POLITECNICO DI TORINO

Master of Science in Engineering and Management

Thesis Title

Assessing of Project Risk Management

With

(RiskyProject Professional 7 - Project Risk Management Software)

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2018/2019

Acknowledgment

Dedicated to "GOD" who has created the world, human, reason, science, knowledge, and love.

My very profound gratitude goes out to my parents, who their heavenly souls are calming my heart. My father, my perennials supporter; and my mother, the most inspirational person of my life. Words fail to express my wholehearted thanks to them regarding their boundless kindness.

I am also grateful for the kind and compassionate heart of my husband, who has been a great companion for me.

Besides, thanks to my beloved son, whose sweet smile helped me to overcome the fatigue.

This journey could not be feasible without the emotional support of my lovely family (my sibling) and all of the people who have assisted me along with this project.

My sincere gratitude goes to my honorable supervisor, "ALBERTO DE MARCO."
Absolutely, his devoted time and contributed ideas made my work productive and stimulating.

I wish them lifelong health and happiness.

Abstract

Any project faces opportunities and risks during its lifetime (from the beginning to the end of its life and reaching its goals). Risks are the factors that can create disorder in the implementation of the project and cause it to fail. To avoid these risks, risk management is essential.

Risk management steps are referred to as the process of identifying, analyzing, and responding to risk factors that may occur in the lifetime of a project. If risk management is done correctly, it can prevent potential hazards by controlling future events.

This issue becomes more significant when faced with a large, long-term project. It is not possible to identify, calculate, analyze, and control risks in a traditional way, and it is better to facilitate and speed up the project risk management using existing advanced tools. Risk management is inevitable. Even in non-organized projects, risk management is done in an unsystematic, intuitive way. What's essential is to systematize risk management with the most favorable outcomes of implementing risk management. The classic project management method is not able to deal with complex projects. In this regard, we are considering introducing and reviewing software designed for this purpose.

INTAVER INSTITUE designed a software for doing the process of management of risks which is name is RiskyProject. The RiskyProject is a complete portfolio of project risk analysis and project risk management software for use independent or integrates with Microsoft Project, Primavera, and other planning tools. RiskyProject includes quantitative and qualitative analysis by the Monte Carlo method.

Risk analysis helps determine how uncertainty in project work and resources affects the scope, results, cost, duration, and other parameters of the project. Project risk analysis also assesses the tasks and resources of the project based on its own risk, calculates the entire project at risk, and determines the effectiveness of risk mitigation and response measures. Cost and planning risk analysis can be integrated and implemented using a high-performance Monte Carlo simulation engine.

Contents

List of Figures & Tables

1. Introduction:

Risk phrase based on the PMBOK project management standard may have a negative meaning in different languages, while in the project management literature it means uncertain future events that can be an opportunity or a threat to the project.

If the opportunities and threats abandoned, many of the problems that could be eliminated at a reduced cost or focus would be lost, and valuable opportunities that could have benefited would be eliminated. Therefore, there should be some measures to attract and repel them.

According to the PMBOK project management standard, the first step is to determine the risk management methodology. After that, they must identify the risks and, after the analysis, select the most critical risks. It then turns out what should be done to control the significant risks, and the results of this section are usually included in other programs such as time and cost. In the end, we need to measure the consequences of these actions to be modified in the form of change requests in the event of a deviation.

PMBOK also introduces risk management with management planning. The risk management program, like all other management programs, will determine what action will be taken in this area. In addition to methodology, risk-based roles and responsibilities should be identified, and parameters that will be used for risk identification and analysis in the future. After the risk management planning process, we must recognize the risks at appropriate times and with the proper tools, and a way to improve that stage is to consider a hierarchical structure for risks. This collection is called the risk breakdown structure (RBS). Therefore, by doing, the risk of management risk's failure and controlling them will be more comfortable. If a Risk Breakdown Structure is to be used, it should be developed at planning time. Clearly, at the identification stage, modifications to the RBS may be proposed.

In the next steps, you should determine the extent of the impact and the probability of occurrence of the risks. Quantitative or qualitative values characterize these two parameters, and these values should also be defined at the planning stage. For example, if we want to identify the likelihood of occurrence with terms such as low, medium, and high, in the planning stage, we need to define these three terms clearly and conclusively that in the future do not get into trouble.

In the risk management methodology, after the planning phase has identified, the remained of risk management activities can be based on the PMBOK standard with the process of identifying risks. In this process, all uncertain events that may happen in the future, and the positive or negative impact on the project should be identified. It should involve all stakeholders in risk identification. Many of the risks are discovered after the initial planning and during the work, and therefore, this process should be re-launched as needed.

You must show the risks, descriptions, and specifications, also the probability of occurrence and the extent of the risks in this document. It is usually better to measure the extent of the impact of risks in terms of time, cost, and quality.

After identifying the risks according to the PMBOK standard, they should be analyzed from both quantitative and qualitative dimensions. In the process of qualitative risk analysis, the goal is to select essential risks for risk response planning.

Usually, the number of identified risks is very high, so only the most critical risks are selected, and only the reaction plan designed for these risks.

The criterion for determining the importance of risks is the combination of the probability of occurrence and the magnitude of their impacts. The weighted average of these two criteria could be based on the determination of importance, and the risks of the greatest weighted were passed into the process of risk response planning.

But in quantitative analysis, it is a more advanced type of risk analysis that requires more energy, cost, and time. If the quantitative risk analysis process is selected in the risk management program, then the significant risks selected in the qualitative analysis are analyzed numerically and their combined impact on the time, cost, and other parameters of the project before applying for the program.

After this, the process of risk response planning is done. The risk situation changes after planning for the response to risks. At the same time, a quantitative analysis should be performed to determine that the planned responses will have done on the whole project? And in other words, planning has been effective?

Quantitative analysis is done in a variety of ways. Once significant risks have been identified by quantitative and qualitative analysis, they should be programmed in the risk management plan, according to the PMBOK standard. If we know something may happen in the future, and it has a significant impact on the project, what are we going to do? The answer to this question sets out the risk response plan.

The vital thing to stay in the end is that every task should be responsible. As well as being responsible for any of the project's activities, it should be responsible for each of the risks. This person should follow the implementation of the risk response program and also, measure everything related to that risk.

2. Principles and Concepts and Project risk management processes

2.1 What is risk management?

Risk management steps are referred to as the process of identifying, analyzing, and responding to risk factors that may occur in the lifetime of a project. If risk management is done correctly, it can prevent potential hazards by controlling future events.

2.2 Risk management systems

In addition to identifying risks and determining their quality, Risk management systems can predict the impacts on the project. Acceptance or non-acceptance of risk usually depends on the level of tolerance of the project manager.

If risk management is carried out regularly to identify potential problems and find solutions to them, it will efficiently complete other processes, including organization, planning, budgeting, and cost control. The project manager who pioneered this can primarily prevent unexpected events during the life of the project.

2.3 Emergency program

A program in which team members work on problem-solving. The final result is a plan that will provide the exact moment of risk. The goal the project team is trying to achieve is the ability to cope with obstacles and constraints that prevent project work (due to time or budget completion) to be successful. The emergency plan assures the team that if they are faced with problems in the forefront, they can quickly find a solution to it and continue to work without problems.

2.4 Why is risk management done?

The value of an organization is maximized when the manager can apply appropriate strategies and goals to balance the goals of growth and income and related risks and build the organization's resources to overcome the risks or to strengthen their effects. Therefore, the scope of organizational risk management objectives will include:

- Identification of organizational risks and its implications for determining the organization's strategies (internal and external analysis stage).
- Determining the precautionary approach to risk management involves accepting, avoiding, reducing, and sharing
- Reduce the costs of neglecting the business of the organization by identifying the risks ahead and eliminating and reducing their risks.
- Increasing the Opportunity by identifying the upcoming events for the organization and utilizing its benefits

- Optimal use of capital by its optimal allocation in different domains due to their risk-taking

Organizational risk management makes it possible for the senior manager of an organization to ensure that the activities of the organization comply with the rules and regulations and to avoid the destruction of the reputation and brand of the organization. As a summing up, it can be said that organizational risk management enables the company to move in the specified direction and achieve the prospect without any events, changes, and uncertainties that can be prevented.

2.5 How is risk management done?

For risk management, you must first consider all the different sources of risk. There are so many resources, and you cannot quickly get a comprehensive list of them. But this list can be a necessary mentality for the project team, so it can be used to identify a large part of the potential risks in the project.

2.6 Project risk management processes

The risk analysis process is mainly referred to as the problem-solving process. The quality and evaluation tools are used to determine and prioritize risks to evaluate and address them. The risk analysis process is as follows.

Risk management is an innate part of the success of a project, and it is a process that helps early identify potential problems and, as a result, take the necessary steps to prevent them from transforming them into real issues and challenges in the future of the project. This section examines the process of risk management.

The risk management process has five stages:

1- Planning
2- Identification
3- Evaluation
4- Management
5- Monitoring and reporting.

There is an overview of project risk management steps, according to PMBOK in the below figure:

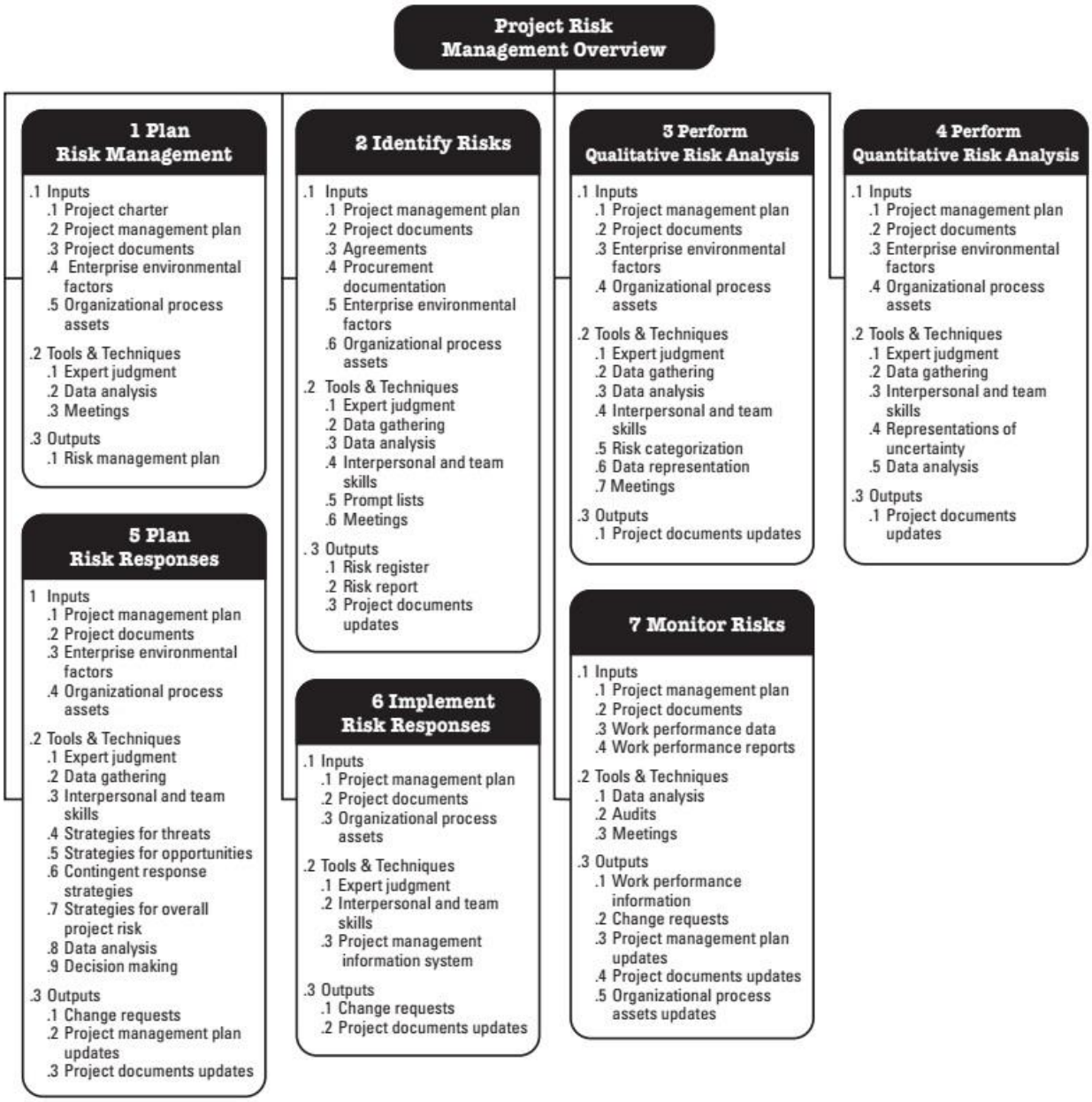


Figure 2.1 – Project Risk Management Overview

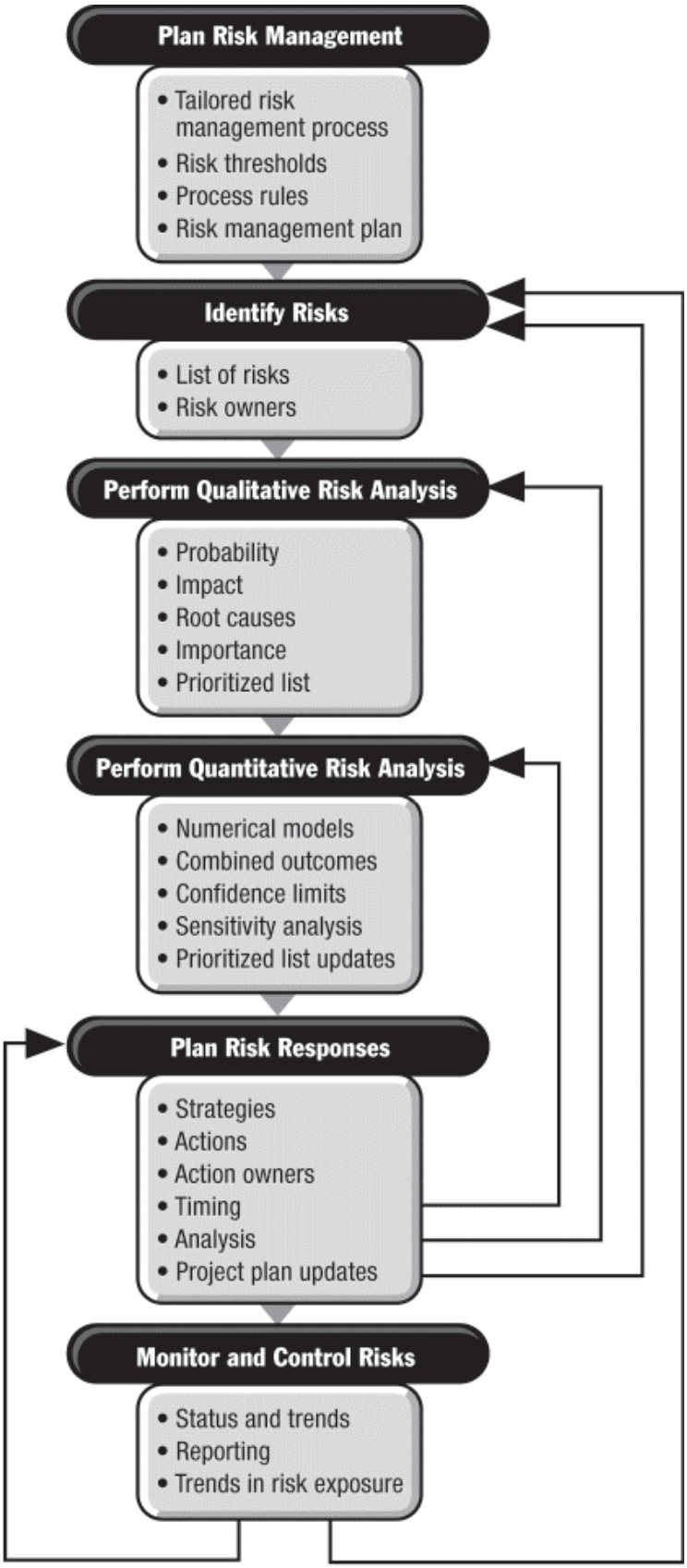


Figure 2.2 - Project Risk Management Process Flow Diagram

2.6.1 Planning

Planning is a step in which the management of potential risks in the project is identified and completed by developing a risk management plan for the project. The plan defines a risk management team, describes the roles and responsibilities of individuals, and documents the criteria for assessing identified risks.

Risk assessment and management is the best way to deal with disasters in the project. By evaluating the program for potential problems and strategies to eliminate them, the team's chances of success will improve. With proper management, higher priority risks are identified, and their likely costs incurred during the project implementation will be managed.

2.6.2 Identification

The second step is identifying risks. At this point, the teams gather together, identify potential risks, and record them in the project risk list. Risks can exist in a variety of ways, such as the production process, the use of tools, workflows, plans, budgets, etc., as well as from experiences and lessons learned from past projects.

Arranging haphazard group meetings is an excellent way to identify risks. This will force people to think and allow them to develop their thoughts and experiences, and it should be remembered that identifying risks does not end in just one meeting, because new and different risks over the lifetime of a project come on. It is better to determine the risk if the phrase "if" - "then" is used: if this is the case, then its consequences will be. The use of such an expression explicitly explains and explains the risk and standardizes our way of expressing it.

At this stage, all potential risks are identified by reviewing a list of potential hazard sources as well as the experiences of the project team and their knowledge;

These risks should be categorized and prioritized by using a measurement tool. The number of risks usually exceeds the time spent by the project team for analyzing them and designing an emergency plan. The prioritization process helps them manage the risks that are both more effective and likely to occur.

2.6.3 Different sources of risk include:

The part that relates to project management

- The senior director does not recognize the activity like a project;
- Many projects are underway simultaneously;
- Program commitments are impossible;
- There is no practical input at the planning stage;

- No one is responsible for the overall implementation of the project;
- Poorly controlled design changes;
- Poor control of customer changes;
- Poor understanding of the work of the project manager;
- Invalid appointment of the project manager;
- Lack of planning and integrated project control;
- The organization is unable to provide resources;
- Project planning is not realistic;
- Failure to process project costs;
- Conflict in project priorities;
- Office of the poor organization of the project.

External resources

1. Unpredictable foreign sources
    - Unpredictable legal requirements;
    - Natural disaster
    - Sabotage, decay and unpredictable side effects.
2. Expected foreign sources
    - Market risk or operational risk
    - Social risk
    - Environmental risk
    - Inflation
    - Exchange rate fluctuations
    - Media
3. Technical external resources
    - Technological changes
    - The risks of the design process.
4. Legal external resources
    - Violation of trademarks and permissions
    - Complaint for breach of contract
    - Worker or workplace problems
    - Litigation due to civil liability law
    - Legislation

2.6.4 Assessment

The third step is to assess the identified risks using the criteria defined in the risk management plan. Risks should be evaluated based on the probability of occurrence and possible consequences. It is imperative to assess the risk implications in terms of cost, planning, and technique, and the

choice of the outcome that can have the most significant impact. For example, an assessment of a cost-risk risk may indicate a low impact on the project, while this evaluation in terms of planning may indicate its high impact on the project, then it should consider a high level of risk in plan. This step has two dimensions of analysis: qualitative risk analysis and quantitative analysis of the risk which will be reviewed separately.

The traditional solution to problems is that it moves from identifying the problem to its solution. However, before doing the best job of determining how risk management is best done, the root causes of the identified risks must first be identified. In this regard, the following questions may be raised to the project team:

- What are the reasons for these risks?
- How can these risks affect the project?

2.6.5 Manage or risk response planning

Now the team is ready to start the process of examining possible solutions for risk management or preventing its possible occurrence. The project team may ask the following questions:

- What should be done to reduce the risk of these risks?
- How can it be managed in the event of a risk?

Establishing an emergency plan or preventive measures for risk:

The project team will get a response to the tasks that are set to reduce or eliminate the impact of a risk. The tasks assigned to risk management become short-term emergency plans. When the risk occurs, these programs come to life and run fast. If implemented in time, these programs will not require risk management. For the step of planning, we can use the MsProject or primavera or use directly from RiskyProject software that we will describe it to continue.

The fourth step is managing the risk management process.

There are four ways to handle risks:

- **Mitigate:** Which means creating operational plans to reduce the risk and consequences of it or reducing the expected financial value of risk by reducing its possible occurrence;
- **Avoidance:** Which means changing something to avoid risk, for example, making a change to the plan to prevent a risk of eliminating a particular risk or threat by removing its cause;
- **Assignment or transfer:** Which means transferring and assigning risk to another group (for example, purchasing insurance).
- **Acceptance:** This method accepts the risk of risk without making plans. This can occur because of this fact that the cost of downsizing schemes is higher than that of covering potential

risk costs or acceptance of the consequences of risk; this is often done through the development of an emergency plan for an event that may occur.

Together reduction plans are the most common way to reduce risk. Revision of the reduction plans is necessary to ensure that there is no new risk as a result of the implementation of these plans if any risks associated with declining programs are to be added to the risk list for assessment by the management team.

2.6.6 Monitoring and reporting

The fifth stage involves tracking and reporting, which can ensure the effective functioning of management programs. To doing this, risk should be evaluated and re-evaluated during the completion of the risk management process, to be aware of its probability. While risks may not be eliminated, it is necessary to reduce to an acceptable level. Even low risks should be controlled so that they can be kept low.

Risks in a project should be included in the risk management report. The report should contain a list of identified risks, management plans for risk reduction, and risk matrix to classify them into three categories: high, medium, and low.

Risk management is a continuous process.

Risk management not only at the beginning of the project, which should be carried out throughout the life of the project. For example, if the duration of the estimated project is three months, the risk assessment should be at least at the end of the first month and the end of the second month. At each stage of the project life, new risks should be assessed and managed after identifying and determining the quality.

After the project team identified all possible risks that might endanger the success of the project, now they have to select the risks that are more likely to occur. This choice should be based on past experiences, and lessons learned current information and the like.

There is usually a lot of risk at the beginning of a project, and the sooner the project goes, it gets closer to those risks. Therefore, risk management should start from the start of the project and go ahead with the project.

An important point here is that in general, the opportunity and risk remain relatively high during project planning (the beginning of the life cycle of the project). But because the amount of investment in this phase is low, the amount of financial risk will be small. In contrast, during the implementation of the project, the level of risk gradually reaches its lowest level, as ambiguous issues will be identified. But as the investment resources required to complete the projected increase, the level of financial risk also increases.

2.7 Benefits of risk management

Risk management is a critical task that can be beneficial if initiated early on in a project and is a powerful tool for early identification of weaknesses so that the management team can organize operational programs to manage risks and turn them into a big issue in the future. And thus your defensive response to potential problems, rather than responding to future challenges and issues, can save your money and time.

These processes are interacting with each other and with operations in other areas of knowledge. Usually, each process occurs at least once per project. In continue, there is an overview of each of these processes and features that the software provides to us in each section, along with the results.

3. Plan risk management

Risk management is the basis of all risk management efforts and covers all its stages, including deciding how to get started, determining who is involved, the time of risk management activities during the life cycle of the project management, and their frequency.

For the risk management process to proceed faster and provide a clear picture of project risks, it is necessary to think of how to complete it before the start.

The objectives of this phase of the risk management process are:

1. Create a program to implement risk management in a specific project

2. Setting policies and procedures for risk management based on project needs

3. Adapting the risk management activities to the needs of the project to ensure the appropriateness of the level, type, and clarity of what has been done, with the following:

- The nature of the project
- Project team experiences
- The importance of the project for the organization
- Tangible level of project risk

In other words, decide on what is needed for the project and use company procedures, but never spend too much time and energy to manage project risk. The threads in this step are all the same as inputs of risk management.

