the requirements. In this phase, also the identified tools must be developed if they are not readily available.

Preparation. In this phase a plan or scenario will be drawn up and people (risk management assistants) are trained. The preparation phase involves converting design specifications into executable programmes. Effective development standards include requirements that project participants can discuss before the programming begins. Such procedures help ensure that staff clearly understands program designs and functional requirements. Now is the time to acquire and test the necessary tools. These tools could range from simple forms to be filled in to support the communication process, to custom made computer programmes.

Realization. This is the de facto implementation of the risk management. All that has been prepared earlier is executed and the tools are brought into use. At this stage, resources are employed as the programme gets underway. In terms of project management, the biggest weaknesses now will be the management and control systems. At this stage, ideally, the programme must contain reactive mitigating activities for particular identified risks together with triggers for contingency plans. Any modifications arising from the earlier phases, e.g. design, can have a detrimental affect in this phase and

this could result not only in time delays but will almost certainly increase project management costs. It is important to plan for enough time for this phase because almost always there will be initial problems and measures that will work counterproductive. Experience learns that in big projects the realization phase can require up to a year. Advanced insight might demand adaptation of the earlier formulated requirements. This certainly will have its toll on the time management of the project, but a fault confessed is half redressed. Last but not least, in this phase the preservation of the risk management programme must be secured by preparing the final phase.

Aftercare. In this final phase risk management is used and utilized within the project organization. The control and maintenance of the risk management programme takes place as well in this phase. Furthermore, evaluation of the risk management programme determines whether the goals and/or (sub) objectives are met and whether some fine tuning is necessary. Recording and reporting of the lessons learned is very important to preserve the gained knowledge for future use.

Execution of Risk Management
With the implementation of risk management in a project the goals, (sub) objectives and expected results are determined and certain issues can be distinguished. First of all the risks have to be made continuously explicit and controllable. By identifying and naming risks they become tangible. In this way 'assumed different risks' in the minds of project managers can turn into uniform risks and everybody involved will have a similar view of the most important risks in the project. This enhances the awareness of risks in the project organization. When project managers envision the same risks, they are willing to go for the common goal, which makes those risks more controllable. Secondly it is essential that risks are dealt with proactively and not reactively. In this way control measures can be implemented before the risks even manifest themselves. Thirdly it is necessary to deal with risks consciously. By performing a risk analysis, risks and control measures should not be dealt with arbitrarily but in a structural way. This provides a more complete picture of the risks for the project and lessens the chance for project blindness. Deterioration of a well-planned risk management process during execution often has its origins traced back to how the project was managed. It is advised to continuously have in mind the goals and objectives that were determined during the risk management implementation phase. A crucial project initiation step is identifying and understanding the goals and objectives of the project. Problems can arise when those goals and objectives are not revisited during execution to determine whether they remain valid and accurate.

The execution of risk management deals with a number of factors that need to be clear to everyone involved. These factors are time/capacity, money, quality, information and organization[3]. (See Table 2. The execution factors of risk management).

Time/capacity. It is necessary to decide how much time as well as capacity within the project may be attributed to risk management. Besides, it is advisable to devise a project planning for the risk management process. This means that it is determined up-front when risks and control measures are discussed and when they are reported. The frequency of these discussions and reports are determined by the length and dynamics of the process. Usually, the shorter the process, the higher the frequency of rapports. This frequency must be optimised for each specific process. Moreover, it is important that the need for reports is keyed to the demand for reports. Need and demand seldom match.

Money. Costs and revenues of risk management must be made visible in such a way that it can be determined whether these will fit into the available budget. These costs and revenues are different for all processes. Possible costs are e.g. (additional) personnel that must be found internally or contracted externally, development of tools and training of personnel. Possible revenues are e.g. less unexpected setbacks and less insurance premiums. Of course it has to be determined whether the balanced costs/revenues will fit the budget for risk management and how they are controlled during the whole process.