Planning processes generate a large number of applications (management products) that may be presented in the form of a document, but anyway, these concepts should exist. In this process, we compile a specific group of management products that play a crucial role in project implementation and control and other processes and are maintained and presented as a package called the project management program. The project management program includes management plans and baselines. Each area of knowledge has a management program, and some areas are more than a management plan: - Change Management Program - Communications Management Program - Configuration Management Program - Cost Management Program - Human Resources Management Program - Logistics Management Program - Process Improvement Program - Quality Management Program - Requirements Management Plan - Risk Management Program - Schedule Management Program - Baseline Stakeholder Management Program is another part of the project management program: - TimeLine - Cost Line –

Processes that directly send their output to this process:

- Stakeholder Engagement Control

- Managing stakeholder management
- Control Procurements
- Conduct Procurements
- Control Risks
- Planning Risk Responses
- Control Communications
- Manage Communications
- Project Management Team
- Project Acquire Project Team
- Quality control
- Quality assurance
- Determine Budget
- Preparing a Schedule
- Control Scope
- Provide Work Breakdown Structure (Create WBS)
- Integrated Change Control
- Monitor and Control Project Work
- Project Management
- Draft Project Charter

Processes that directly use the output of this process:

- Stakeholder Engagement Control
- Stakeholder Management Plan
- Close Procurements
- Control Procurements
- Planning Procurement Management
- Control Risks
- Risk Management Planning
- Control Communications
- Plan Communications Management
- Planning Human Resource Management
- Quality control
- Plan Quality Management
- Cost Control
- Cost Management Planning
- Schedule control
- Plan Schedule Management
- Control Scope

- Plan Scope Management
- Project or Phase Completion
- Integrated Change Control
- Monitor and Control Project Work
- Project Management

3.1 Risk management inputs

Risk management inputs are the work to be done or the information that must be collected before the risk management process begins to complete the process. Perhaps, It is important to note that, to carry out quick and effective risk management, all prerequisites must be provided and made available before the start of the work. Without essential inputs, some of the risks will remain unknown.

3.2 Persons involved in the project

Sometimes, for project risk management, only the project team's cooperation-as individuals-is enough. Depending on the intricacy of the project in some cases, all stakeholders may also be involved in risk management.

The project manager usually does risk management planning, but in this case, it can also use advice from members of the project team and the project office (a formal structure that supports project management within the organization).

Adherence to policies and procedures and the implementation of risk management activities with project needs is an essential requirement.

One of the top reasons for project failures is that project managers do not set up the project management process based on the specific needs of the project. They use the same forms, processes, and management practices in all projects so that even the intervals of periodic sessions are the same in all projects.

Projects are different, and each project is unique and non-repetitive. Therefore, each project needs to be managed in a way that is different from other projects. If the project has a high priority for the organization, then project management activities need to be more comprehensive than the conditions for which the project has a lower priority. Also, if no similar projects have been carried out in the organization so far, it will be necessary to spend more time on risk management compared to a variety of projects implemented by the organization.

3.3 Risk management planning processes

Before starting a risk management process (or any other area of management), first of all, a roadmap must be drawn up for the whole process so that the project team members are not confused during the implementation of the process (or, in other words, what they are going to do and seeks to achieve). The development of this road map is called "risk planning," and its output is called "risk program." The risk program is, in fact, the project team manifesto and their approach to project risks.

An overview of project risk management (risk, risk management, risk management planning) recommended the steps to complete risk management planning are:

- Check the current procedures for risk management, and experience gained and available historical records.
- Determine which methods you will use to identify the risks of the current project (methodology).
- Recognize the responsibilities of those involved in risk management (roles and responsibilities).
- Determine how much risk management activities (budget).
- Identify the time of execution of risk management activities during the life cycle of the project (period).
- Identify the methods you will use to qualify and quantify the risks (scoring and commentary).
- Specify how you can identify which one of the risks is to be addressed (thresholds).
- Determine how to document, analyze, and transfer risks to project team members, other stakeholders, project sponsors, etc. (reporting templates).
- Describe how to maintain and track the risk records for use in future projects (follow up).

3.3.1 Definition

First, we need to provide a formal and relevant description of the project at the beginning of the project risk planning. This definition can vary from project to project. So, the first step in planning the risk of each project is to explain adequately to the nature and objectives of the project. For example, a definition of project risk can be as follows:

"any event that probably harms the capabilities of the project to achieve its defined goals."

The reverse word reflects the general approach of project managers to the concept of risk. It means the nature of the project is that its managers are only trying to manage its negative risks.

3.3.2 Categories

In this section, we identify different types of concepts for ease in future classifications. These categories should be based on the location of the risks. Each of these categories can be one of the project areas that can take risks during the life cycle of the project.

- Customer requirements
- Benefits
- Project schedule
- Budget
- Delivery times
- Project issues
- Scope of the project
- Suppliers
- Acceptance
- Communication
- Resources

3.3.3 Preparation of risk information worksheet

The general framework of risk information worksheets

The risk information sheet contains information about the risk profile. Information that completes the risk or updates the details. An example of information is:

- Risk identifier
- Risk description
- Condition
- Cause of risk
- Possibility
- Effects on any of the goals
- Risk rating
- Response strategies
- Likely to be reviewed
- Revised effect
- Revised rating
- Responsible department
- Actions
- Secondary risks
- The risk remains

- Precautions
- A precautionary time or cost savings
- Repeat programs
- Suggestions

All projects do not require this level of detail. The template should be adapted if necessary to meet the project's requirements.

3.4 Risk management software

Although risk management is a human-centered process, today, to optimize planning and prevent duplication of processes, especially in complex and large projects, it is best to pursue related software to risk management. When a project is programmed and guided from the beginning by existing software, it is possible to track the progress of projects and the strengths and weaknesses of a project that can be tracked and identified in the software. The next projects are as effective as possible. Falling down the error and making a unique template for the projects. The most valuable asset is risk management, ideas, and information that is processed by humans, but the recording, maintenance, and control of it by humans are tedious and sometimes impossible. You must first realize what needs to be done for project management and risk. Then, according to these findings, we use software for risk management or project management. Some of the available risk management software are as follow:

- Active Risk Manager (SWORD)
- Optial
- Parapet
- Orcanos ALM 2.0
- StandardFusion
- Fraud.net
- Purpose-built (Essential ERM)
- Beakon
- MetrikStream
- RiskyProject (INTAVER)

Figure 3.1 – The Logos of Risk Management Software

3.4.1 What is RiskyProject? [9]

RiskyProject is an advanced project risk management software with integrated risk analysis. Most projects contain many uncertain parameters: task duration, start and finish times, uncertainties in costs and resources, uncertainties in quality, safety, technology, and others. RiskyProject analyzes project schedules with risks and uncertainties, calculates the chance that projects will be completed within a given period and budget, ranks risks, and presents the results in formats that are easy to read and understand.

RiskyProject also helps you to perform project risk management:

- Identify project risks
- Rank risks
- Identify mitigation and response plans
- Manage risk properties, including descriptions, probabilities and impacts, costs associated with risks, mitigation strategies, and all other information about risks
- Facilitate risk reviews, opening, and closing risks, conversion of risks to issues and lessons learned
- Save risk history

RiskyProject performs both qualitative and quantitative risk analysis. If both the risk register and project schedule are populated, RiskyProject performs quantitative risk analysis. If there is no Project data (cost or schedule), RiskyProject performs qualitative risk analysis. RiskyProject seamlessly integrates with Microsoft project or can run as a standalone application. RiskyProject integrates with other project management software such as oracle primavera. RiskyProject employs event chain methodology to analyze project uncertainties defined by multiple risks (events). An example of an event would be a task delay due to the changes in requirements.

In many cases, one event can cause another event or multiple events, which can significantly affect the project schedule. RiskyProject recalculates the project schedule various times to compute the distribution of possible outcomes and probabilities of meeting specific objectives. These facilities can show differences in management risks of project manually or with using the software.

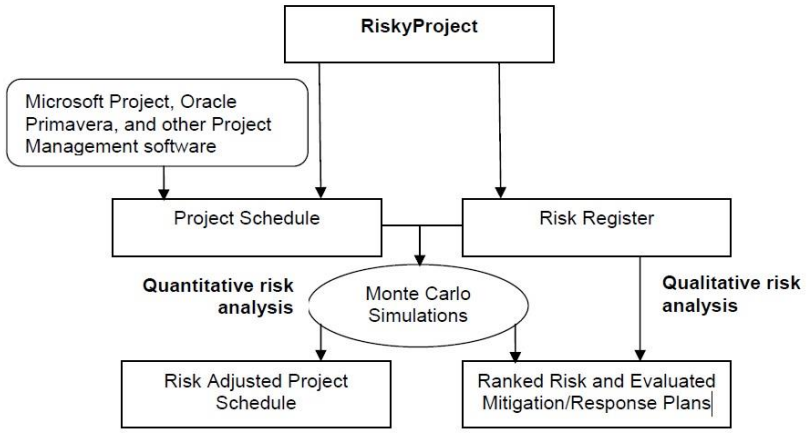


Figure 3.2 - How the RiskyProject software works

3.4.2 Who should use RiskyProject? [24]

RiskyProject performs two significant functions:

- Risk management: identification, recording, ranking, and reviewing risks, mitigation and response plans, and all associated risk information.
- Risk analysis: determining how risks might affect your project.

RiskyProject is beneficial for managers who want to perform risk analysis on their projects without specialist expertise or training in risk analysis. RiskyProject allows managers to quickly analyze a complicated project schedule and associated costs, with multiple tasks and dependencies. It is a user-friendly system with an intuitive interface, which hides its advanced mathematical calculations and helps managers make informed decisions.

RiskyProject is useful for managers of research and development projects, including software projects, who run projects with multiple uncertainties using an iterative development process. It is a widely accepted fact that project management best practices and procedures emphasize the importance of iterative development and risk tracking, which represents the cornerstone of the RiskyProject workflow. RiskyProject is used in many industries, including aerospace and defense, IT, engineering and construction, manufacturing, agriculture, pharmaceutical, energy, and mining.

3.4.3 RiskyProject interface [25]

RiskyProject supports a multi-document interface. You can open and close multiple project schedules during one session in RiskyProject. The risk register is a set of all your project risks. You can view the project risk register in the risk register and risk properties views.

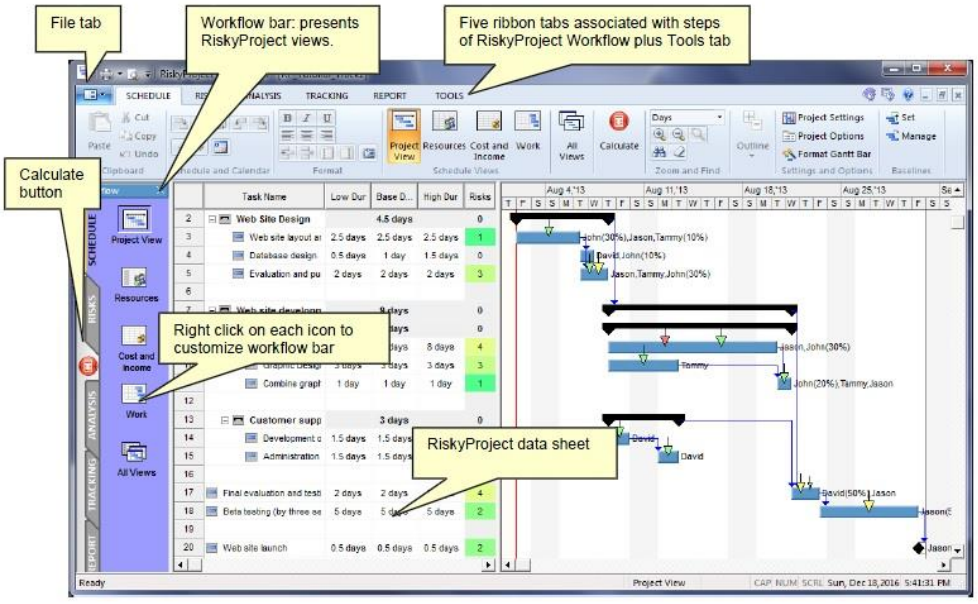


Figure 3.3 - RiskyProject interface

- Modifying the workflow bar

You may modify the RiskyProject workflow by inserting and hiding views. Any changes you make to the workflow bar becomes the default for all projects.

- Application look

You may change the color and style of title bars, toolbars, and status bars, as well as change the theme for the datasheets. The theme is used for any grid, including grids inside dialog boxes.

- RiskyProject data sheets

All RiskyProject views, except for the project summary view and project dashboard, contain datasheets. Datasheets are used to enter and present data in a grid format. Grids are also used in some dialog boxes. All data sheets have similar features.

Datasheets are used to display task information, resources, risks, and results of sensitivity analysis. Datasheets are composed of columns and rows. Each column has specific properties,

Which represents a particular type of data. For example, resource name, resource type, etc. You can customize data sheets to display the columns in any order and any with a title in the column header.

- Copying, cutting and pasting selected rows

You can copy, cut, and paste selected items in each data sheet except for the results of sensitivity analysis.

- Inserting and deleting items

You can delete and add items from, or to, any datasheet except for the results of sensitivity analysis. The quickest way to add or remove items is to use the insert and delete buttons located on the formatting toolbar.

- Saving column layout

After you modify a column layout, you can save it in the system registry for all new projects created on your computer.

4. Identify risks

4.1 Risk and uncertainty in project management

There are different perspectives on uncertainty in the field of project management. Below are three examples of these perspectives.

4.1.1 The viewpoint of the project purpose function

Some researchers point out the risks and uncertainties of a strategic vision based on the objective function of the project. From this perspective, for each project, a goal function is defined that describes the project under study and then calculates the probability of achieving the specified values of the target. The amount of investment, the completion time of the project, and are examples of the project's objective function. Risk management is also in line with this definition, modeling the actual function of the project against the project variables. Project variables include general costs such as cost, primary resource values, external factors, etc. Those affect project activities.

Since most project variables are inherently random and dynamic, and over time, they show varying degrees of uncertainty, it is natural that the objective function of the project is random and subject to uncertainty due to different sources. The uncertainty of the project can be called in this definition, the probability that the project objective function will not achieve the pre-target values.

4.1.2 Opportunity and threat view

Some other researchers also define risk and uncertainty opportunities using well-known terminology. The advantage of these definitions is to connect the concept of uncertainty with the concepts of risk and opportunity. In this perspective, uncertainty is defined as "the context or context for risk-taking - events that have a negative impact on project goals - and the occurrence of opportunities - events that are beneficial to the purpose of the project." This definition refers to the dual nature and cover of uncertainty, which, according to the authors, is considered as the most crucial reason for the higher efficiency of uncertainty management.

Risks are definite. The project manager can think of potentially hazardous events and perform pre-emptive calculations. But on the contrary, uncertainty is an event or a situation that is not expected to occur, although it can be considered from the beginning of the project.

4.1.3 Uncertainty categorization view

Some scholars have also explained the concept by categorizing uncertainty. One of the most common of these categories is to consider two aspects of uncertainty, namely, changes and ambiguities. Changes are related to the future of the project, while ambiguity has originated in the

past. Uncertainties are described in two categories dependent on knowledge-based luck. Luck uncertainty stems from things that were initially considered and unpredictable, and the uncertainty associated with knowledge is the uncertainty that arises from the lack of knowledge; that is, if there is more knowledge available, from the start of a possible it was anticipated. In these definitions, the relationship between risk, opportunity, and uncertainty is generally not clear.

4.2 The scope of uncertainty in projects

The extent of uncertainty in each project is significant, and most of the project management activities are not under the umbrella management of uncertainty under the specific framework but with uncertainty management.

Uncertainty exists in the initial phases of the project life cycle - uncertainty about what can be done, deciding what to do, and ensuring what will be done.

Uncertainty is partly related to changes in performance metrics, such as cost, duration, and quality of the project, and partly due to the lack of transparency and ambiguity resulting from factors such as the behavior of other actors related to the project, the lack of knowledge, information and necessary details, and lack of proper structure for considering them and known or unknown sources of deviation.

Uncertainties are believed to exist in all phases of the project, but somewhat more significant in the early aspects of the project, while others believe that only for projects that operate in a stable environment, uncertainty in the early stages and design of the project concept it is high and will be significantly reduced in later stages. But in most projects that operate in an environment full of uncertainty and environmental communication, uncertainty does not necessarily reduce the life cycle of a project, and even a process cannot be imagined for its change.

4.3 Tools and Techniques for the Identify Risks Process [1]

A range of tools and techniques is available for risk identification. These fall into the following three categories, as illustrated in Figure:

4.3.1 Historical Review

Historical reviews are based on what occurred in the past, either on this project, or other similar projects in the same organization, or comparable projects in other organizations.

4.3.2 Current Assessments

Current assessments rely on detailed consideration of the current project, analyzing its characteristics against given frameworks and models to expose areas of uncertainty.

4.3.3 Creativity Techniques

An extended range of creative techniques can be used for risk identification, which encourages project stakeholders to use their imagination to find risks that could affect the project. The outcomes or effectiveness of these techniques depend on the ability of participants to think creatively.

Each category of risk identification technique has strengths and weaknesses, and no single technique can be expected to reveal all knowable risks. Consequently, the Identify Risks process for a particular project should use a combination of techniques, perhaps selecting one from each category.

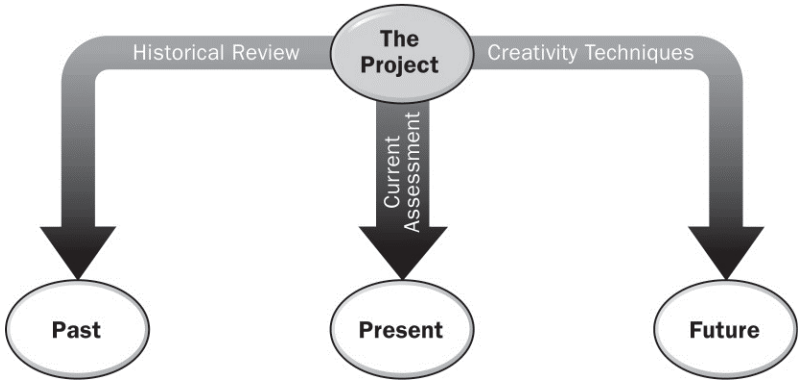


Figure 4.1 - Three Perspectives of Risk Identification

4.4 Identify risks

Risks are planned in other processes, and results are implemented in the form of programs. In this process, we evaluate the effectiveness of risk response programs and design corrective actions to solve potential problems. All corrective actions are sent to the integrated control process of the changes so that they can be implemented in the event of approval by the programs.

Processes that directly send their output to this process:

- Stakeholders identification
- Planning procurement management
- Risk management planning
- Planning human resource management
- Plan quality management
- Estimate costs
- Cost management planning
- Estimate activity durations
- Plan schedule management
- Provide work breakdown structure (create WBS)

Processes that directly use the output of this process:

- Planning procurement management
- Control risks
- Planning risk responses
- Perform qualitative risk analysis
- Perform qualitative risk analysis
- Plan quality management
- Estimate costs

In this process, both at the beginning and the beginning, we identify the risks of the project, that is, the desirable or unpredictable events that may fall into the future and are unlikely to occur. We store the risk information in the "risk list" to be used in other processes. After identifying risk categories, we identify and list the potential risks for each category.

The next phase is to quantify the risks. Calculating the probability of occurrence of risks in many projects may be a difficult task since the probability of occurrence of phenomena requires much information from the past and the history of that event. For example, we calculate that the probability of not receiving certain resources at a specific time is precisely (or even approximately) 0.7, which is difficult or futile to do. Because also if there is such a number, reliability is not high due to changing circumstances. But the use of fuzzy and linguistic phrases and their conversion into numbers or scores can be helpful. Accordingly, for each risk, we define three indices:

1. Probability of occurrence,

2. Impact of occurrence,

3. Priority risk indicator.

4.4.1 Probability of occurrence

In this part of the risk planning, we need to develop a system to quantify the risk.

- Very weak - 20 - the probability of occurrence is very low. Although it still needs to be monitored throughout the project, it may increase as a result of changing circumstances.
- Weak - 40 - based on current information, there is little chance of occurrence, as risk factors are not likely to occur.
- Medium - 60 - possible risk occurrence.
- Strong - 80 - the risk of high risk is based on project conditions.
- Very strong - 100. The project conditions are in such a way that the risk is inevitable.

4.4.2 Impact of occurrence

Then, we create a system to quantify the impact of the risk on the project.

- Inaccurate - 20 - the effect is very low, which cannot be measured.
- Low - 40 - for example, creating less than 5% of the deviation in the range, project completion date, or project budget.
- Tangible - 60 - the impact of measurable risk occurrence. For example, create a 10% -5% deviation in the range, project completion date, or project budget.
- Impressive - 80 - for example, create a 25% -10% deviation in the range, project completion date, or project budget.
- Extreme - 100 - the project strongly influences exposure to risk. For example, creating more than 25% of the deviations in the range, the completion date of the program, or the project budget.

4.4.3 Risk priority

After obtaining the numbers as quantitative criteria, the probability and impact of the occurrence of the risks with a significant combination of them, we get a criterion for prioritizing the handling and assignment of risk response measures.

In this section, the performance of calculations manually or with the software is entirely different because manual prioritization of constraints and the number of events should not be high because of complexity, but in calculations, with our software, we can many modes for different possibilities and effects for various risks and tasks. This is bringing up in more detail in the risk analysis section.

4.5 Components of risk information

Generally, elements of risk are as follow;

- Id or risk id
- Risk comment: a full description of the risk
- Status: risk situation (open or closed).
- Risk: explains the circumstances or triggers that are the source of risk
- Probability: determine event probability and event occurrence.
- Effect: impact on the goal or objectives of the project.
- Score: if a numerical scoring is used, the probability is multiplied by the factor to determine the risk rating. If a relative scoring is used, two scores are combined (such as top-down or medium-high)
- Response: strategic response strategy for risk or circumstance

- Likelihood of reconsideration: determining the probability of an event and occurring after the implementation of the risk response program
- Revised effect: an explanation of the impact after the implementation of the risk response program
- Revised point: revision of risk rating after application of the risk response program
- Responsible: organizational unit or person responsible for risk management
- Actions: describe the steps to be taken to respond to risk
- Secondary risks: a description of the new risks that arise from implementing risk response strategies.
- Risks remaining: remaining risks after implementation of reaction strategies
- Caution: a program that starts in the event of certain events, such as losing a significant intermediate event. Precautionary measures are taken when the risk or remaining risk is accepted.
- Precautionary budget: budget required to meet identified risks.
- Precautionary times: the time required to deal with identified risks.
- Reaction rehearsal programs: a program that is used to use when other response strategies fail.
- Description: provide useful explanations or useful information about risk, event.

4.6 Risks in RiskyProject [10]

4.6.1 Risk register

The risk register is a set of all the project risks. You can enter risks in either the risk register or risk properties views:

Use the risk register to:

1. View risks with their attributes such as probabilities, impacts, scores, and properties.

2. Create a risk register hierarchy based on:

- risk categories
- open/closed risks
- risk/issues/lessons learned
- risks assigned to managers
- risks assigned to owners
- threat mitigation or opportunity mitigation strategies
- assigned/unassigned risks (active or inactive)
- hidden and visible risks

3. Rank risks based on the risk score.

4. Sort risks alphabetically or using risk ids.

5. Filter risks based on risk properties: open, closed, risk, issue, or lessons learned. Data for the risk register can be subdivided into three categories: risk registry, risk mitigation/response plans, and settings:

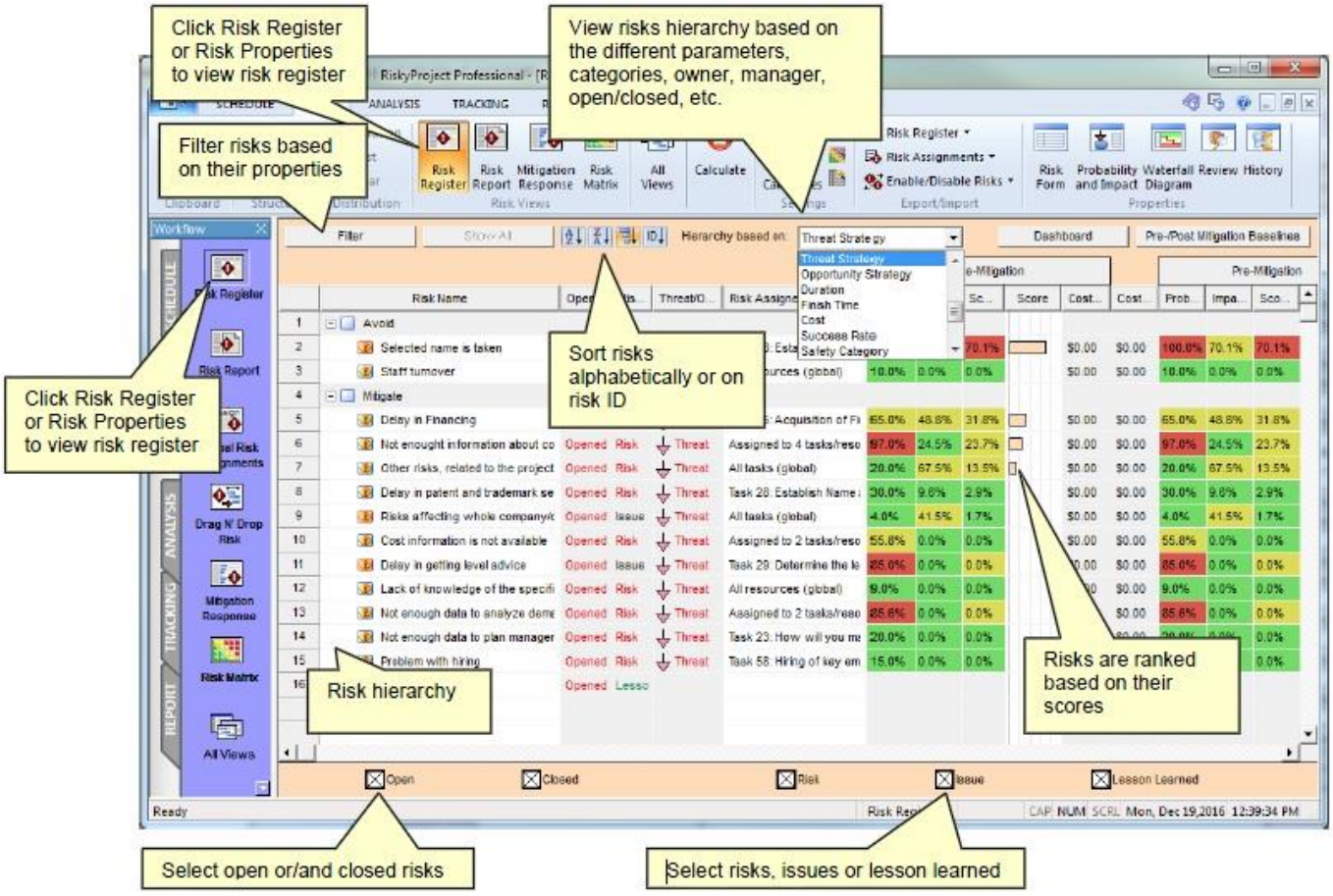


Figure 4.2 – Risk Registration

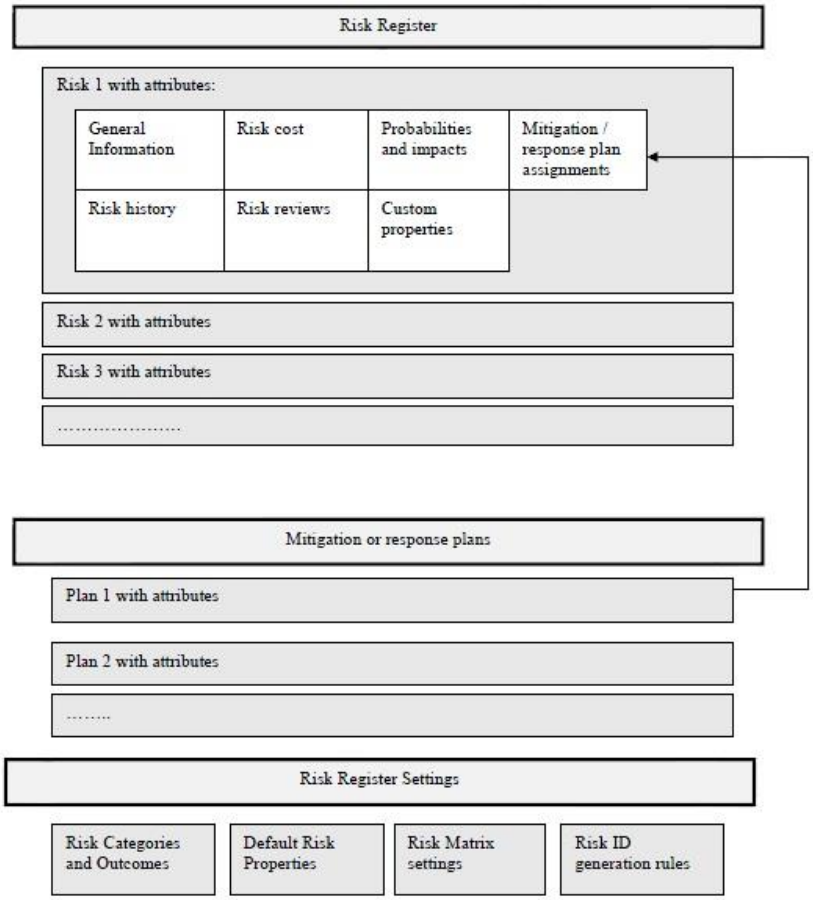


Figure 4.3 - Overview of the Risk-Register process

4.6.2 Defining columns for risk register

You can modify the risk register by inserting, modifying, or hiding columns depending on the type of information you would like to view. The risk register view allows you to define the upper header for the group of columns. The top header can have two rows of text and a tooltip. It can have different background colors, outline colors and text colors. There are two pre-defined top headers: pre-mitigation and post-mitigation.

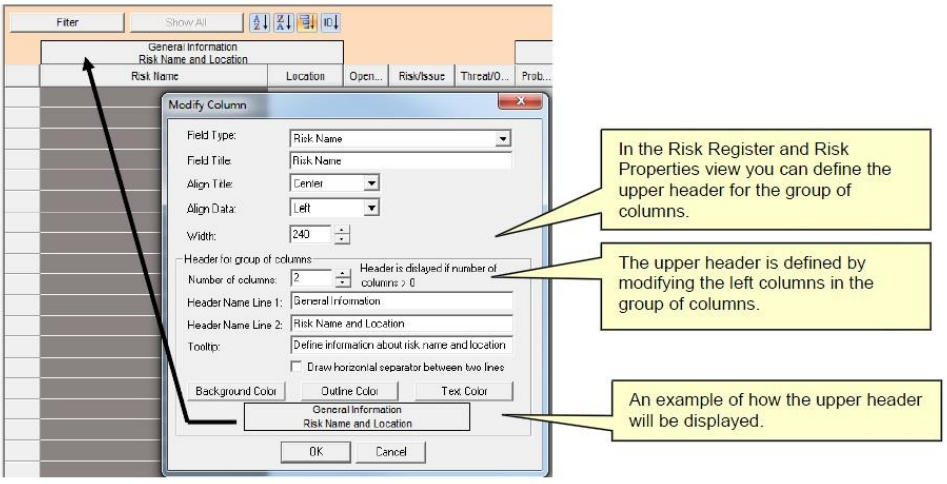


Figure 4.4 - Defining columns for risk register

Facilities of software in this section:

1. Adding risks to the risk register

2. Deleting risks from the risk register

3. Updating risk properties for individual risks

4. Updating risk properties for a group of risks

5. Filtering and sorting risks using the risk register

The risk register offers powerful tools for filtering and sorting risks:

- The show opened and closed risks and issues - use the checkboxes at the bottom of the risk register to make a selection.
- Find a risk based on the actual value of a risk property using the find risk dialog (filter button) at the bottom of the risk register. You may combine different risk properties using And or Or.
- Sort the risk register alphabetically using and buttons or based on pre-mitigation risk score using the button. You may also sort the risk register based on risk id.

You can filter risks that affect different risk categories. Risks can affect:

- Duration
- Finish time
- Cost
- Success rate
- Non-schedule risk categories.

6. RiskyProject calculates the combined impact of risk on all risk categories. Pre-mitigation and post-mitigation risk impact, probability, and score are displayed for selected risk categories.

7. With the risk register or risk properties views, you can rename risks and copy risk information to the clipboard. You may also copy and paste risks inside the risk register.

8. View risk register dashboard

The risk register dashboard provides a quick summary of the overall status of the risk register. It includes the following measurements:

- Total number of risks
- % of open
- % of the risk, issue, and lessons learned

- % of threat, opportunities or both
- Number of mitigation and response plans
- Number of assigned mitigation and response plans
- Dates and names of latest risk, latest update, and most recent review.
- Cost of all risks before and after mitigation and/or response.

4.6.3 About Risk Categories, Probabilities and Impacts

4.6.3.1 Risk Categories

Risk Categories are a group of risk outcomes. RiskyProject calculates risk probabilities, impacts, and scores for each category. The default risk categories are:

- Duration
- Cost
- Safety
- Environment
- Legal
- Performance
- Technology

RiskyProject calculates the score and rank for all risks in each risk category. You can view risk scores and rankings for each risk category or all categories. You can customize the risk categories in the Risk Categories dialog box.

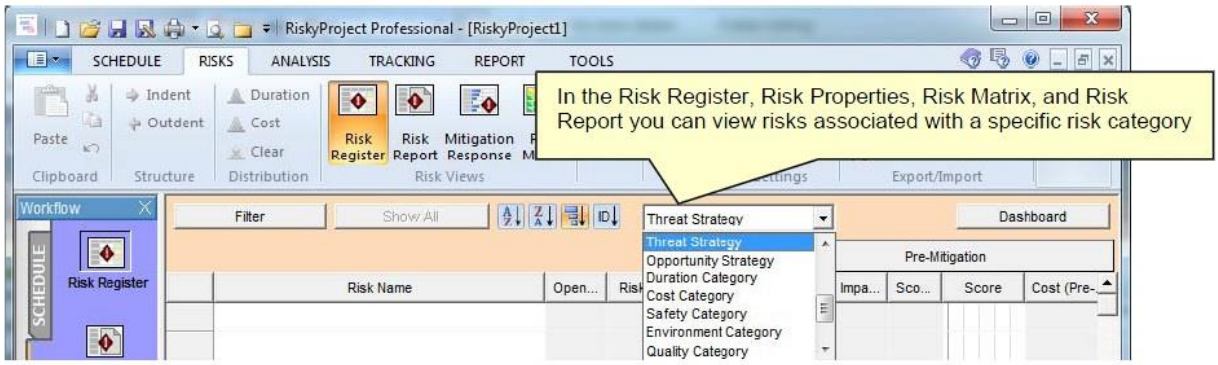


Figure 4.5 – Risk Categories

4.6.3.2 Risk Outcome Types

A Risk Outcome Type is a result if a risk occurs. While every risk category must have a least one outcome, they can have several. For example, one of the default risk categories is Legal. You may want to further define the outcome types as Litigation Risk, International Legal Risk, etc. You can customize the set of outcome types using the Risk Categories dialog box.

Quantitative risk analysis, RiskyProject automatically adds several schedule-specific risk outcomes, such as restart task, fixed cost increase, etc.

4.6.3.3 Risk Probability and Chance

Risk Probability is the calculated chance that an event will occur. You can view risk probability in the Risk Matrix, Risk Register, and other views and dialog boxes. Risk Chance is the input parameter for risk probability. Risk chance (input parameter) and risk probability (calculated attribute) can be different; particularly when a risk has multiple mutually exclusive alternatives as risk chance is an input parameter for each option. In these cases, Risk probability is calculated based on the risk chance for each mutually exclusive option.

4.6.3.4 Risk Outcome

Risk Outcomes indicate the severity of a risk event for the specific risk category. You need to enter risk outcomes when you define risk chance and outcome type. For example, here are the default risk outcomes for the risk category Schedule:

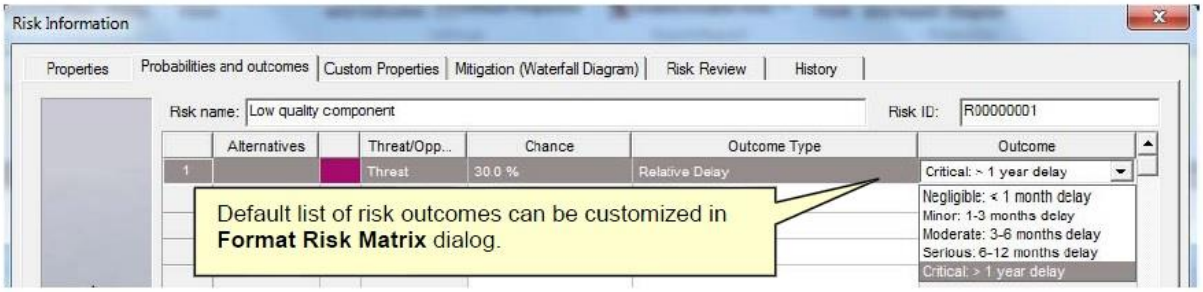


Figure 4.6 – Risk Outcome

Outcome types can be a label (e.g. Critical > 1-year delay) or a percentage (e.g. 5%), or a combination of both. You can set how you want to enter and view risk outcomes in the Format Risk Matrix dialog box. Each label is associated with the percentage, which is the midpoint of the interval for each label:

Label	Interval	Midpoint
Negligible: < 1 month delay	From 0% to 20%	10%
Minor: 1-3 month delay	From 20% to 40%	30%
Moderate: 3-6 months delay	From 40% to 60%	50%
Serious: 6-12 months delay	From 60% to 80%	70%
Critical: > 1 year delay	From 80% to 100%	90%

Table 4.1 – Risk Outcomes Percentages

When you define outcome types as a percentage, you can enter it as any number from 0% to 100%. In this scenario, it will be associated with a label based on the interval to which this percentage belongs. For example, 76%, corresponds with the "Serious: 6-12 months' delay" outcome type.

In RiskyProject, risk outcome types can be probabilistic. You can define a statistical distribution for outcome types and perform Monte Carlo simulation even it is part of qualitative risk analysis. The diagram below shows the relationship between risk categories, risk outcome types, and risk outcomes.

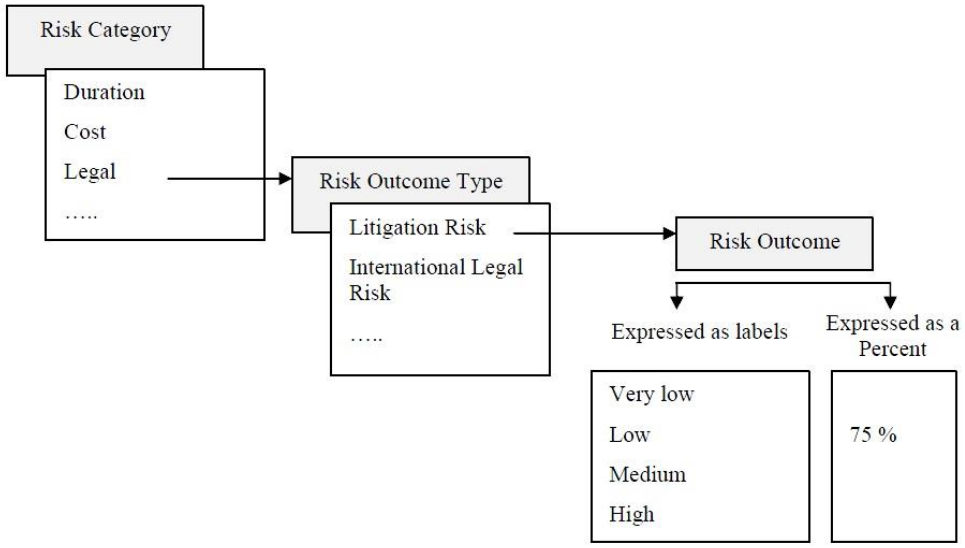


Figure 4.7 – Risks Attributed to Relationships

4.6.3.5 Threats and Opportunities

Risks can be threats, opportunities or both. Threats and opportunities are defined for risk assignment depending on the results of the risk outcome. Negative risk outcomes mean opportunities.

- Example 1:
  Risk: Change Requirements
  Outcome: Fixed Delay
  Result: 2 days
  This is a threat
- Example 2:
  Risk: Change of technology
  Outcome: Delay in technology introduction
  Result: -10% Low
  This is an opportunity: a negative number indicates that this is an acceleration rather than a delay in the technology introduction
- Example 3:
  Risk: Chance of supplier
  Outcome: fixed cost increase
  Result for mutually exclusive alternative 1: $30,000
  Result for mutually exclusive alternative 2: -$20,000
  This is both a threat and an opportunity depending upon the supplier.

4.6.3.6 Risk Impact

Risk impact is the calculated result of the risk event. Risk outcome (input parameter) and risk impact (determined attribute) can be different, particularly when a risk has multiple mutually exclusive alternatives, in which case the risk outcome is a parameter of each option. Risk impact is calculated based on the risk chance for each option. The diagram below shows the difference between risk chances and outcomes (input parameters) and risk probabilities and impacts (output parameters):

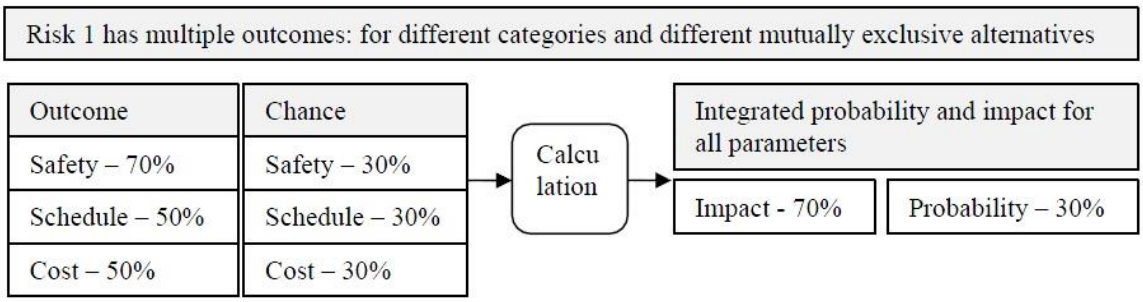


Table 4.2 – Risk with several different outcomes and chances

4.6.3.7 Risk Score

The risk score is a calculated parameter that equals probability multiplied by impact. The risk score is calculated for each risk category as well as all risk categories. Original, Pre- and Post-Mitigation Probabilities, Impacts and Scores RiskyProject calculates three sets of probabilities, impacts, and scores for each risk category as well as for all categories:

1. Original: when risk chance and outcome are defined. This information is saved in Risk History. If you want to change original probabilities, impacts, and scores, you would need to make modifications in Risk History using the History tab on the Risk Information dialog.

2. Pre-mitigation or Current: reflects the most recent changes to chance and outcomes. If you enter chance and outcome, your original probability, impact, and score will be represented as Pre-mitigation or Current value.

3. Post-Mitigation: Pre-mitigation probability, impact, and score, with changes to do mitigation plans.

You can view all sets of probabilities, impacts, and scores in the Risk Register.

4.6.3.8 Risk Properties

Risk Properties are other risk attributes, which include:

- Risk Name, ID, description, statement, objectives, assumption, cause, and trigger
- Open/close risk
- Risk life cycle status: Risks, issues, lesson learned
- Risk ownership
- Risk mitigation strategy
- Risk costs
- Risk start and end date
- Other information about risk

Some risk properties are predefined as General Information about risk and Risk Costs. However, you may define any other risk properties.

4.6.4 Risk Attributes

4.6.4.1 About Risks

Each risk in RiskyProject can have several attributes. Some of the most common characteristics are predefined and are found in the Properties tab of the Risk Information dialog box; however, you are not required to complete all of them. The information required should be defined as part of your risk management plan.

General Information includes:

- Risk Name: the risk name for each risk must be unique. Names are case-sensitive.
- Open/closed risk: open risks are active risks that may occur. Closed risks are those risks that are no longer active because of risk response or other factors or measures taken. Closed risks may contain important information and should not be deleted from the risk register.
- Risks, issues, lessons learned: risks are events that may or may not occur and have a probability between 0 – 100%. Issues are events that have already occurred and require a response. Lessons learned are events that happened in the past and have a history associated with them. When you add a new record to the risk register, by default, it is a risk.
- Risk statement, objectives, assumption, cause, and trigger: contain textual information about risks.
- Risk ownership: includes risk manager and risk owner. You may define other custom fields for risk reviewer, recorder, and other participants in the risk management process.
- Risk mitigation strategy: you can enter mitigation strategies for threats and/or opportunities. Status of threats and/or opportunities are automatically calculated when you enter risk probabilities and impacts. If the risk is only a threat, you will only be able to enter strategies for threats and vice versa. For more information about threats and opportunities, read "Risk Probabilities and Impacts."
- Risk start and end date (risk sunrise and sunset): dates between which a particular risk is active.
- Risk ID: Risk ID can be automatically generated when you create a new risk. You may sort the Risk Register based on Risk IDs. You can overwrite the automatically generated risk ID. Rules for risk ID generation are defined in Risk Options. To view Risk Options, click the Schedule tab. In the Settings group, click Options.
- General Information about risks is a set of attributes that do not affect the calculation of probabilities, impacts, risk cost or mitigation efforts for qualitative risk analysis.
- In the case of quantitative risk analysis, changing risk from Open to Closed, from Risk to Issue or Lesson Learned will affect risk probability and impact.

- You define the default risk mitigation strategy and default time between risk sunrise and sunset in the Default Risk Properties dialog box (Risk tab of the ribbon, Settings pane).

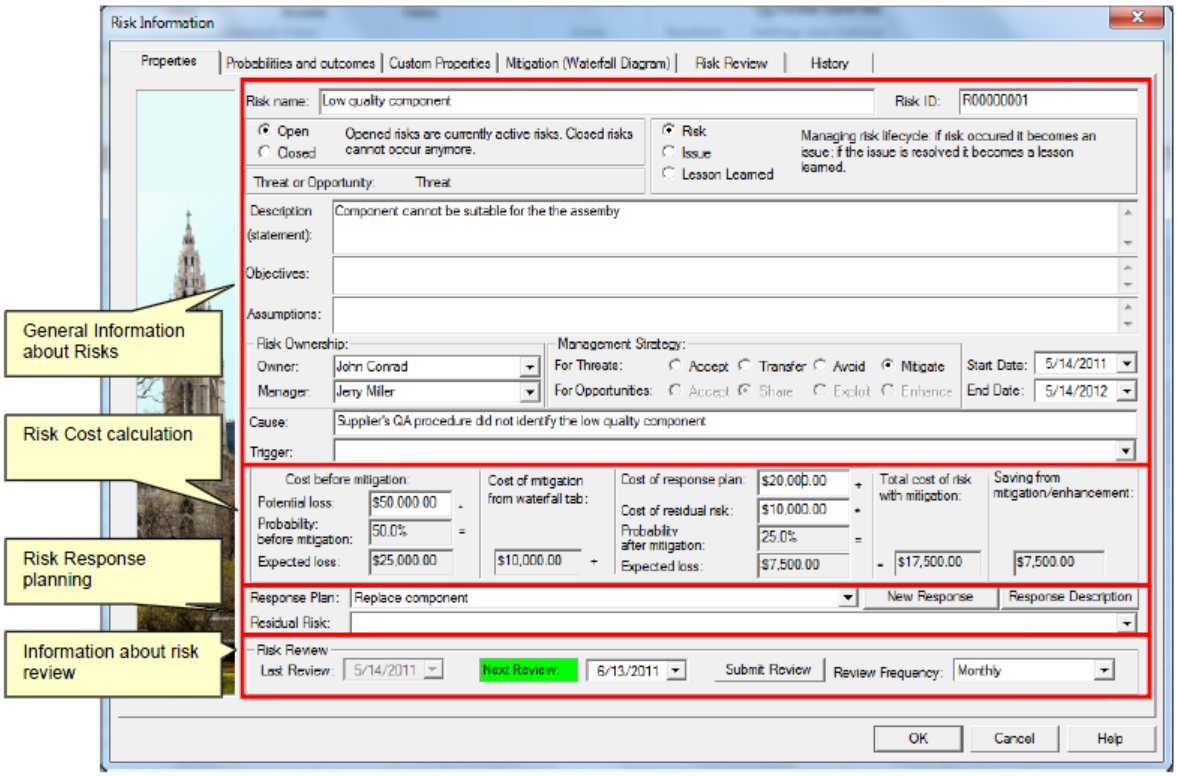


Figure 4.8 - Risk Properties dialog box

4.6.4.2 About Cost of Risk Calculations

Risk cost calculates the total cost of a risk that takes into account the risk mitigation plans linked to the risk. The Risk cost calculation is performed in the Properties tab of the Risk Information dialog box.