Quality. From the beginning it has to be decided what the needed quality in terms of completeness, personnel, etc. of the risk management must be. When done, it has to be determined how this quality can be guaranteed by checking at certain times, evaluations and/or audits. For example, if there is not enough qualified personnel, then it must either be trained or drawn in from outside the organisation.

Information. A very important element within the risk management process is the information and reporting process. Different levels within an organisation need different information from the risk management process. By defining the information streams about risks, everyone on each level will receive the information necessary to control their project (part). Reporting should address the risk control methods for which the project management is responsible, the processes used to identify risks and how these processes are addressed by the risk management system, the primary control measures that are used and the results of the monitoring and review system. Any significant deficiencies uncovered by the system, or in the system itself, should be reported together with steps taken to deal with them[4]. Numerous (automated) risk management information systems have been devised and brought onto the market. The one more fancy then the other; they all promise the ultimate solution. Care should be taken when considering the investment in such systems. Too much information is not good for the project management, they may drown in it; too few information is not good either, they may grave for it. The following considers the information distribution and risk reporting.

When time/capacity, money, quality, information and organization are being scrutinized, the risks of the project must also be looked at. This is especially impor-

tant when phase changes are due, but also during the evolvement of a phase. The moments when explicit attention is given to project control, e.g. during monthly reporting sessions, are the moments to report about risks. By planning the stream of information about risks in the project well, stakeholders at all levels will get the information that is necessary for their involvement at their specific place. Planning this way means that information must be filtered upstream (top management needs information that they can use to make decisions) and freedom of action must be granted downstream (executive management needs information to regulate the process). Not only has risk management its own place within the organization, the information process also must fit in the information management process of the organization. It is best when informing and reporting about risks can be coupled into the existing reporting structure within the project. When reporting, the following information is mandatory:

– Description of the risk;
– Description of the causes of the risk;
– Description of the consequences of the risk for time/capacity, money, quality, information and/or organization;
– Assessment of the chance of the risk actually occurring
– Assessment of the damage when the risk occurs;
– Possible control measures and which measure(s) have been chosen;
– Personnel responsible for the risk;
– Personnel responsible for executing the control measure(s).

Very important is that something actually will be done with the reporting and that there is a follow-up with earlier reports. Questions that should be asked are: "Why are certain risks not mentioned anymore? Have they disappeared and is that because of the control measures or otherwise?" If the same risk is mentioned as in an earlier report, one should ask whether the control measures were not effective (enough).

When controlling risks and control measures and reporting about them, use can be made from different tools; from simple report tables to automated risk databases. Information in such tools is almost always the same and will in principle contain the following information (An example of reporting with the use of a table is depicted in table 3, Reporting risks in the information process.):

– Description of the risk;
– Causes;
– Results;
– Control measures.

Risk databases have been developed for risk management systems and vary between basic with little data to very complicated. (See figure 1. Print Report page from a Risk Database).

Organization. Important principles when organizing risk management are:

– The risk management process must fit in the current method of work;

– The risk management process must follow authority;
– The risk management process becomes the responsibility of each and every project team member.

Risk management has to fit in with the existing method of working in a project. Reporting on risks and control measures has to be done at the same level and time as other reporting in the project. Risk management follows authority means that the responsibility for a risk must be institutionalized where the responsibility for the work is situated. In other words: every project leader and every project team member is responsible for signalling risks and for taking measures within his scope of normal work responsibility. The third principle is pivotal for the successful implementation of risk management. By making the project team members responsible for the execution of risk management – this responsibility cannot be transferred to others – they are committed to the project and the success of it.

Evaluation of Risk Management

It is also necessary to look at the state of affairs of the control measures. Are the measures being executed and have they the desired effect? Activities that have to be carried out are the monitoring of control measures and the assessment of their effects. In this process the following questions should be asked:

– What is the probable cause if desired effects have not been achieved?
– Is the frequency of consultation to satisfaction?
– Is it necessary to adapt the current information and reporting facilities?
– Has the information needed been communicated?
– Have the responsibilities and authorities been assigned correctly?