Expected loss = Potential Loss * Probability (pre-mitigation)

For example, probability of risk "low-quality component" equals 50%. Potential loss equals $50,000. Expected loss will be $25,000 = $50,000 * 50%

Expected loss after mitigation = (Cost of Response Plan + Cost of Residual Risk) * Probability after information

For example, probability of risk "low-quality component" after mitigation equals 25%.

Expected loss after mitigation will be $7,500 = ($20,000 + $10,000) * 25%

Total Risk Cost after Mitigation = Expected loss after mitigation + Cost of Mitigation

For example: Total cost after mitigation of risk “low quality component” will be $17,500 = $7,500 + $10,000

Saving from Mitigation is the difference between costs with and without mitigation. If this number is negative mitigation efforts will not lead to cost-saving.

Saving from Mitigation = Expected Loss – Total Risk Cost after Mitigation

For example, total cost after mitigation of risk “low-quality component” will be $17,500.

4.6.4.3 Risk Reviews

RiskyProject helps you to facilitate regular risk reviews. You can define the risk review periodicity (weekly, monthly, quarterly). RiskyProject will notify you before a review is scheduled.

During the risk review, you may analyze all risk attributes, make necessary changes, and write notes. Risk reviews are essential components of risk management monitoring and control

a process as the status of risks and their attributes, such as probabilities and impacts, are in constant flux during a project.

4.6.4.4 Risk review due date

Each risk review has a due date. The risk must be reviewed on or before the due date. A few days before due date RiskyProject will notify you regarding the scheduled review. The notification will come in the form of changing color of the Next Review property. Next Review is shown by default in Risk Properties view:

You may also view the Next Review date on Properties and Risk Review tab of Risk Information dialog box. You may also insert a Next Review column to the Risk Register view.

The default risk review frequency and number of days before incoming risk review are defined in Default Risk Properties dialog (Risk tab of the ribbon, Settings pane).

5. Analysis (Quantitative, Qualitative)

The process of calculating and determining the size and magnitude of identified risks are based on indicators and criteria. Based on this measurement, risks are prioritized, to decide on admission, reduction, or rejection in the next steps. Risk assessment is the qualitative or quantitative measurement process of risk and decision making about acceptability or risk tolerance. Risk assessment should:

- Include the effects of activities, products, and services.
- Identify the effects and risks of human and hardware factors.
- It is based on the information provided by the staff at risk.
- Recognize Qualified staff.
- It is based on standardized methods.
- Update at fixed intervals.

Risk assessment results formally facilitate the following:

- Assess the feasibility of the proposed activity, based on compliance with prescriptive selection criteria
- Determine the need for specific control measures to prevent, reduce or mitigate risk
- Determine the monitoring requirements
- Prioritizing opportunities for improvement

5.1 Qualitative vs. Quantitative Risk Analysis [10]

RiskyProject performs both qualitative and quantitative risk analysis.

A typical **qualitative risk** analysis workflow is used to:

1. Identify risks and add risks to the risk register.

2. Define risk properties, probabilities, and outcomes.

3. Analyze risks and prioritize risks.

4. Assign mitigation and/or response plans.

5. Update risk properties, probabilities, outcomes as necessary.

6. Review the status and properties of the risk and report information about risks.

A typical **quantitative risk** analysis workflow is used to:

1. Create a project schedule.

2. Add risks, uncertainties, and other risk-related information.

3. Run a simulation, perform analysis and generate a report of the results.

4. Update risks and uncertainties as necessary.

5. During project execution, perform project tracking with risks and uncertainties at key phases or milestones to update forecasts.

6. Report results

If you do not have a schedule for your project, RiskyProject will only perform qualitative risk analysis. However, if you add a schedule by either adding activities or importing a schedule, RiskyProject automatically switches to quantitative analysis. You may switch between the qualitative and quantitative analysis by adding or removing a project schedule.

Because of the character of the qualitative and quantitative analysis, the outcome can be different even with similar risks, exclusively for schedule-related risks affecting project duration and cost.

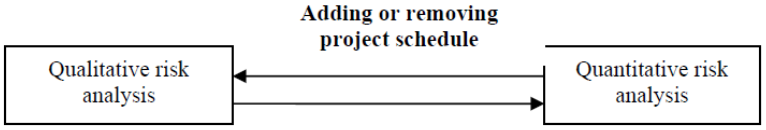


Figure 5.1 - quantitative and qualitative risk analysis in RiskyProject

A high-level correspondence of quantitative and qualitative risk analysis processes is demonstrated in Figure 5.2.

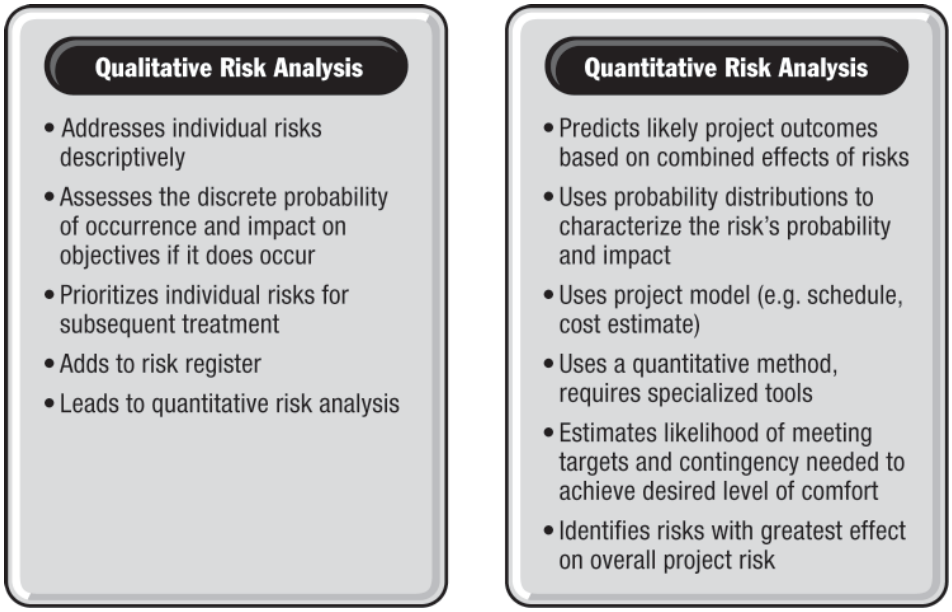


Figure 5.2 - Comparison of Qualitative & Quantitative Approaches

5.2 Qualitative Risk Analysis

Risks that have already been identified should be planned, but risk planning is not easy, and it's usually best to devote our energy only to the preparation of essential risks. This process is implemented after the process of identifying risks and before the risk response planning process to select significant risks for planning. In manual calculations, the easiest way to highlight essential risks is to multiply the likelihood of their occurrence and their impact on achieving a score. After that, the boundary between the importance and importance of the score is determined, and the risks to which they are above are sent to the risk response planning process. Risks that are not relevant are also monitored and may be necessary for the future, the extent of their impact or the likelihood of occurrence.

But in calculations with other software, this is not a concern because the software automatically combines a variety of risk modes with the Monte Carlo simulation and displays the most optimal results for each category of risk.

Processes that directly send their output to this process:

- Identify Risks
- Risk Management Planning
- Provide Work Breakdown Structure (Create WBS)

5.2.1 Purpose and Objectives of the Perform Qualitative Risk Analysis Process [1]

The Perform Qualitative Risk Analysis process assesses and evaluates characteristics of individually identified project risks and prioritizes risks based on agreed-upon characteristics.

Assessing individual risks using qualitative risk analysis evaluates the probability that each risk will occur and the effect of each individual risk on the project objectives. As such, it does not directly address the overall risk to project objectives that results from the combined impact of all risks and their potential interactions with each other.

One step in the analysis is to categorize risks according to their sources or causes. If several risks arise from a common source, sometimes called a root cause, risk responses may be more effective when they focus on addressing this root cause.

Identifying common effects from groups of risks allows identification of the areas of most considerable risk exposure.

The methods of qualitative risk analysis are applied to the list of risks created or updated by the Identify Risks process to provide project management with the characteristics of the risks that have the most influence (positive or negative) on achieving the project’s objectives. Risks that are

assessed as high priority to either threaten or to enhance the achievement of project objectives will be an essential focus in the Plan Risk Responses process.

5.2.2 Tools and Techniques for the Perform Qualitative Risk Analysis Process [1]

The tools and techniques used for assessing individual risks will identify the risks that are important to the project's success. This process is illustrated in Figure:

Figure 5.3 - The Perform Qualitative Risk Analysis Process

Hint: See the case study section for qualitative analysis information in a real project.

5.3 Quantitative analysis of risks

This process is optional. During this process, we model the risks in the timetable to determine the impact of their uncertainties over the entire project. This process is usually performed once before the risk response planning process and one time after that to find out to what scope of the schedules are appropriate. For example, if the cost of avoiding adverse risks is higher than the probable cost of occurring, which means some loss, we will realize at this stage and repeat the risk response planning.

Processes that directly send their output to this process:

- Identify Risks
- Risk Management Planning
- Cost Management Planning
- Plan Schedule Management

5.3.1 Purpose and Objectives of the Perform Quantitative Risk Analysis Process [1]

The Perform Quantitative Risk Analysis process provides a numerical estimate of the overall effect of risk on the objectives of the project, based on current plans and information, when considering risks simultaneously. Results from this type of analysis can be used to evaluate the likelihood of success in achieving project objectives and to estimate contingency reserves, usually for time and cost that are appropriate to both the risks and the risk tolerance of project stakeholders.

It is generally accepted that analyzing uncertainty in the project using quantitative techniques such as Monte Carlo simulation may provide more realism in the estimate of the overall project cost or schedule than a non-probabilistic approach which assumes that the activity durations or line-item cost estimates are deterministic. However, it should be recognized that quantitative risk analysis is not always required or appropriate for all projects. For example, qualitative risk analysis may provide enough information for the development of effective risk responses, especially for smaller projects. Therefore, during the Plan Risk Management process, the benefits of quantitative risk analysis should be weighed against the effort required to ensure that the additional insights and value justify the extra effort.

Partial risk analyses, such as qualitative risk analysis, aim at prioritizing individual risks viewed one at a time and therefore, cannot produce measures of overall project risk when all risks are considered simultaneously.

Calculating estimates of overall project risk is the focus of the Perform Quantitative Risk Analysis process.

Specific project risks are usually best understood and quantified at a detailed level, such as the line-item cost or schedule activity level. By contrast, project objectives such as achievement of the project's budget or the schedule are specified at a higher level, often at the level of the total project.

The implementation of overall risk analysis using quantitative methods requires:

• Complete and accurate representation of the project objectives built up from individual project elements. Examples of these representations include the project schedule or cost estimate.

• Identifying risks on individual project elements such as schedule activities or line-item costs at a level of detail that lends itself to a specific assessment of individual risks.

• Including generic risks that have a broader effect than individual project elements.

• Applying a quantitative method (such as Monte Carlo simulation or decision tree analysis) that incorporates multiple risks simultaneously in determining the overall impact on the overall project objective.

5.3.2 Tools and Techniques for the Perform Quantitative Risk Analysis Process [1]

Its tools and techniques have several characteristics, as follows:

- Comprehensive Risk Representation
- Risk Impact Calculation
- Quantitative Method Appropriate for Analyzing Uncertainty
- Data Gathering Tools
- Effective Presentation of Quantitative Analysis Results
- Iterative Quantitative Risk Analysis
- Information for Response Planning

The elements of quantitative risk analysis are illustrated in Figure.

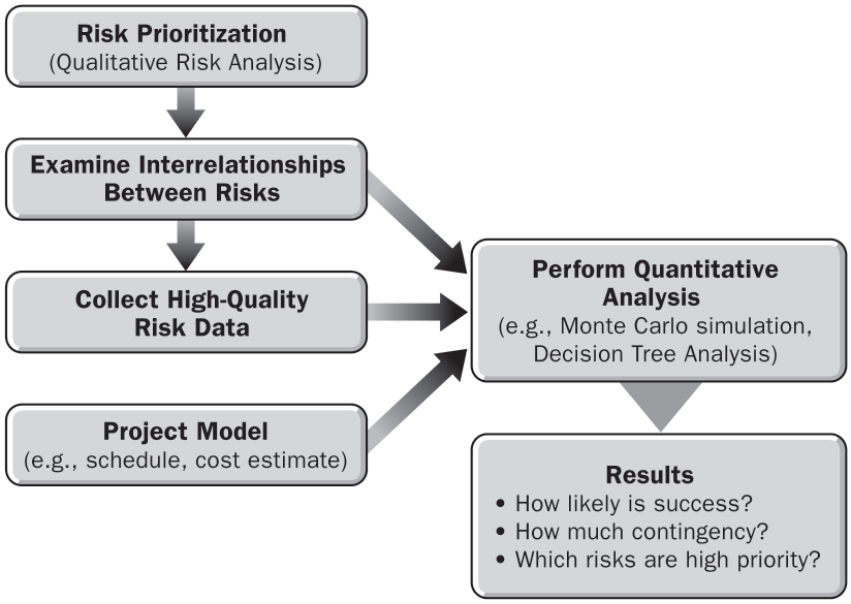


Figure 5.4 - Structure of a Quantitative Risk Analysis

5.3.3 Decision Tree Analysis [1]

Decision tree analysis is usually performed using the specialized, but widely available software. The software allows the user to specify the structure of the decision with decision nodes, chance nodes, costs, benefits, and probabilities. The user can also evaluate the different choices using linear utility functions based on Expected Monetary Value or non-linear utility functions of various shapes. An example is shown below where:

- The negative numbers represent outflows or investments (e.g., COTS)
- The percentages represent probabilities of the event occurring (e.g., Major Problems)
- The positive numbers represent rewards or values (e.g., after “Fix the Problem”)

- "True" indicates the decision option taken from the square decision node, whereas "false" indicates the decision option not made

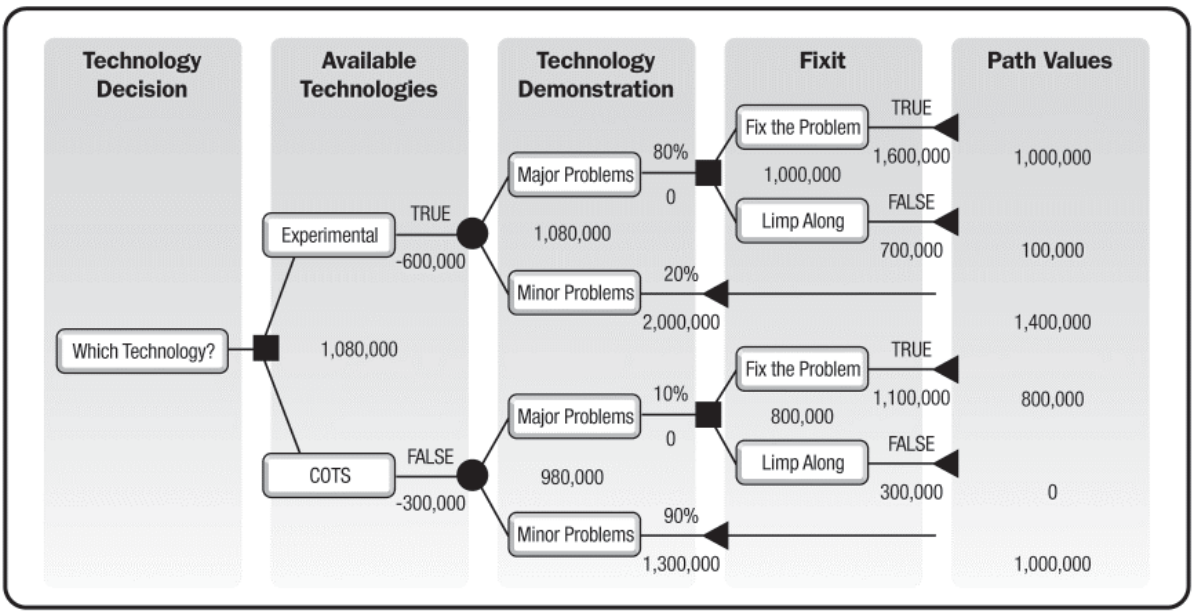


Figure 5.5 - Example of a Decision Tree for Choosing between an Experimental Technology vs. Commercial Off the Shelf (COTS) Technology
Source: Precision Tree from Palisade Corporation

5.3.4 Expected Monetary Value [1]

Expected Monetary Value (EMV) is a simple calculation of value such as weighted average or expected cost or benefit when the outcomes are uncertain. All reasonable alternative outcomes are identified. Their probabilities of occurring (summing to 100%) and their values are estimated. The EMV calculation is made for the entire event by weighting the possible individual outcomes by their probabilities of occurring, as shown in Figure.

Example of an Expected Monetary Value (EMV) Calculation for a Business Strategy that Depends on Uncertain Market Demand

Uncertain Outcome	Reward ($000)	Probability (%)	Contribution to EMV
High Market Demand	800	30%	240.0
Moderate Market Demand	450	45%	202.5
Low Market Demand	250	25%	62.5
TOTAL EMV			**505.0**

Figure 5.6 - Example of an Expected Monetary Value Calculation when there are Three Uncertain Product Demand Scenarios

5.3.5 Monte Carlo Simulation [1]

The Monte-Carlo method is a computational algorithm that uses random sampling to calculate the results. Monte-Carlo methods are commonly used to simulate physical, mathematical, and economic systems. On the other hand, the Monte Carlo simulation is a class of computational algorithms that rely on random iterations to calculate their results. Monte Carlo simulation is often used when simulating a mathematical or physical system. Because of their reliance on duplicate calculations and false or random numbers, Monte Carlo methods are usually configured to run on a computer. The tendency to use Monte Carlo methods is further enhanced when it is impossible or unjustified to calculate the correct response using deterministic algorithms. Monte Carlo simulation methods are especially useful for studying systems where there are many variables associated with the degree of pairwise freedom. Besides, Monte Carlo methods are also helpful for simulating phenomena with high uncertainties in their inputs, such as project risk calculation. These simulations are also widely used in mathematics.

Monte Carlo simulation is a detailed, computer-intensive simulation approach to determining the value and probability of possible outcomes of a project objective such as a project schedule (e.g., the completion date) or cost estimate (e.g., the total cost). It computes the schedule or cost estimate many times using inputs drawn at random from ranges specified with probability distribution function for schedule activity durations or cost line items. The solutions using these different input values are used to build a histogram of possible project outcomes and their relative probability, and cumulative probability from which to compute desired contingency reserves of time or cost. Additional results include the relative importance of each input in determining the overall project cost and schedule. Examples of the output of schedule and cost risk results are shown in Figures. RiskyProject used this technique for analyzing quantitative Risk analysis.

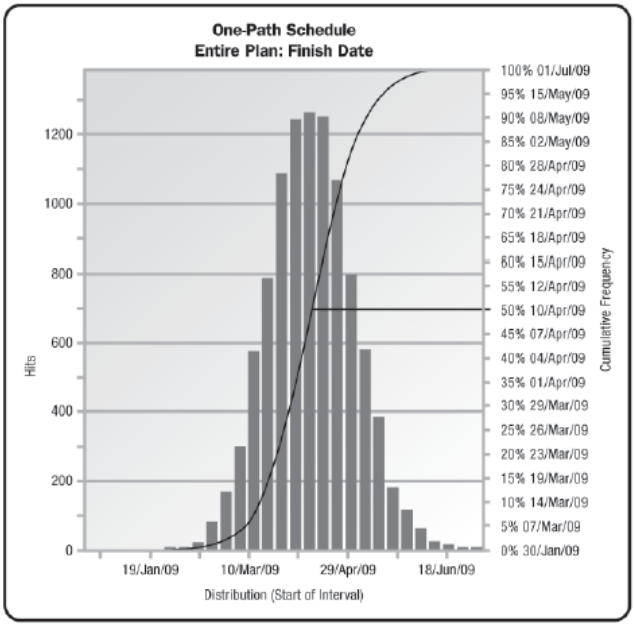
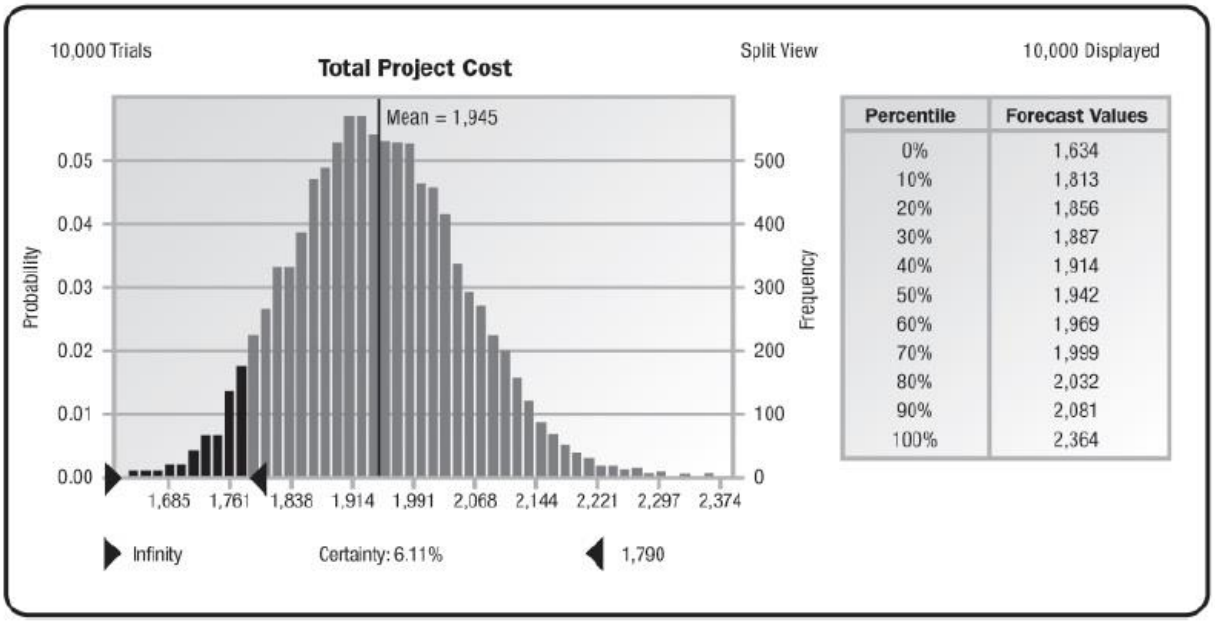


Figure 5.7 - Example Histogram from Monte Carlo Simulation of a Project Schedule
Source: Pertmaster v. 8.0 Primavera Pertmaster

Figure 5. 8 - Example Histogram from Monte Carlo Simulation of a Project Cost Estimate
Source: Crystal Ball v. 7.3.8 from Oracle Hyperion (Decisioneering)



Hint: See the case study section for quantitative analysis information in a real project.

5.3.6 RiskyProject for Microsoft Project as a Standalone Application [26]

1. RiskyProject as a Standalone Application

You can launch RiskyProject directly from the Windows Program menu. When you open RiskyProject, the main Project view appears in which you can enter schedule and risk, perform the analysis, track project performance, and report the results.

2. RiskyProject for Microsoft Project

RiskyProject seamlessly integrates with all versions of Microsoft Project from 2003 and later. When you install RiskyProject, it checks if Microsoft Project is installed on the computer. If Microsoft Project 2003/2007 is installed, RiskyProject and adds a toolbar and macro to Microsoft Project. If Microsoft Project 2010/2016 is installed RiskyProject installs ribbon tab and Add-In to Microsoft Project.

5.3.7 Assigning Risks to Tasks and Resources [10]

5.3.7.1 Risk Assignments

Risks must be assigned to calculate their impact. If a risk is not assigned to any tasks or resources, it will remain in the risk register, but probability, impact, and score will not be shown.

RiskyProject has two types of risks assignments:

- Global Risk Assignments – Global risk assignments are those risk assignments that have a chance of affecting the project as a whole and are not limited to specific tasks or resources. For example, political or weather risks would be assigned as global.
- Local Assignments – Local risk assignments are those risks that have a chance of affecting only specific tasks or resources. A local risk assignment can affect more than one task or resource.

5.3.7.2 Converting your project from Qualitative to Quantitative Risk Analysis [27]

If you have risks in the Risk Register, but no schedule, you can perform a qualitative risk analysis of your project. If you add even one task to the project, all your risks will convert to global risks, and will, therefore, be assigned to all tasks.

In quantitative risk analysis risk categories are separated into two groups:

- Schedule related risk categories: "Schedule and Scope" which is related to category "Duration" in qualitative analysis and "Cost and Income" which is related to the category "Cost" in qualitative analysis.
- Non-schedule categories (Safety, Quality, Technology, etc.) In qualitative risk analysis the "Duration" category has only one outcome type "Relative delay";

5.3.7.3 Risk Attributes for Quantitative Risk Analysis

Each risk has the following information relevant to quantitative analysis.

- Risks should be assigned to Resources and Tasks

- Risks are determined by the chance of incidence (from 0% to 100%). The chance might be defined per task (by default) or per the duration unit.

- Each risk has a different outcome type. Outcome types can be schedule and cost-related and non-schedule related, which you can customize using the Risk Outcome dialog box.

- The Outcome is relevant to the outcomes “Fixed cost increase,” “Relative cost increase,” “Fixed delay,” “Relative delay,” and “Rate Increase.” It specifies how much the duration or cost will be an enhancement or reduced.

- RiskyProject calculates the Risk Impact for duration and cost using sensitivity analysis and displays this in the Risk Register, Global Risk Assignment views, and Risk Tabs for Tasks and Resources.

5.3.7.4 Parallel Risks [28]

Parallel risks represent a way of modeling risks in cases where multiple risks occur simultaneously. If risks are parallel, RiskyProject will only account for the maximum impact of the most critical risk during each iteration of a simulation. This is useful if one or less significant risks occur in conjunction with a vital risk recovery from all potential risks which can occur over the same period. In such cases, only the impact of the most critical risk will be accounted for in the simulation.

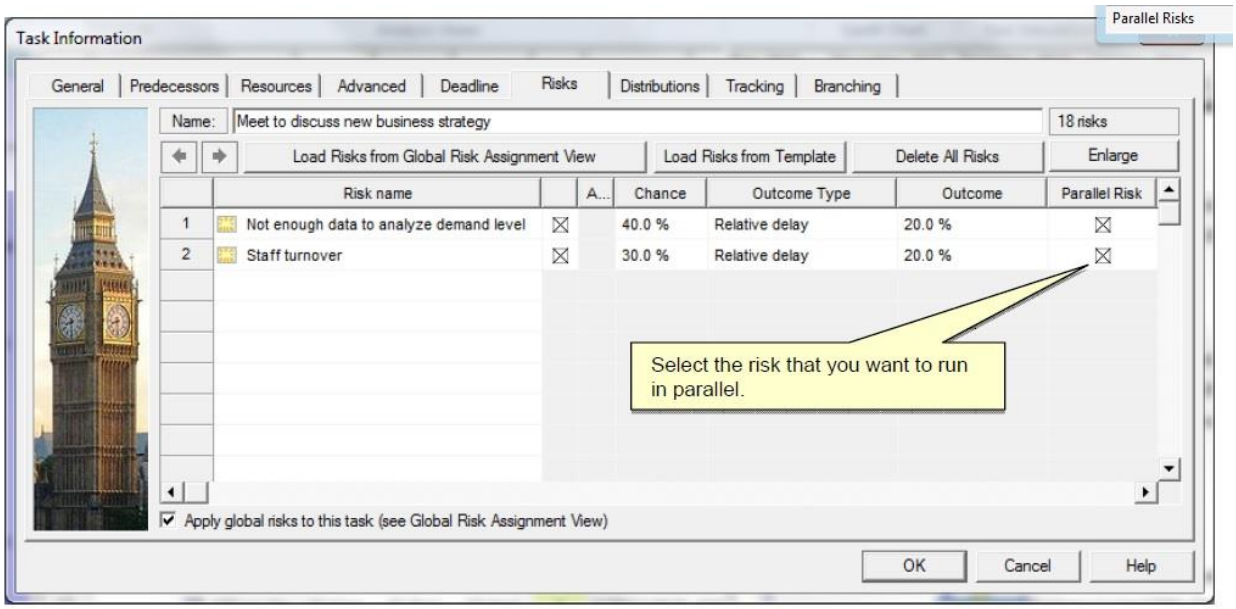


Figure 5.9 - Parallel Risks

6. Analyzing Project Results

6.1 Calculations [10]

RiskyProject has two types of calculations:

- Deterministic calculation of current schedule - The default calculation is automatically performed when you modify a project schedule. As this calculation occurs automatically, you do not need to press the Calculation button. This calculation uses the Base input parameters (duration, start time, lag) without calculating the effect of risk or uncertainty.
- Probabilistic (Monte Carlo simulations) - Use this to calculate the project schedule and costs with uncertainties and risks.
- Automatic Monte Carlo simulations for small tasks are enabled by default.
- By default, RiskyProject performs convergence monitoring. Simulations can be stopped when they convergence equals mean and standard deviation values defined in Schedule tab > Options > Calculation.
- The minimum number of simulations is 200.

6.2 Analyzing Results

6.2.1 Project Summary [10]

The Project Summary view shows the main information about your project: total cost or income (if income is defined), finish time, duration, and success rate for both deterministic and probabilistic calculations.

The Project Summary is divided into four sections:

- Main project information – the main project information includes the project name, manager, etc.
- Main project parameters with and without risks – this table is located in the center of the project summary and shows the project start time, duration, finish time, cost, income, and profit for the current schedule (no risks) and the low, base, and high calculated results.
- Main project parameter frequency/cumulative probability charts – interactive charts that show the distribution of the results.
- Meters: provide project risk scores for cost and duration.

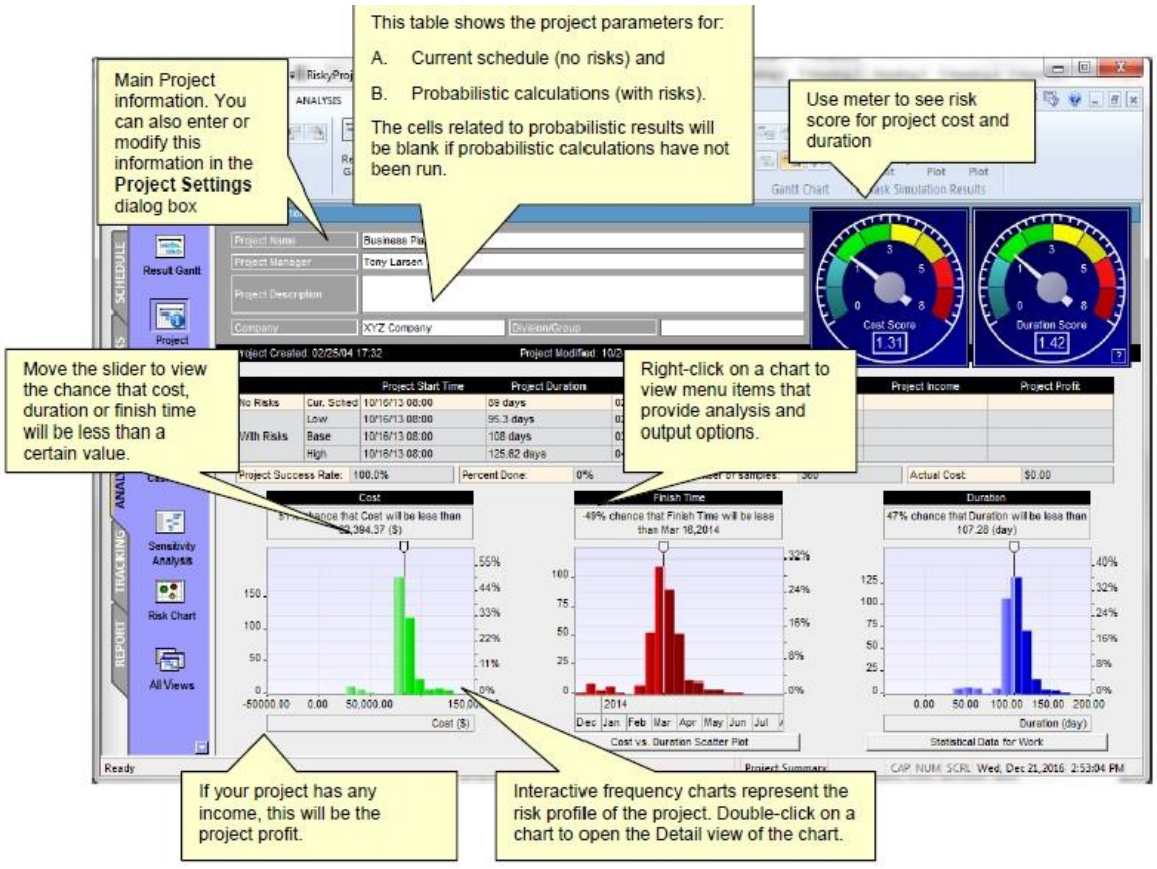


Figure 6.1 - Project Summary

6.2.2 Task Simulation Results [10]

RiskyProject allows you to quickly view the cost (profit, if income in any task is defined) duration, start time, and finish times uncertainties associated with each task.

The particular task will start and finish on specific dates and will have a duration and a cost less than a particular value. The six charts available are for:

- Cost (Profit)
- Duration
- Start Time
- Finish Time
- Variable cost
- Work

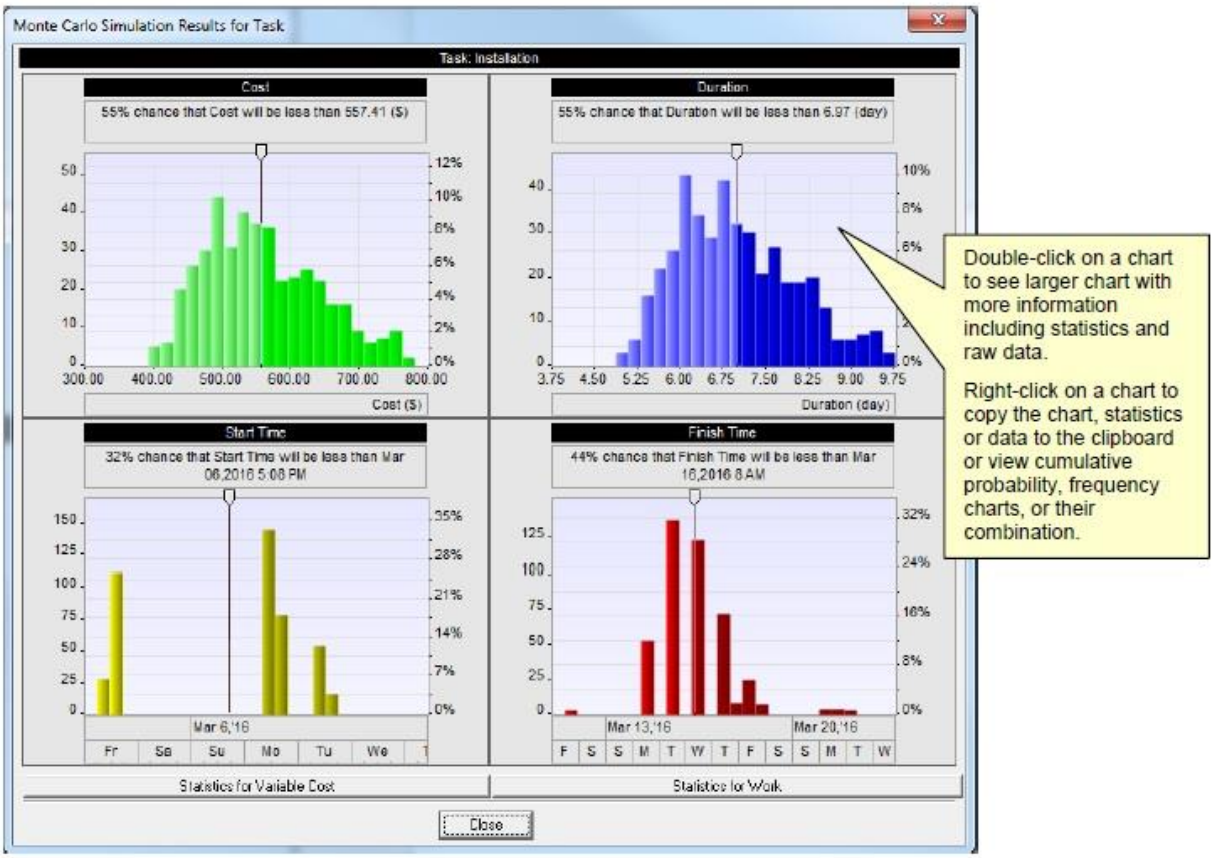


Figure 6.2 – Monte Carlo Simulation Results for Task

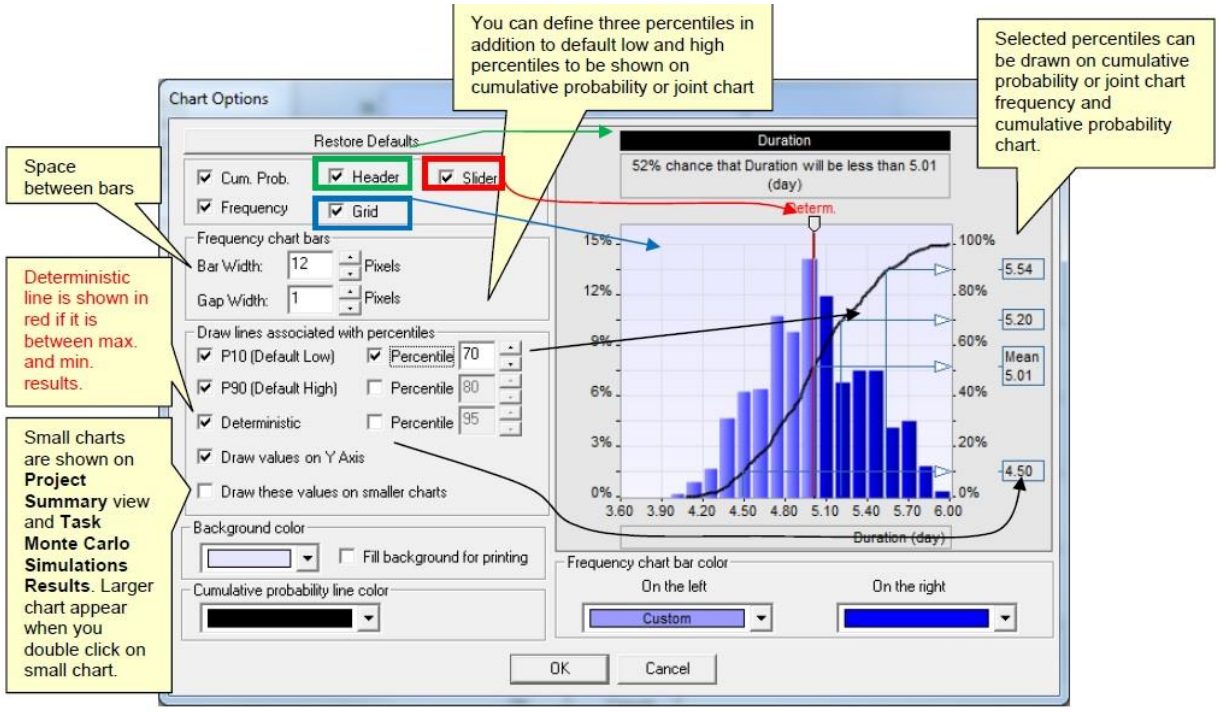


Figure 6.3 – Chart Option

6.2.3 Cash Flow results

The Cash Flow view demonstrates a comparison between the Current Schedule, Calculated (with risks and uncertainties), and Actual project cost and income.

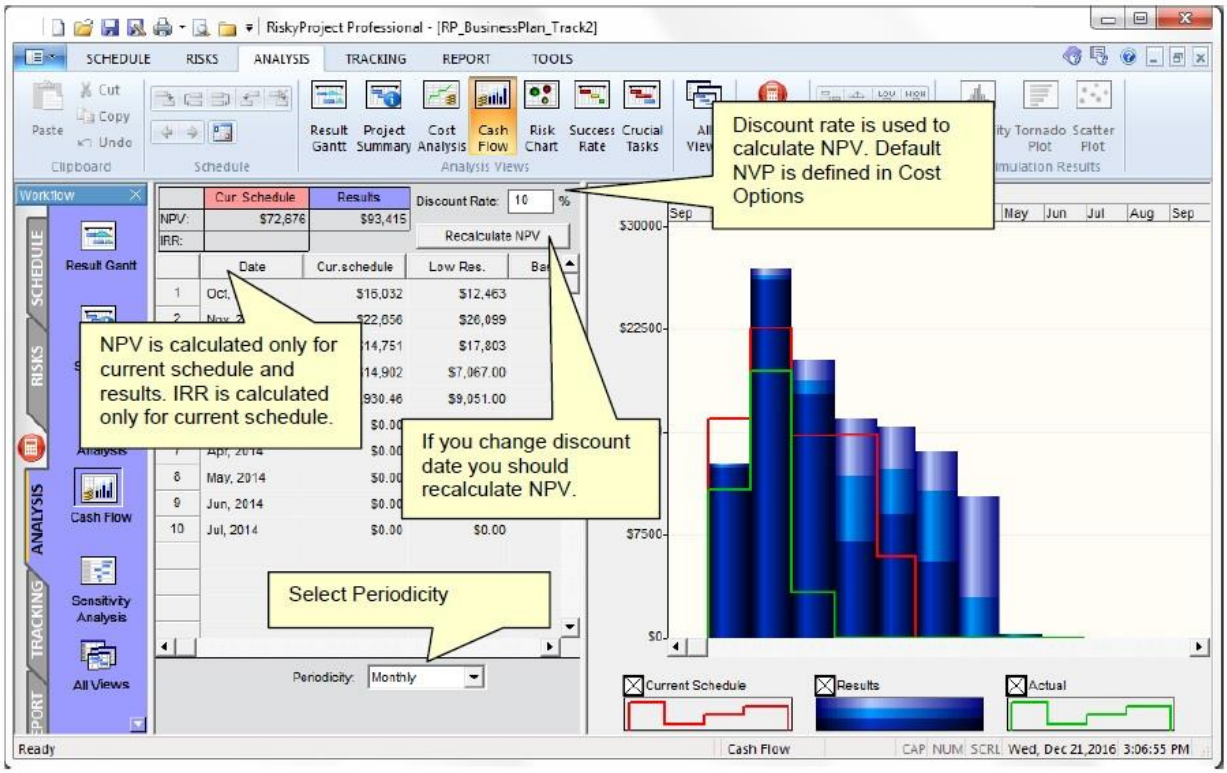


Figure 6.4 – Cash Flow Results

6.2.4 Sensitivity Analysis [10]

Sensitivity analysis shows which variables have the potential to have the most significant effect on the main project parameters. RiskyProject performs calculations for the sensitivity analysis as part of all probabilistic calculations. The results of sensitivity analysis are shown as a sensitivity chart in the Sensitivity View.

The Sensitivity view shows how sensitive or how much potential each project input parameter has on the main project parameters. Sensitivity measures how much a change in an input variable will affect the selected project parameter. For example, if a risk occurs, how much this will affect the project duration.

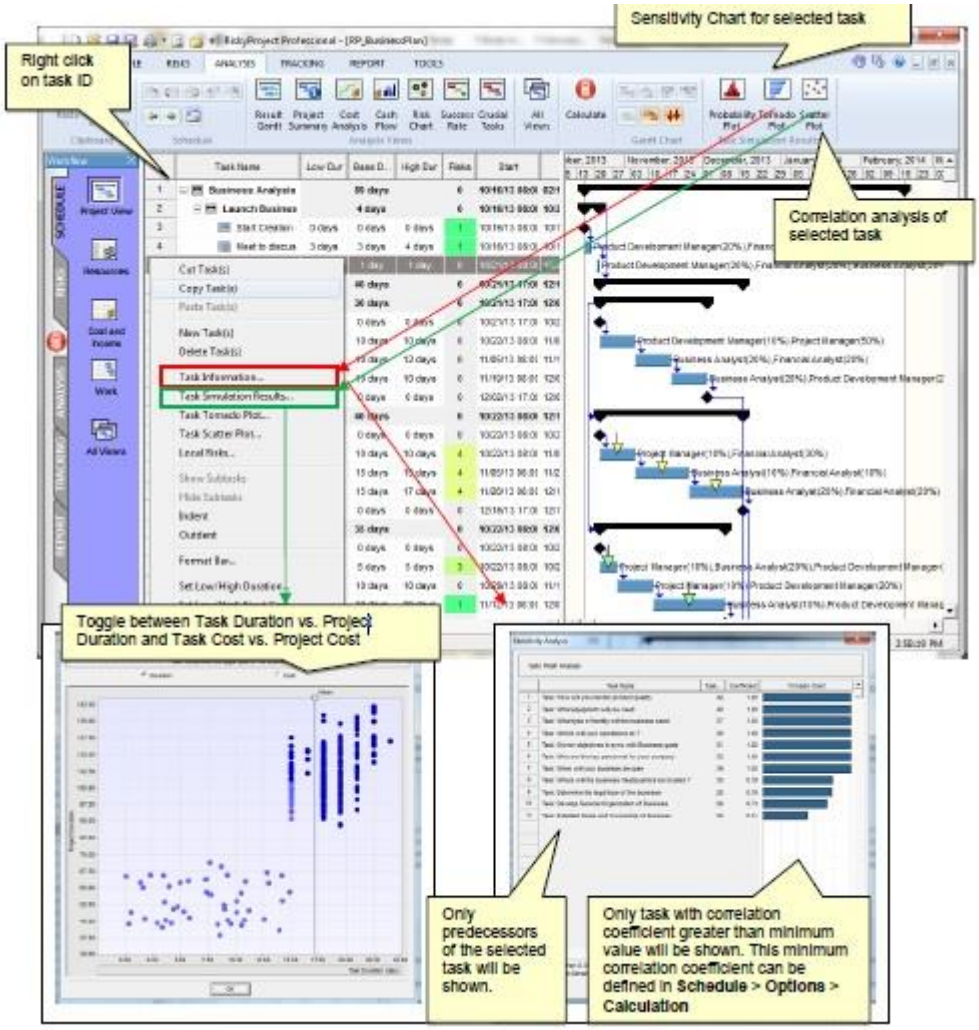


Figure 6.5 – Sensitivity Analysis

RiskyProject uses six input parameters to calculate sensitivity:

- Task duration
- Task Start Time
- Task Success Rate
- Task Cost
- Lags
- Risks

You can select these inputs using the checkboxes at the bottom of the chart.

RiskyProject has the following output parameters:

- project duration
- cost
- finish time

- success rate
- non-schedule risk categories

You can also select “All Parameters.” You can only measure the effects of risks on “All Parameters” and all non-schedule risk categories. If you choose “All Parameters,” the sensitivity chart shows the ranking across all risk categories, using the risk weighting entered for each risk category.

6.2.5 Risk Chart [10]

The Risk chart shows risks associated with tasks versus task duration or cost. The risk is expressed as:

- task standard deviation of task duration or cost
- maximum or minimum values
- ranges: the difference between maximum and minimum values
- percentiles

7. Project Control (Plan Risk Responses, Monitor and Control Risks)

7.1 Risk Responses

This reaction process is planned for significant risks. Each reaction is a measure taken before the occurrence of a risk (possibly from the beginning of the work) to reduce the likelihood of occurrence or the extent of the adverse effects of risks and increase the likelihood of occurrence or the extent of the impact of the desired risks. Measures such as ensuring accidents at a construction workshop are a kind of risk response that reduces the impact. Emphasizing safety issues and taking safety training is another type of response to events that reduce the likelihood of occurrence.

Processes that directly send their output to this process:

- Identify Risks
- Risk Management Planning

Processes that directly use the output of this process:

- Preparing a Project Management Plan

7.1.1 Risk Response Strategies

The project manager can develop risk response strategies for individual risks, sets of risks, and project-level risks. The affected stakeholders can be involved in determining the strategy. Once the strategies have been chosen, they require to be agreed upon by the body that approves them. There are four strategies which inscribe individual risks for threats and opportunities as described

1. Avoid a Threat or use an Opportunity

This strategy includes taking the actions required to address a threat or an opportunity to ensure either that the threat may not occur or can have no influence on the project, or that the opportunity will occur and the project will be able to take advantage of it.