After evaluation of the control measures the cycle is completed and the risk analysis can be updated. This update of the risk analysis is sometimes necessary because the evaluation leads to an update of the risks. Risks will change because of the implemented control measures; they may diminish or even disappear completely, other risks may become higher because of wrong or failing control measures.

Conclusions

Risk management is more than just the execution of a risk analysis. It needs follow-up by implementing it into the regular project planning. By correct implementation, execution and evaluation of risk management and its accompanying control measures, the total cycle of good risk management in the project guarantees better results.

**Table 1 – Implementation of risk management as a project**

Phase	Description
Initiation	Determine the goals (necessary/useful)
	Determine the results (when and what)
	Set the project boundaries
Definition	Determine the requirements the risk management must meet
	Determine whether these demands are achievable and non-conflicting
Design	Think up how the risk management should fit into the project management
	Design the necessary tools
Preparation	Draw up the scenario of the implementation
	Train risk management assistants
	Acquire and test the tools
Realization	Implement/bring into use the risk management
	Put the tools into use
	Draw up an aftercare plan
Aftercare	Use/execute risk management
	Adapt risk management when necessary
	Record and report lessons learned

Table 2 – The execution factors of risk management

Factors	Explanation
Time/capacity	Lay down the necessary/available capacity to execute risk management
	Decide at what moments risks and control measures are discussed
Money	Determine the costs and revenues of risk management
	Establish whether the costs fit within the available budget
Quality	Lay down the mandatory quality of risk management
	Ascertain how this quality can be guaranteed
Information	Prescribe the way how risks are recorded and reported
	Stipulate who gets what kind of information about risks
Organization	Define the necessary organisation to execute risk management

Table 3 – Reporting risks in the information process

Risks	Control Measures	Responsible Staff	Date Finished	Status
Risk 1				
Risk 2				
Risk 3				
Risk 4				
Risk 5				
Risk 6				
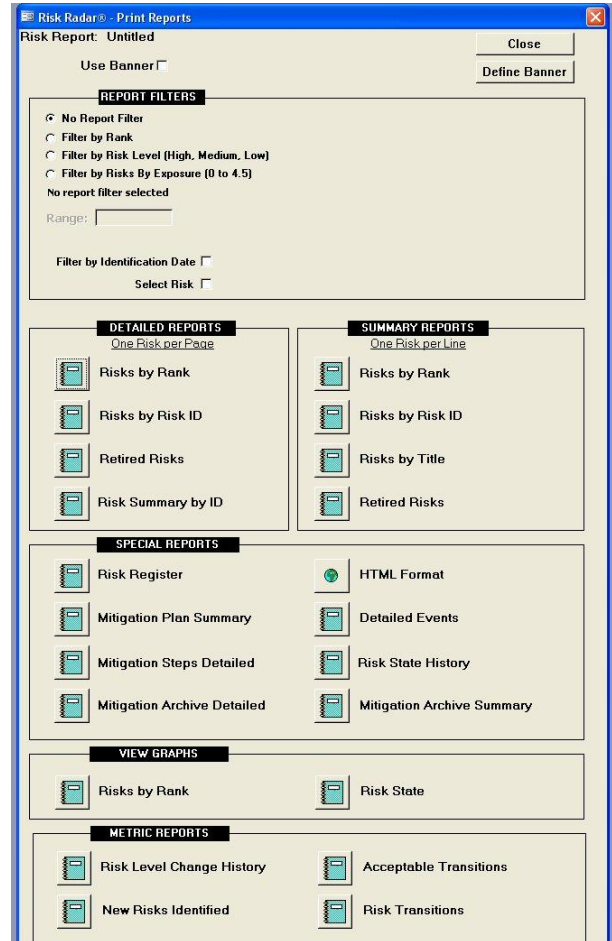
Fig. 1 Print Report page from a Risk Database [Source: Risk Radar]

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