2. Transfer a Threat or Share an Opportunity

This strategy entails transference to a third party that is better positioned to address a particular threat or opportunity.

3. Mitigate a Threat or Enhance an Opportunity

Mitigation and enhancement are the most widely proper and widely used response strategies. Here, the approach is to recognize actions that will decrease the probability and/or the impact of a threat, and enhancement the probability and/or the impact of an opportunity.

4. Accept a Threat or an Opportunity

This strategy exerts when other strategies are not considered suitable or feasible. Acceptance entails taking no action, but the risk happens, in which case contingency plans may be extended ahead of time, to be implemented if the risk presents itself.

7.1.2 The Steps Involved in Planning Risk Responses

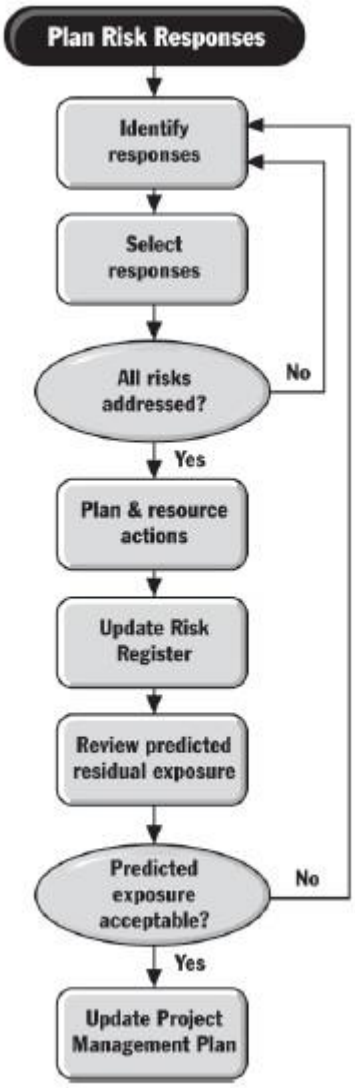


Figure 7.1 - The Steps Involved in Planning Risk Responses

7.1.3 Risk Mitigation and Response Plans [10]

You can model risk mitigation or response efforts in RiskyProject using the Mitigation or Response View. Response plans are activities that are executed when a risk occurs and are used for quantitative risk analysis. Mitigation plans are actions that are performed to minimize risk probability and/or impact and can be visualized using the Risk Mitigation Waterfall diagram. A mitigation or/and response plan must be assigned to a particular risk.

7.1.4 Assigning Risk Response Plans [10]

Response plans defined in the Mitigation and Response view can be assigned to risks. Only one response plan can be assigned to a particular risk.

7.1.5 Assigning Mitigation Plans [10]

You can assign mitigation plans defined in the Mitigation and Response view to your risks. One risk may have multiple sequential mitigation plans. They can be shown as a Waterfall diagram. Waterfall diagrams can be used to visualize the timing of mitigation efforts throughout the project.

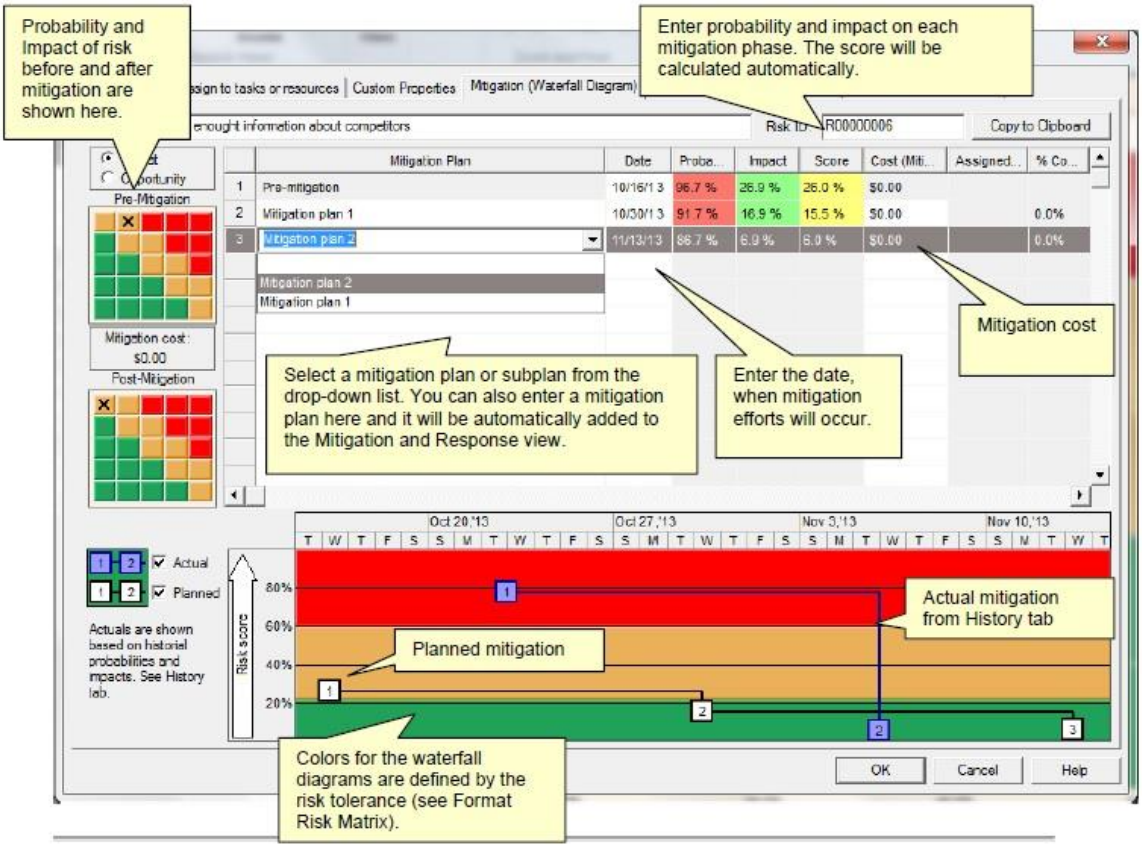


Figure 7.2 - Assigning Mitigation Plans

7.2 Risk control

Risks are planned in other processes, and results are implemented in the form of programs. In this process, we evaluate the effectiveness of risk response programs and design corrective actions to solve potential problems. All corrective actions are sent to the integrated control process of the changes so that they can be implemented in the event of approval by the programs.

Processes that directly send their output to this process:

- Identify Risks
- Monitor and Control Project Work
- Project Management and Project Management (Direct and Manage Project Work)
- Preparing a Project Management Plan

Processes that directly use the output of this process:

- Integrated Change Control
- Monitor and Control Project Work
- Preparing a Project Management Plan

Supervision and control of risk lead to tracking of known risks, remaining risks, and new risks. It also ensures the implementation of risk response programs and evaluates their effects. Risk monitoring and control continues throughout the project. A list of project risks is identified at the same time as the modified project, and the new risks are identified.

Project management has regularly reviewed the project risk over time. The degree of risk and priority of each risk will be considered and changed throughout the project.

If the risk is unpredictable or the risk effects are higher than expected, the correctional program would certainly not be adequate. The project manager will provide a new response to risk management.

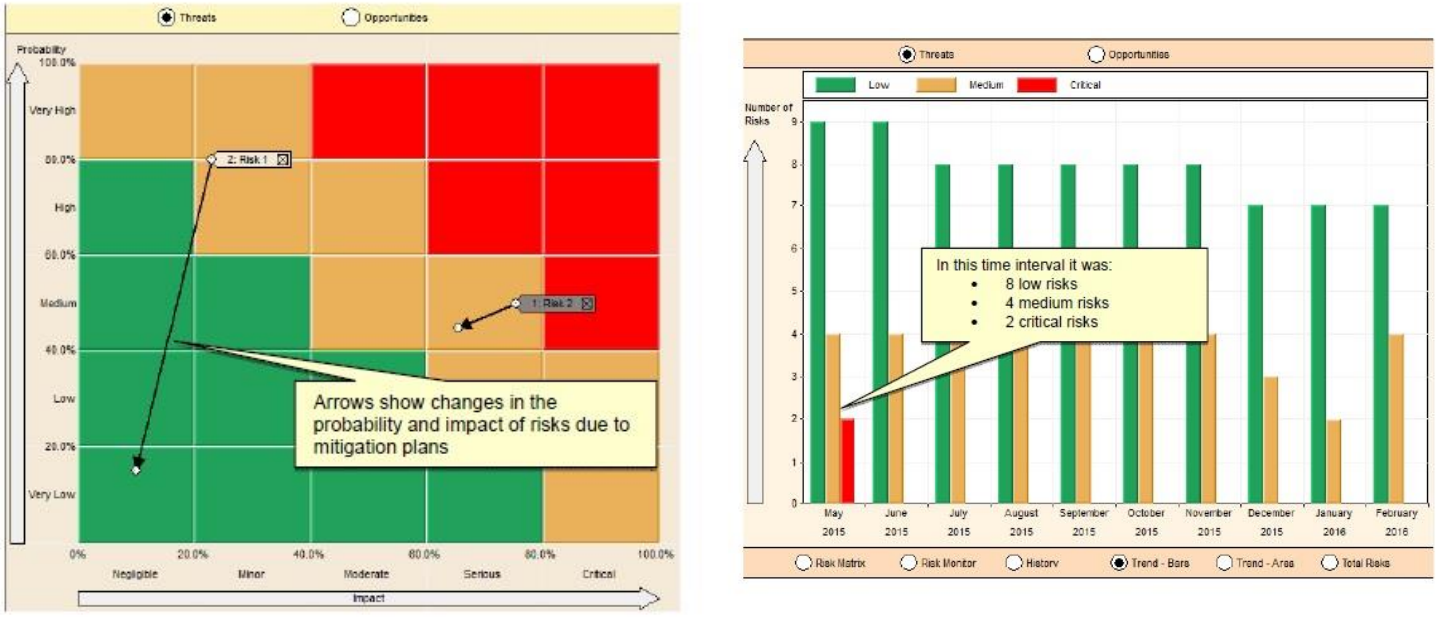
Risk control includes:

- Choosing an alternative reaction strategy
- Preparing a Possible Event
- Performing an appropriate action
- Reprogramming

7.3 Risk Matrix and Risk Trend Chart [10]

Risk Matrix and Risk Trend views allow you to determine the severity of a risk and analyze how risks are changing over time:

- The Risk Matrix is a tool that will enable you to determine the severity of a risk. The Risk Matrix view is divided into two sections: a table with a list of risks with their actual calculated values for probability, impact, and score. When you select these risks, they are shown visually on a matrix, which provides a visual comparison of this data put as well as putting each risk into the context of your organization's risk tolerance.
- Risk Trend shows how project risk changes over time. The Risk Trend can be presented as a bar chart, stack area chart, or in table format (Total Risks).
- Risk History shows how the probability and impact of an individual risk have changed over time.
- The Risk Monitor shows the number of risks per cell in the risk matrix.



Figures 7.3, 7.4, 7.5 - Risk Matrix and Risk Trend Chart

7.4 Tracking Performance

Tracking is an essential step in the project risk management workflow. Tracking information is demonstrated on the Tracking Gantt and Result Gantt views. The progress of summary tasks is a function of its subtasks; RiskyProject will calculate monitoring data for a summary task and complete the project automatically.

8. Reporting Project Results

One of the main tools for monitoring, reporting, and informing, documenting the evaluation process and Risk Management. Documentation involves collecting and summarizing information and compiling the results to a Report form. The essential part of such a report is to specify the goals of the study, the methods and methods used, the results obtained, the hypotheses and the uncertainties based on them Risk characterization and description, as well as risk management decisions, are made. The report should be of such a kind as to provide interested persons with sufficient information and reasons for any decision to express Some ideas for documenting risk assessment are:

- Describe how to conduct a risk assessment;
- Provide evidence-based on a systematic approach to the risk assessment process
- Establish a basis for judgment about the methods and methods used and the decisions to be made have been
- Continuous monitoring and review of risk management operations
- Participation and communication in the information
- Solving common problems and limitations in risk management
- Avoid superficially and without risk assessment planning

8.1 Risk Report [10]

Risk Report is a view, which exhibits attributes of chosen risks. The report for one risk may consist of one or a lot of pages. The quantity of the total number of pages per report equals the number of selected risks multiplied by the number of pages per risk. The Risk Report includes six sections:

1. General Properties
2. Pre- and post-mitigation probabilities, impact, and score
3. Cost of Risk
4. Custom Properties
5. Waterfall Chart
6. Mitigation Plans

Each page of the risk report contains a header and a footer. The header and footer may include up to three lines of text and a logo located on the left or right side.

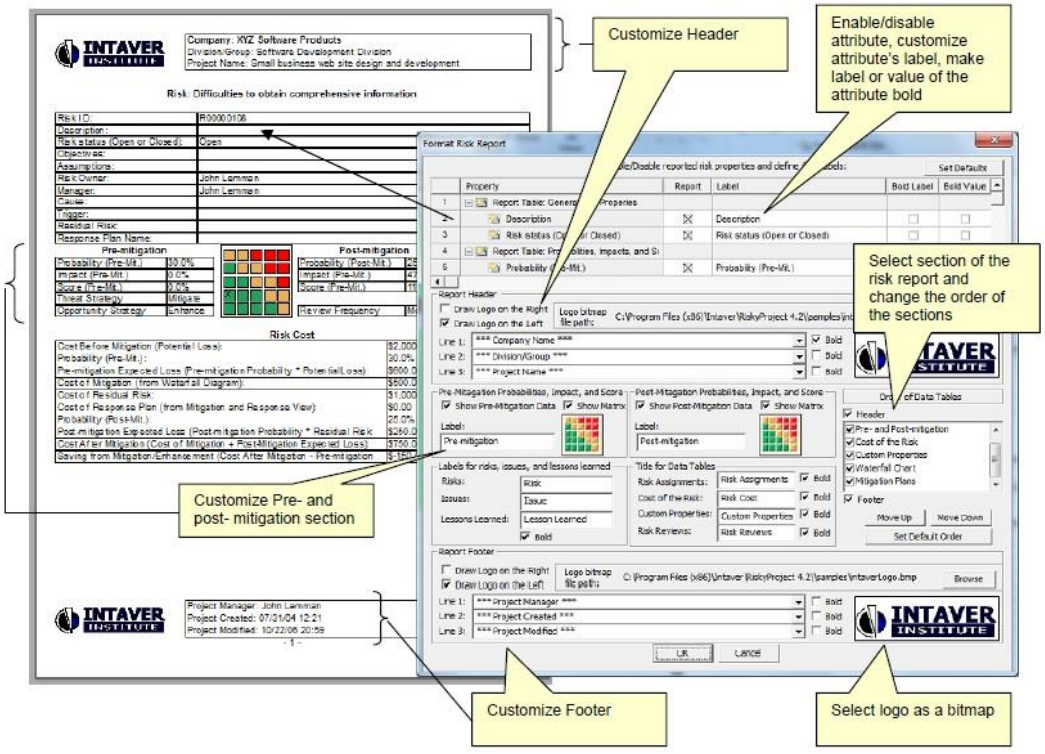


Figure 8.1 – The sample of a report

8.2 Statistics Report for Quantitative Analysis [10]

Once you have completed the Monte Carlo simulation, you can quickly generate a statistics report for selected tasks in your project schedule. The statistics report can include histograms for Start Time, Finish Time, Duration, and Cost as well as a Sensitivity to Finish Time table with a Tornado chart. Statistics reports can be exported to PowerPoint.

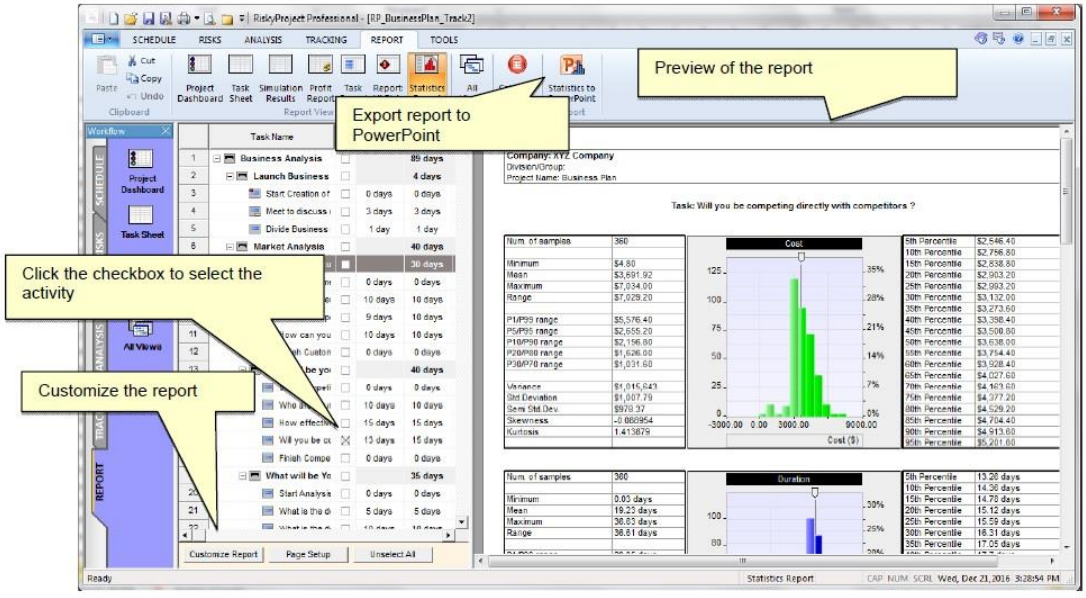


Figure 8.2 - Statistics Report for Quantitative Analysis

8.3 The Project Dashboard 3x3 [10]

RiskyProject includes the Project Dashboard 3x3. This view shows the results of your analysis in a logical and easy to understand manner. Total project cost, duration, and finish time with risks are the mean values for each. Crucial tasks and critical risks are the results of the sensitivity analysis.

Three main project parameters for the current schedule and with risks and uncertainties (mean values):

1. Total Project Cost
    - Project Finish Time
    - Project Duration
2. Three most crucial tasks
    - Effect on project cost
    - Effect on project duration
3. Three most critical risks
    - Effect on project cost
    - Effect on project duration

8.4 Task Sheet, Results, and Profit Reports

Use the Task Sheet view to enter and view baseline, low, base, and high task durations without a Gantt chart. The Results view is similar to Task Sheet View but shows the results of the probabilistic analysis. You can use these views for the reporting and analysis of your results. Profit Report view shows input data and results associated with cost, income, and profit. Report: All tasks

8.5 Task Reports

Use the Task Report View to display information for all tasks. This information includes:

- General task information (task duration, start and finish time, and costs)
- Predecessors
- Successors
- Advanced task information: task calendars, task type (Fixed Units, Fixed Duration, Fixed Work), Milestones, and other information
- Task notes
- Local risks assigned to tasks
- Resources assigned to tasks
- Tracking information

- Statistical distributions
- Branching information
- Branching notes
- Moment of risk information

8.6 Exporting Projects [10]

You may export project data to a variety of 3rd party applications. You may export data to Microsoft Project XML format, or MPX format. Most project management scheduling software supports Microsoft Project XML format. When Microsoft Project no longer saves data in the MPX format, it can still read this format.

9. Conclusion

The turbulent world of today has created unstable conditions for organizations and corporations. These conditions make organizations more vulnerable to risks, in addition to being more flexible. These risks, depending on their type and effects, can cause the organization problems in the short, medium, and long term. Sometimes these problems can be so significant that it threatens the foundation of the organization.

Managers today view risk management as one of the most critical requirements for their strategic management. They try to identify, assess, monitor and reduce the risks within and outside their organization through risk management processes and thus place their organizations at the margins of certainty against rapid changes in the environment and various hazards.

Risk management means using individuals or groups of skills to ensure that all risks are identified, measured, and implemented in a project that is in most cases out of range of time and human capability. So, it's best to do this using software tools that are designed to reach the objectives of project management more efficiently.

The purpose of risk management software is to facilitate the proper management of existing and defining risks in organizations and optimize time and cost, which includes identifying, evaluating, monitoring and reducing the impact of existing risks on businesses.

Considering the issues raised, the following are for the establishment of an effective risk management structure Required:

- Availability of financial, human, and information resources for conducting risk management programs at the decision and executive levels.
- Involvement of risk management considerations in the organization's strategic plans
- A clear understanding of risk
- Continuous identification and monitoring of opportunities and threats outside the organization and weaknesses and strengths within the organization
- Utilizing a dynamic and dynamic approach instead of a reactive and static approach
- Accountability and accountability of units and individuals for responsibilities assigned to risk management programs.
- Establish and maintain a supportive organizational culture
- Development and development of performance metrics to measure risk-based programs
- Reporting, information, and education to realize the principle of employee participation and interest groups
- Continuous review of risk management structure to identify recovery opportunities

In the case of effective risk management, it does not matter how well it is designed and operational. It only needs to provide reasonable assurance about the achievement of the goals for managers. Achieving goals is affected by inherent constraints in all management processes. These types of limitations include the judge's mistakes in decision making and failures that result from decision making.

False positives. On the other hand, management's ability to circumvent risk management processes involves decision-making in response to risk and control measures. Other limiting factors,

Paying attention to the cost and benefits of the desired responses to the risk.

Given the limitations of risk management, it should be noted that many factors, individually and collectively, affect the concept of project management.

The actions that may have to be done as a result of this report point to the role and position of using existing software to facilitate identification, analysis and computation, planning, control and monitoring, and especially the documentation.

RiskyProject is a complete and seamless package of project risk management software. It is simple to use, it integrates with all available scheduling and planning tools, and it includes the complete risk life cycle, all at a market-leading price. With RiskyProject, you no longer require two or more applications to perform Monte Carlo project risk analysis and to manage your risks.

9.1 RiskyProject Benefits [12]

- Manage your project risks and issues: Identify and track risks and issues using the Risk Register.
- Predict the course of your project: Determine how risks and uncertainties will affect your project schedule and budget.
- Instantly see which project parameters are the most critical: Project start and finish dates, durations, and costs with and without factoring in risks, crucial tasks, significant risks, and project success rates.
- Improve your ability to manage the course of your project: Track project performance and risk together and analyze the effects of your mitigation efforts.
- Analyze and manage risk in your project portfolio: share risks within your organization and analyze their impact of different projects within a portfolio.

9.2 RiskyProject Features [12]

- Schedule risk analysis using Monte Carlo simulations helps determine the impacts of risks and uncertainties on your schedule and generates risk-adjusted project schedules.

- Cost and cash flow risk analysis is integrated with schedule risk analysis. Cost and cash flow charts provide you easy access to how risk can impact cost and revenue streams. The joint confidence level chart allows you to analyze project duration and cost, including time and non-time dependent costs.
- Sensitivity analysis helps to rank risks within a risk register and to determine crucial tasks. Interactive tools can help you assess project contingency and analyze multiple project scenarios.
- Risk Register covers the entire risk life cycle for project, program, or portfolio risks: threats, opportunities, issues, and lessons learned with their properties. You can rank risks within the risk register based on their probabilities, impacts, and scores. Risks from risk register can be quickly linked to project tasks and resources using the Risk Drag'N'Drop View.
- The project risk management process includes risk identification and analysis, mitigation and response planning, and risk communication. RiskyProject includes risk reviews and risk history. You can assign any documents to the risks. RiskyProject will notify you about any changes to risk properties.
- RiskyProject's risk register includes schedule-related and non-schedule risks. These risks can affect not only project schedule and cost, but also performance, safety, and security, among other risk categories.
- You can create and assign risk mitigation and response plans to any risks and determine what impacts they might have on the project schedule and ranking risks within the risk register.
- Using RiskyProject Enterprise, you can perform a project portfolio risk analysis and risk management. The risks from the organization-wide risk register can be assigned to different projects and within a specified project to various tasks and resources. RiskyProject Enterprise supports your project portfolio hierarchy and allows you to rank projects within a portfolio. RiskyProject Enterprise also provides a common depository of response and mitigation plans.
- RiskyProject Enterprise includes user management functionalities, user roles, and permissions.
- RiskyProject allows you to report the results of the Monte Carlo schedule risk analysis in customizable histograms and charts. RiskyProject also includes project risk management reporting, be it for an individual risk or a group of risks with their properties, as well as containing the complete risk register.

9.3 Comparison of software capabilities with the standard PMI

The first stage is the critical success factors for project risk management. As stated in PMI, these factors depend on six factors:

- Recognize the Value of Risk Management
- Individual Commitment/Responsibility
- Open and Honest Communication
- Organizational Commitment
- Risk Effort Scaled to Project
- Integration with Project Management

Some of the above are outside of the calculations and procedures of risk management, and most reflect the external aspect and understanding and commitment of an organization. With these interpretations, one might argue that besides the best and most professional software and tools designed to perform the process more efficient and more comfortable, but if there are no responsible, professional and committed people in a team or organization, the project will not succeed. However, it can be said that from the operational point of view of the factors mentioned above, this software can be integrated with other project management processes besides, if we invested in professional software to do the risk management process more comfortable and reduce the cost and time of the project we can create value for our project because we understood the importance of risk management.

To better understand the capabilities of this software in project risk analysis, it is best to compare it with the minimum requirements of this process as outlined in the PMI book. Therefore, we have prepared a table to understand better this, which describes the various stages of a project's risk management process and its requirements. (Refer to Table 9.1 at the end of the chapter)

In the following, we want to explore more details that see if the computing method chosen in this software is appropriate or not?

One of the controversial issues in quantitative risk analysis of the project is the disadvantages of using the Monte Carlo simulation method. Therefore, it is best to first give an introduction about simulation and then its advantages and disadvantages.

Man has created various systems of production and service to meet his needs. These systems have grown and developed over time and in turn, have multiple problems.

On the other hand, the complexities of these systems have made the decision-making, guidance, and control process very difficult for those responsible. Therefore, different systems, methods, and techniques have been developed to solve problems and ultimately help authorities to identify and improve the performance and decision making of different systems depending on the type of system and problem concerned. Mathematical analysis, objective and empirical observation, and various techniques of operational research can be considered as examples of these methods. Naturally, each of these methods has its strengths and limitations, and it is not merely possible to apply them to a particular system and produce the same results.

Simulation is another way to identify the situation and improve the performance of the systems. Simulation is one of the powerful excellent tools for analyzing the performance of complex systems processes. So modeling relies heavily on computer science, mathematics, probability, and statistics through simulation.

Generally, it can be said that the model is the right combination of the characteristics of a system and its related information used to evaluate the system. It is usually the type of survey that determines the model and the amount of information contained in it. Therefore, different studies may require different models of a system. In other words, systems do not have a unique model in various studies. The problem that arises here is to learn the details of the system by model or how close the model is to reality. Two questions arise:

What type and how many features and details of a system should be included in a model?

How much is the model similar to the real system?

Indeed, the more details of the system are included in the model, the more similar it is to the system, and we have better shows of its behavior. On the other hand, more details in the model make the study more difficult and delay in concluding.

Missing some of the details makes it easier and shorter to make the model easier to analyze and, on the other hand, makes the results farther from the realities and more useless in the real system.

Therefore, it is one of the analysts' responsibilities to balance the model in the modeling and incorporation of the system into it, given the accuracy required in the results. This equilibrium should be such that it is possible to verify first by existing techniques and tools and secondly that the results of the verification are consistent or close to reality.

As mentioned, one of the systems analysis methods is a simulation. Simulation applies to all sciences.

Simulation is the trend of designing a model of a real system and experimenting with the model to find out the behavior of the system, or to evaluate different strategies.

When is the simulation used?

Where analytical methods are due to the complexity of models or the need to produce more realistic system behavior is impractical. In the simulation, there is complete control over time. The following can also be used for simulation:

- Conditions where algebraic analysis is not possible
- Uncertain systems
- Dynamic systems
- Complex systems
- Conditions that cannot be tested in the real world
- The system has not yet been created.
- There are many risks involved.
- The cost of testing is high.

One of the disadvantages of the simulation may be that it may be complicated to maintain the same operating conditions for each iteration or test run. For example, if people are an integral part of the system, the simulation may change due to changes in attitudes.

Developing a reasonable simulation model is often expensive and time-consuming and requires a lot of information that may not be readily available.

Simulation can pretend to represent the real-world situation accurately, but not in reality.

The simulation results are usually numerical and are determined by any number of decimal places the experimenter chooses.

The superiority of Monte Carlo is its ability to collect a lot of factors in a range of values for different inputs; this is also its most significant disadvantage. It means that assumptions need to be fair because the outputs are excellent only when the inputs are proper too. There are no constraints for it. In essence, and only users create constraints in a model. Such as any model, you need quality inputs to get quality outputs.

Another problem with this method of analysis is that it doesn't convey the right level of success because success isn't defined appropriately.

In this part, we describe the major limitation of only using Monte Carlo simulation to perform risk analysis.

It is that it needs a lot of data. It should be express all the variables with probability distributions and to understand the means of modeling and all the correlations between variables.

In many real problems, information is scarce. When we have a lack of data, the analyst may be forced to use subjective judgment to create probability distributions. Correlations are a big problem when there is a lack of knowledge, so it can be an image that all variables are independent. Neglecting correlations cause a serious problem with the analysis of risk.

In summary, Monte Carlo simulation is the main tool in our analysis, but it should be used with great caution, mainly where data are infrequent and when correlations are not well understood.

** for review the calculation algorithm of this software with a simple example see this link:
http://www.intaver.com/IntaverFrm/viewtopic.php?f=4&t=1022&p=2098&hilit=problem#p2098

9.4 RiskyProject Software: Advantages & Disadvantages

Since risk management is an essential aspect of project management, it involves many different analytical computation techniques that are more related to risk analysis. Such procedures are sometimes complicated and time-consuming, as in the Monte Carlo simulation risk analysis method. Due to such complications, many software has been developed to settle this problem.

Risk management software can be separated into two main classes: integration software and standalone ones. The Risky project can be both of them, and it is a pro. Nevertheless, using risk management software, in any type of it, has both advantages and disadvantages.

Apart from the clear advantage of saving time and eliminating the complexity of risk analysis techniques, this software allows project managers to access the latest tools for project risk assessment easily.

The key features that users, especially project managers, can access them are:

- Chance of the project being completed on schedule and within budget
- Chance that recognize the particular task on the critical path
- Tasks impact on the project duration at most
- The project success rate
- Necessary alerts regarding any risk for control
- Preparing charts, tables, and different reports in the most comfortable and most time-efficient manner

Besides, User-friendly is a common characteristic of this software. Being able to quantify the impact of risks with an almost entirely customizable ranking system makes it easier to adapt to various projects.

The disadvantages of using such software are the additional costs that may be incurred on a project except for maintenance and support. It also can be costly and time-consuming to learn this software, by all involved project persons, from the administrator to the expert in different departments.

Another disadvantage may be that relying on automated results in the form of charts and other types of reports, and it can create unpredictable risks of inaccurate data entry due to inexperience or doing wrong, or software error.

And perhaps it can be said that since risk identification and calculation of the probability of occurrence and the degree of significance and effectiveness of risk is an empirical and tasty matter and does not have the same formula, it can cause computational error because in manual calculations the factors can be reduced to a simple calculation but for automatic calculations you enter all the parameters, and you will not be able to detect errors.

In other words, one factor that can't be seen on such software is the level of technical autonomy. Many large companies have standards or methods which are intended to reduce costs. Project Management Software Technical can't cover these standards or methods.

The point to note is that time is the most strategic asset for any project and company. But if there is improper time management, it can be caused a significant risk factor. To get rid of this issue, perhaps Integrate this software with a time tracking software can help to have more safety risk management software with a higher confidence factor.

Importing data into this software is very time-consuming, and as Microsoft's suite of software, it is not possible to easily copy and paste data between cells. Therefore, in large projects where there are different risk scenarios with varying coefficients, the possibility of error is high, and it cannot avoid having to redo work.

RiskyProject mismatch with Any Excel File: In this case it can be described that, given the lack of a specific standard or at least one predefined Excel table for risk data, when we import our customized Excel file in to the software We are experiencing problems, and it cannot detect the relationship between the data or the titles. So, to solve this problem, it may be advisable to provide an Excel table pre-designed by INTAVER institute, which is compatible with software tools, to fill in the risk profile to solve this problem and reduces the time of adding risk features one by one directly in the software.

The absence of a valid global standard or contract to integrate all types of risk and scenarios involves the significant problem of human and software error, so far no software has been independent of human preferences.

In summarized Project Management Features in RiskyProject <u>included</u>:

- Agile Methodologies
- Cost-to-Completion Tracking
- Gantt Charts
- Milestone Tracking
- Portfolio Management
- Resource Management
- Traditional Methodologies

And Project Management Features that are <u>not included</u> in RiskyProject:

- Budget Management
- Client Portal
- Collaboration Tools
- Customizable Templates
- Idea Management
- Time & Expense Tracking

<u>Existing</u> Risk Management Features in RiskyProject:

- Alerts/Notifications
- Corrective Actions (CAPA)
- Legal Risk Management

- Operational Risk Management
- Reputational Risk Management
- Response Management
- Risk Assessment

<u>Not Existing</u> Risk Management Features in RiskyProject:

- Auditing
- Business Process Control
- Compliance Management
- Exceptions Management
- Internal Controls Management
- IT Risk Management
- Predictive Analytics

To conclude, although risk management software has been developed to make projects successful at minimal or controlled risks, the use of such tools requires a full awareness of the consequences of any associated misuse. Also, team collaboration and clarity are crucial for success.

9.5 Interoperability with Microsoft project

Since the Management software is a long term solution to leverage existing investment in Microsoft technology, therefore, if subsidiary software is more adapted with MsProject, such as RiskyProject, there is a higher chance of achieving a more significant market share and success in upgrading software capabilities. In this part, we take a precisely look at the gaps between the two software.

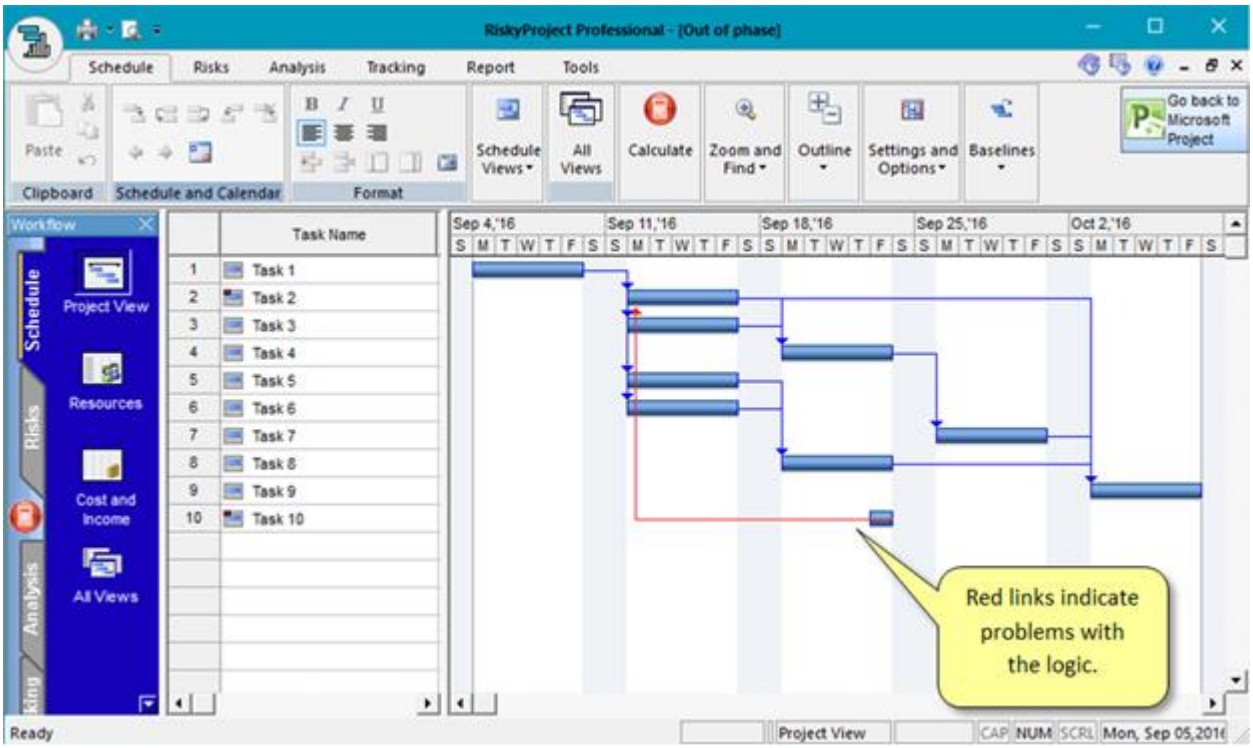
- **Import MS Project schedule**

Master schedules are often problematic with RiskyProject. They are usually representing a program of projects that are being managed by several different project teams. They mostly become out of date or synchronization with each other, and this can create a problem with links between the subprojects.

So we can see in some cases that, we import the master schedule, but the dates for some activities have moved. This can often happen if due to sort of issues, the logic in the Master Schedule is broken. When there are errors with the network logic, RiskyProject highlights the issue predecessor links in red. By following the predecessor links, you can be able to go back and edit your master schedule to modify the link.

A simple instance below presents activities that have real start dates. While, Task 10 is the predecessor of Task 2; As it started before Task 2. The broken logic is visible with the red link. As you can fix this in RiskyProject, when these issues become manifest, we recommend that these issues are rooted in the originating schedules.)

Figure 9.1 - lack of synchronization



- **Move original file from Ms project to RiskyProject**

As mentioned earlier, we can transfer project schedule files from Ms project to RiskyProject in two ways. One is to exit the XML format from Ms project and call it in RiskyProject, and the other is to use a toolbar added as RiskyProject in Ms project.

In the first case, it is not possible to update the modifications to the original schedule files provided by Ms project, and the XML format output needs to be repeated frequently, or it can be entirely run in RiskyProject software.

In the second case, there is still no possibility of automatic updating, and we should continue our activities in the RiskyProject software or any changes made manually to the original file or as in the first case, using formatting transforming.

Table 9.1 - Comparison of software capabilities with the standard PMI

	Different Parts, aspects and steps Of Project Risk Managements	Important dimensions of the step	The term of used or tools and techniques	Status in RiskyProject
			Generally	
1	Project Risk Requirements	uncertainty and effect on a project's objectives	"probability" and "impact"	defined and will be calculated on the software with specific parameters.
		demonstrate Positive and negative of impact	"threats" and "opportunities"	will be calculated and show with negative and positive numbers in the table of software.
		definition of cause-risk-effect chain	"risk statement" or "risk description"	there is a cell for describe each risk or add comment on it.
		Identify Individual Risks and Overall Project Risk	-	assign the risk to the each task or in the global
		Stakeholder Risk Attitudes	-	it is out of scope of software capabilities because it strongly influenced by an organization's culture. Understanding stakeholders' attitudes toward risk is an important component of risk management planning that precedes risk identification and analysis, in order to optimize both project success and stakeholder satisfaction with the project's results.
		Iterative Process	-	The amount of information available about risks will usually increase as time goes on. To ensure that Project Risk Management remains effective, the identification and analysis of risks should be revisited periodically, the progress on risk response actions should be monitored, and the action plans adjusted accordingly. It is an important feature of the software that is capable of periodic alerts and reviews.
		Communication	-	Communication of the results of the Project Risk Management process should be targeted to meet the specific needs of each stakeholder and should be reflected within the overall project communications strategy with each stakeholder's responsibility and role in risk management identified and agreed-upon. it should be noted taht this communication is outside the scope of the software domain and is related to project organization and management.
		Responsibility for Project Risk Management	-	risk management is everyone's responsibility, however, Roles and responsibilities for Project Risk Management will be clearly defined and communicated in the software. also individuals should be held responsible and accountable for results.

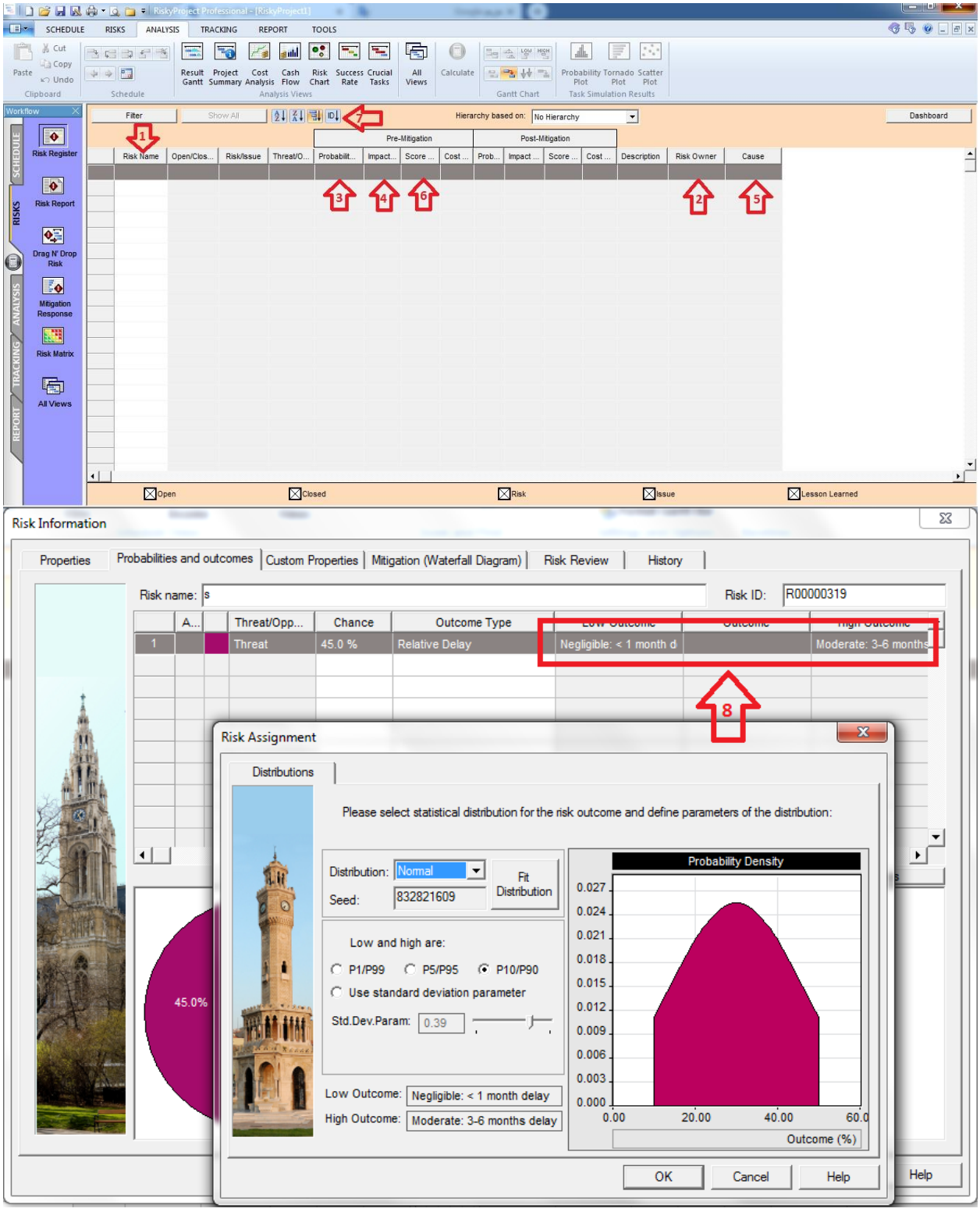
	Different Parts, aspects and steps Of Project Risk Managements	Important dimensions of the step	The term of used or tools and techniques	Status in RiskyProject
1	Project Risk Requirements	Project Manager's Role for Project Risk Management	-	this software can be a great guid or help for project managers with its results and reports and feedbacks that they can do their tasks more optimally and have more effective decisions.
2	the role of Project Risk Management and Project Management	The outputs of Project Risk Management should be taken into account within many of the project management processes. They can, for example, impact: • Estimating resource requirements, cost, or duration; • Assessing the impact of proposed scope changes; • Planning or re-planning the forward strategy of the project; • Allocating resources to tasks; and • Reporting progress to stakeholders. None of these actions can be performed properly without a clear view of the risk involved, as determined during the Project Risk Management process. In other words, project management process effectiveness is increased by using the information and results from Project Risk Management. In addition, effective Project Risk Management requires input from other project management processes. Outputs such as the work breakdown structure (WBS), estimates, the project schedule, assumptions list, etc. are all important prerequisites for effective Project Risk Management.	-	RiskyProject covers all this requirements.

	Different Parts, aspects and steps Of Project Risk Managements	Important dimensions of the step	The term of used or tools and techniques	Status in RiskyProject
3	Project Risk Management Processes	It is clear that different projects are exposed to different levels of risk, so each step in the Project Risk Management process should be scalable to meet the varying degrees of risk. Scalable elements of the process include: • Available resources, • Methodology and processes used, • Tools and techniques used, • Supporting infrastructure, • Review and update frequency, and • Reporting requirements.	-	respectively: • Available resources: are assigned in the software like Msproject. • Methodology and processes used: Quantitative and Qualitative analysis are the base of methods of analysing the risks and also the step of process risk management are defined in the software. • Tools and techniques used: for example we can pointed to the monte carlo calculation that is a tools for simulation of condition. • Supporting infrastructure: It has been able to support infrastructures by defining the tools needed to make software easier to use and adapt to other software such as Msprojects and Primavera • Review and update frequency: as we mentioned before Iterative Process is an important part for cover this on the software. • Reporting requirements: there are any kind of requirement reports as we described on the thesis before.
		The main actions to provide the required tailoring are as follows: • Define those objectives against which risks will be identified, • Define how the elements of the Project Risk Management process will be scaled for this project, • Define risk thresholds, tolerances, and the assessment framework. The outputs from this initial step should be documented, communicated, and then reviewed by the stakeholders to ensure a common understanding of the scope and objectives for the Project Risk Management process. The document should be formally approved at a senior level.	-	Some of these actions are covered in the software, but if the requirements are defined, approved and documented by the beneficiaries before proceeding to define them in the software, as they are entirely to the taste of the individual. Such as the risk threshold or the number of replications or their importance and ...

	Different Parts, aspects and steps Of Project Risk Managements	Important dimensions of the step	The term of used or tools and techniques	Status in RiskyProject
Steps Project Risk Management Processes				
1	Plan Risk Management	Tailored risk management process Depending upon the size and complexity of the project, some or all of the following elements will be present in a risk management plan. • I ntroduction; • Project description; • Risk management methodology; • Risk management organization; • Roles, responsibilities, and authority; • Stakeholder risk tolerance; • Criteria for success; • Risk management tools and guidelines for use; • Thresholds and corresponding defi nitions; • Templates; • Communications plan; • Strategy; • Risk breakdown structure.	-	In fact, risk management planning is a process that must be started before using the software and some parts of it are almost out of software scope, but the outputs and decisions made in this step have a direct impact on the software input data and its analysis. In continue othe parts are covered in the other steps of risk management process that it can be seen as follow.
2	Identify Risks	List of risks	Tools and Techniques 1. Historical Review 2. Current Assessments 3. Creativity Techniques We should to add that Due to the possibility of different iterations and evaluations and displaying different types of results extracted from the analysis, tools and techniques of all step are embedded in software.	* show on the picture as a number 1

	Different Parts, aspects and steps Of Project Risk Managements	Important dimensions of the step	The term of used or tools and techniques	Status in RiskyProject
2	Identify Risks	Risk owners	the point that we should emphesized on it here is that identification of the types of risks are according to each project and are different from one project to other one, so it can be said identification of risks and their features are completely humans process and software only can help to analysis and create necessary outputs for risk management.	* show on the picture as a number 2
3	Perform Qualitative Risk Analysis	Probability	Tools and Techniques 1. Select Risk Characteristics that Define Risks' Importance 2. Collect and Analyze Data 3. Prioritize Risks by Probability and Impact on Specific Objectives 4. Prioritize Risks by Probability and Impact on Overall Project 5. Categorize Risk Causes	* show on the picture as a number 3
		impact		* show on the picture as a number 4
		root causes		* show on the picture as a number 5
		importances		* show on the picture as a number 6
		prioritized list		* show on the picture as a number 7
4	Perform Quantitative Risk Analysis	Numerical models	Tools and Techniques 1. Comprehensive Risk Representation 2 .Risk Impact Calculation 3. Quantitative Method Appropriate to Analyzing Uncertainty 4. Data Gathering Tools 5. Effective Presentation of Quantitative Analysis Results 6. Iterative Quantitative Risk Analysis 7. Information for Response Planning	using the Monte Carlo method demonstrated a numerical model for simulation condition.
		combined outcomes		Based on previously detailed described about softwares' features, the software has this capability to combine a variety of risk scenarios with different probabilities and impacts. We can be acess to this capability from the risk information window.
		confidence limits		* Show on the picture as a number 8 In the part of risk information we can defined the limitation for our outcomes.
		sensitivity analysis		Sensitivity Analysis view icon will be shown only of you have a project schedule. To see which activities these are on the ribbon, click Analysis > All Views > Sensitivity Analysis

	Different Parts, aspects and steps Of Project Risk Managements	Important dimensions of the step	The term of used or tools and techniques	Status in RiskyProject
4	Perform Quantitative Risk Analysis	prioritized list updates		In any steps all the tasks, risks, results have ability to priority and be updated automatically and manually.
5	Plan Risk Responses	Strategies	Risk Response Strategies 1. Avoid a Threat or Exploit an Opportunity 2. Transfer a Threat or Share an Opportunity 3. Mitigate a Threat or Enhance an Opportunity 4. Accept a Threat or an Opportunity There are four categories of tools and techniques, as follows: • Creativity tools to identify potential responses, • Decision-support tools for determining the optimal potential response. • Strategy implementation techniques designed to turn a strategy into action, and • Tools to transfer control to the Monitor and Control Risks process. The steps involved in planning risk responses are shown: 1. Response Identification 2. Response Selection 3. Action Planning 4. Ownership and Responsibility Assignment	* Show on the picture as a number 9
		actions		* Show on the picture as a number 10
		action owner		These are embedded within the software. Also we can see there are facilities on the software that see the features before and after mitigation response plan or define some response plan and choose between them for each selection risk.
		timing		
		analysis		
		project plan updates		
6	Monitor and Control Risks	Status and trends	Tools and Techniques 1. Managing Contingency Reserves 2. Tracking Trigger Conditions 3. Tracking Overall Risk 4. Tracking Compliance	Clearly, with tools and parts like riskreview or traking and reporting, this step of risk management is completely covered in software.
		reporting		
		trends in risk exposure		


SCHEDULE
RISKS
ANALYSIS
TRACKING
REPORT
TOOLS
Risk Register
Risk Report
Drag N' Drop Risk
Mitigation Response
Risk Matrix
All Views
Filter
Show All
Hierarchy based on:
No Hierarchy
Dashboard
Pre-Mitigation
Post-Mitigation
Risk Name
Open/Clos...
Risk/Issue
Threat/O...
Probabilit...
Impact...
Score ...
Cost ...
Prob...
Impact ...
Score ...
Cost ...
Description
Risk Owner
Cause
1
2
3
4
5
6
7
Open
Closed
Risk
Issue
Lesson Learned
Risk Information
Properties
Probabilities and outcomes
Custom Properties
Mitigation (Waterfall Diagram)
Risk Review
History
Risk name:
Risk ID:
R00000319
A...
Threat/Opp...
Chance
Outcome Type
Threat
45.0 %
Relative Delay
Negligible: < 1 month d
Moderate: 3-6 months
8
45.0%
Risk Assignment
Distributions
Please select statistical distribution for the risk outcome and define parameters of the distribution:
Distribution:
Normal
Seed:
832821609
Fit Distribution
Low and high are:
P1/P99
P5/P95
P10/P90
Use standard deviation parameter
Std.Dev.Param:
0.39
Low Outcome:
Negligible: < 1 month delay
High Outcome:
Moderate: 3-6 months delay
Probability Density
0.027
0.024
0.021
0.018
0.015
0.012
0.009
0.006
0.003
0.000
0.00
20.00
40.00
60.0
Outcome (%)
OK
Cancel
Help
Help

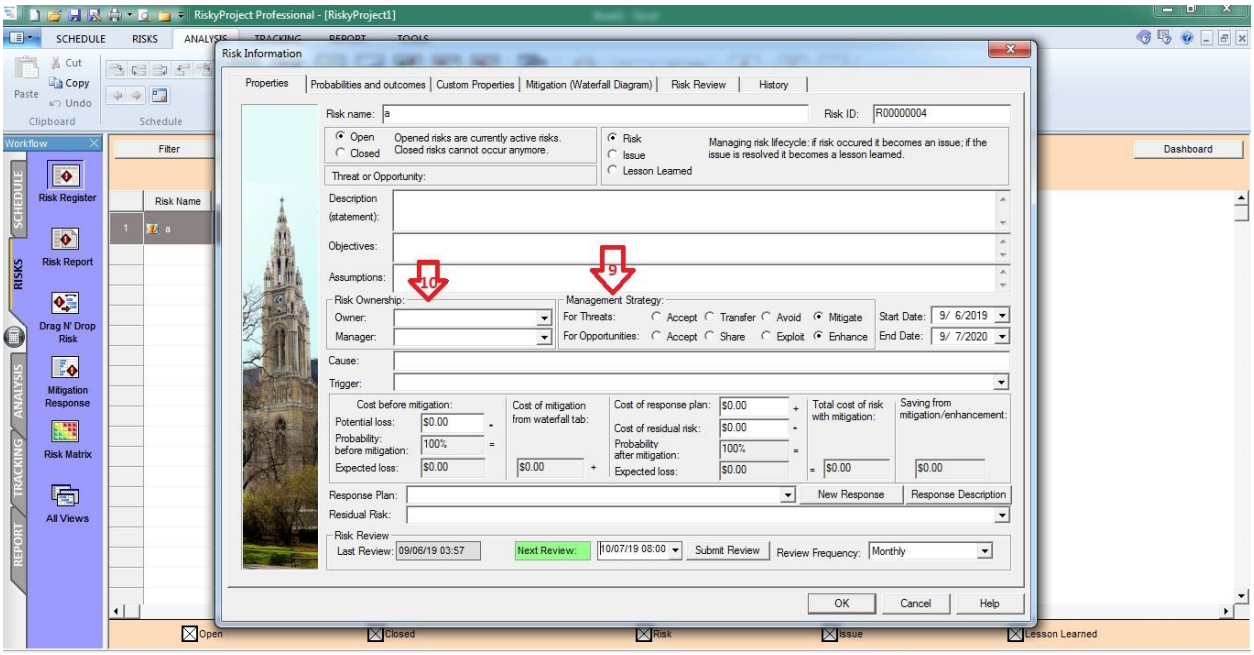


Figure 9.2,9.3,9.4 - Comparison of software capabilities with the standard PMI

Case Study:

Request for proposals hydroelectric power station construction project

To better evaluate the performance of the project risk analysis software (RiskyProject), we implemented a real project of relatively large size on it. This case is about a project that was planned in the year 2017-18 for a project management course to familiarize students with all the topics and stages of project management. The data used in this section are from the final output of the best project team that year. The description is as follows:

Brief description of the project: *

1. Introduction and Background

This Request for Proposal (RFP) solicits turnkey proposals from organizations with experience and expertise in power station projects. This scope includes a supply of a completed hydroelectric power station (including all infrastructures, civil works, plant, and production equipment as specified below). Nalcor Energy seeks delivery of these services cost-effectively.

Nalcor Energy intends to have a hydroelectric facility provided by the Vendor. Nalcor Energy shall only consider proposals from financially responsible firms presently engaged in the business of delivering power station construction projects. Each Vendor (proposer/firm) shall furnish the required documents in the required format as outlined in this RFP to be considered responsive. Nalcor Energy expects to award the contract to the best-valued Vendor based on the requirements in this solicitation. The Vendor selected for an award will be the Vendor whose proposal is responsive, responsible and is the most advantageous to the Nalcor Energy, as determined by Nalcor Energy in its sole discretion.

2. Manual Risk Management Result:

You can see the results of this project's manual calculations, which are the result of numerous consultative team meetings and different reviews and the use of similar project experiences.

Legend		Impact				
		1	2	3	4	5
Probability	1	0.04	0.08	0.12	0.16	0.2
	2	0.08	0.16	0.24	0.32	0.4
	3	0.12	0.24	0.36	0.48	0.6
	4	0.16	0.32	0.48	0.64	0.8
	5	0.2	0.4	0.6	0.8	1

Risk Response (General Rule)
Accept
Transfer to Client (Contingency)
Mitigate

* In this section, we do not go into the other phases of project management and only want to examine the risk management part from manual computing or software.

Qualitative Risk Table

Project Risks	Type	Categories	Outcome Types	Risks / Outcome Types	Environmental Risk		Legal risk		Performance risk		Quality risk		Relative cost increase		Relative delay		Safety risk		Technology risk	
					P	I	P	I	P	I	P	I	P	I	P	I	P	I	P	I
	External	Ambiental	Environmental Risk	Acts of God	1	1					1	3	1	2 , 3	1	1 , 3	1	2 , 3 , 4	1	3
				River Overflow									1	3	1	2 , 3 , 4	1	3 , 4		
				River Freezing											2	3	2	4		
		Social	Relative delay	Environmental Demonstration											2	1 , 2 , 3	2	2		
				Trade Union Strike	1	1					1	2 , 3	1	2 , 3	1 , 2	1 , 2 , 4	1 , 2	2 , 3 , 4	1	3
		Political		Regulation change													1 , 4	2 , 4		
		Financial	Relative cost increase	Exchange Rate							3	3								
				Material Cost Increase							1	1	1	1	1	2	1	1 , 2 , 3	1	1
		Commercial (Suppliers)	Quality risk	Low Raw Material Quality							1	2 , 3	1	2 , 3	1	1 , 3	1	1 , 2 , 3	1	3
				Turbines and Generators Quality							1	3								
				Third Party Delay							1	2 , 3 , 4	1	3	1	2	1	3 , 4	1	3
				Supplier Bankruptcy (Insolvency)							1	3								
		Legal	Legal risk	Authorization & Approval Delay			4	1 , 5												
	Internal	HR	Safety risk	HR Availability					2	3	1 , 2	1 , 2 , 3	2 , 3	1 , 2 , 3	1 , 2	2 , 4	1 , 2 , 3	1 , 2 , 3 , 4	2	1 , 2
				Workplace Safety (HSE)	1	1					1 , 2 , 3	2 , 3	1 , 2 , 3	1 , 2 , 3	1 , 2	2 , 3	1 , 2 , 3	1 , 2 , 3	2	3
				Expertise							1 , 2 , 3	2 , 3	1 , 2 , 3	1 , 2 , 3	2	3	1 , 2 , 3	1 , 2 , 3 , 4	2	2
		Technical	Technology risk	Facilities & Equipment Breakdown							1	2	2	1	1	2	1	1 , 2	2	1
				Test Failure															2	3
				Changes in the Work or Design					2	3							2	2 , 3	2	2
		Project Management	Performance risk	Planning and Controlling					1	3										
				Coordination & Cooperation					1	3	1	2					1 , 2	3	1	3

Quantitative Risk Probability Table

Impacting Tasks \ Risks	External													Internal								
	Ambiental			Social		Political	Financial		Commercial (Suppliers)				Legal	HR			Technical			Project Management	
	Acts of God	River Overflow	River Freezing	Environmental Demonstration	Trade Union Strike	Regulation change	Exchange Rate	Material Cost Increase	Low Raw Material Quality	Turbines and Generators Quality	Third Party Delay	Supplier Bankruptcy (Insolvency)	Authorization & Approval Delay	HR Availability	Workplace Safety (HSE)	Expertise	Facilities & Equipment Breakdown	Test Failure	Changes in the Work or Design	Planning and Controlling	Coordination & Cooperation
Hydroelectric Power Station Construction Project																						
Contract Finalization and Signature						1							1	1								
Mobilization, Site Equipment, Installation	1	1		2	1				1						1							
Temporary Bridge	1	1		2	1			1	1		1			2	2	2	1					
Access Roads, Ramps and Pads	1	1		2	1			1	1		1			1	1	1	1					
River Diversion	1	1	2	2	2									1	2	2						
Dewatering of structure areas	1	1	2		2										1	2	1					
Basic Design														2		2			2			2
Permits and Authorization Basic Design						4							4	2								
Detailed Engineering (Dams)														2					2			1
Detailed Engineering (Intake/Powerhouse and Turbines)														2					2			1
Detailed Engineering (Spillway)														2					2			1
Base Slab Spillway	1				1			1	1		1			1	1	1						
Concrete Casting and Pouring Spillway	1				1			1	1		1			1	1	1						
Steel Structure realization Spillway	1				1			1	1		1			2	2	2						
Spillway Bridges	1							1	1		1			2	3	1						
Discharge Channel	1							1	1		1			2	1	1						
Electrical Works Spillway					1			1	1					2	3	3						
Substructure Intake/Powerhouse	1				1			1	1		1			2	1	2						
Concrete Works Intake/Powerhouse	1				1			1	1		1			3	1	1						
Steel Structure Intake/Powerhouse	1				1			1	1		1			3	3	2						
Building and Architectural Works	1				1			1	1		1			2	2	2						
Electrical Works Intake/Powerhouse								1	1					2	2	2						
Turbines Erection					1		3		1	1	1	1		1	1	1	1					1
Generators Erection					1		3		1	1	1	1		1	1	1	1					1
Foundation - Preparation, Jet Grouting and Drainage (North Dam)	1	1			1			1	1		1			2	1	1						
Elevation - Concrete Casting and Pouring (North Dam)	1	1			1			1	1		1			2	1	2						
Structural Steel and Miscellaneous Metal (North Dam)	1				1			1	1		1			2	2	2	2					
Electrical Work (North Dam)					1			1	1		1			2	3	3						
Foundation - Preparation, Jet Grouting and Drainage (Central Dam)	1							1	1					2	1	1						
Elevation - Concrete Casting and Pouring (Central)	1							1	1					2	1	2						
Structural Steel and Miscellaneous Metal (Central)	1							1	1					2	2	2	2					
Electrical Work (Central Dam)								1	1					3	3	3						
Foundation - Preparation, Jet Grouting and Drainage (South Dam)	1	1						1	1					2	1	1						
Elevation - Concrete Casting and Pouring (South)	1							1	1					2	1	2						
Structural Steel and Miscellaneous Metal (South)	1							1	1					2	2	2	2					
Electrical Work (South Dam)								1	1					2	3	3						
Connection to Switchyard and Cornverter Station					1			1	1						3	3						
Commissioning and Testing																		2				
Project Management																					1	1
Site Management																					1	1
Demobilization	1				1										1							

Quantitative Risk Impact Table

Impacting Tasks \ Risks	External													Internal							
	Ambiental			Social		Political	Financial		Commercial (Suppliers)				Legal	HR			Technical			Project Management	
	Acts of God	River Overflow	River Freezing	Environmental Demonstration	Trade Union Strike	Regulation change	Exchange Rate	Material Cost Increase	Low Raw Material Quality	Turbines and Generators Quality	Third Party Delay	Supplier Bankruptcy (Insolvency)	Authorization & Approval Delay	HR Availability	Workplace Safety (HSE)	Expertise	Facilities & Equipment Breakdown	Test Failure	Changes in the Work or Design	Planning and Controlling	Coordination & Cooperation
Hydroelectric Power Station Construction Project																					
Contract Finalization and Signature						2							1	3							
Mobilization, Site Equipment, Installation	1	2		1	1				1						2						
Temporary Bridge	3	3		2	2			2	3		2			2	2	3	2				
Access Roads, Ramps and Pads	2	3		2	2			2	1		3			2	2	2	1				
River Diversion	3	4	3	3	4									4	3	3					
Dewatering of structure areas	3	4	4		4										3	3	2				
Basic Design														4		4			3		3
Permits and Authorization Basic Design						4							5	4							
Detailed Engineering (Dams)														1					2		3
Detailed Engineering (Intake/Powerhouse and Turbines)														3					3		3
Detailed Engineering (Spillway)														1					2		3
Base Slab Spillway	3				2			1	3		4			3	2	2					
Concrete Casting and Pouring Spillway	3				3			3	3		3			2	2	2					
Steel Structure realization Spillway	3				3			1	2		3			2	2	2					
Spillway Bridges	3							1	2		2			1	2	2					
Discharge Channel	3							1	2		2			1	2	2					
Electrical Works Spillway					3			1	3					3	3	2					
Substructure Intake/Powerhouse	3				2			1	3		3			1	2	2					
Concrete Works Intake/Powerhouse	3				2			3	3		3			1	1	1					
Steel Structure Intake/Powerhouse	3				2			1	3		3			1	2	1					
Building and Architectural Works	3				2			3	2		3			1	1	2					
Electrical Works Intake/Powerhouse								1	3					3	3	3					
Turbines Erection					2		3		3	3	4	3		3	2	3	2				2
Generators Erection					2		3		3	3	4	3		3	2	3	2				2
Foundation - Preparation, Jet Grouting and Drainage (North Dam)	4	4			3			2	3		4			3	2	4					
Elevation - Concrete Casting and Pouring (North Dam)	3	3			3			3	3		3			2	2	3					
Structural Steel and Miscellaneous Metal (North Dam)	3				3			1	3		3			2	3	2	1				
Electrical Work (North Dam)					3			1	2		3			3	2	2					
Foundation - Preparation, Jet Grouting and Drainage (Central Dam)	2							1	3					1	1	3					
Elevation - Concrete Casting and Pouring (Central)	2							1	2					1	2	2					
Structural Steel and Miscellaneous Metal (Central)	2							1	2					1	2	1	1				
Electrical Work (Central Dam)								1	2					1	1	2					
Foundation - Preparation, Jet Grouting and Drainage (South Dam)	3	3						1	3					2	2	3					
Elevation - Concrete Casting and Pouring (South)	3							1	3					2	3	2					
Structural Steel and Miscellaneous Metal (South)	3							1	3					2	3	1	1				
Electrical Work (South Dam)								1	2					3	2	2					
Connection to Switchyard and Cornverter Station					3			2	3						3	3					
Commissioning and Testing																		3			
Project Management																				3	3
Site Management																				3	3
Demobilization	1				1										1						

Quantitative Risk Score Table

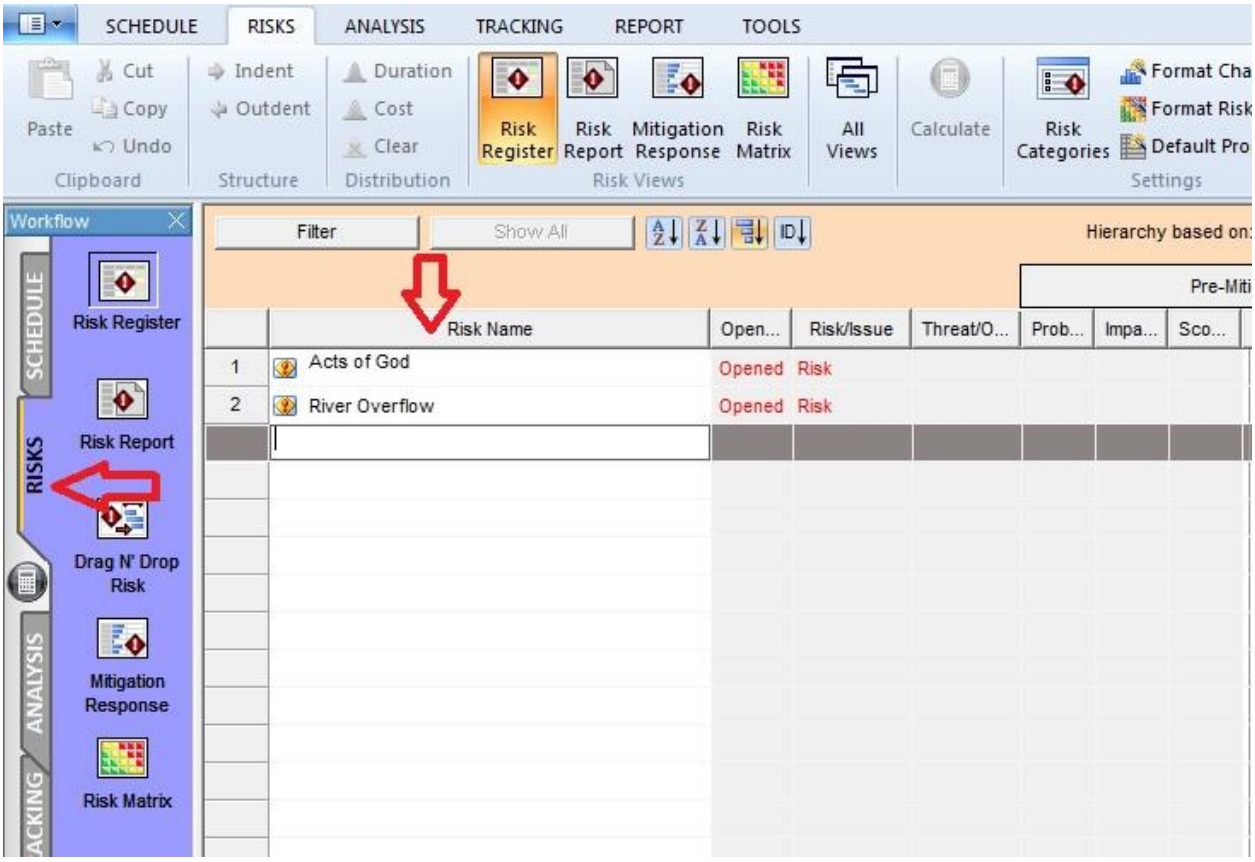
Impacting Tasks \ Risks	External													Internal							
	Ambiental			Social		Political	Financial		Commercial (Suppliers)				Legal	HR			Technical			Project Management	
	Acts of God	River Overflow	River Freezing	Environmental Demonstration	Trade Union Strike	Regulation change	Exchange Rate	Material Cost Increase	Low Raw Material Quality	Turbines and Generators Quality	Third Party Delay	Supplier Bankruptcy (Insolvency)	Authorization & Approval Delay	HR Availability	Workplace Safety (HSE)	Expertise	Facilities & Equipment Breakdown	Test Failure	Changes in the Work or Design	Planning and Controlling	Coordination & Cooperation
Hydroelectric Power Station Construction Project																					
Contract Finalization and Signature	0	0	0	0	0	0.08	0	0	0	0	0	0	0.04	0.12	0	0	0	0	0	0	0
Mobilization, Site Equipment, Installation	0.04	0.08	0	0.08	0.04	0	0	0	0.04	0	0	0	0	0	0.08	0	0	0	0	0	0
Temporary Bridge	0.12	0.12	0	0.16	0.08	0	0	0.08	0.12	0	0.08	0	0	0.16	0.16	0.24	0.08	0	0	0	0
Access Roads, Ramps and Pads	0.08	0.12	0	0.16	0.08	0	0	0.08	0.04	0	0.12	0	0	0.08	0.08	0.08	0.04	0	0	0	0
River Diversion	0.12	0.16	0.24	0.24	0.32	0	0	0	0	0	0	0	0	0.16	0.24	0.24	0	0	0	0	0
Dewatering of structure areas	0.12	0.16	0.32	0	0.32	0	0	0	0	0	0	0	0	0	0.12	0.24	0.08	0	0	0	0
Basic Design	0	0	0	0	0	0	0	0	0	0	0	0	0	0.32	0	0.32	0	0	0.24	0	0.24
Permits and Authorization Basic Design	0	0	0	0	0	0.64	0	0	0	0	0	0	0.8	0.32	0	0	0	0	0	0	0
Detailed Engineering (Dams)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0	0	0	0.16	0	0.12
Detailed Engineering (Intake/Powerhouse and Turbines)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.24	0	0	0	0	0.24	0	0.12
Detailed Engineering (Spillway)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0	0	0	0.16	0	0.12
Base Slab Spillway	0.12	0	0	0	0.08	0	0	0.04	0.12	0	0.16	0	0	0.12	0.08	0.08	0	0	0	0	0
Concrete Casting and Pouring Spillway	0.12	0	0	0	0.12	0	0	0.12	0.12	0	0.12	0	0	0.08	0.08	0.08	0	0	0	0	0
Steel Structure realization Spillway	0.12	0	0	0	0.12	0	0	0.04	0.08	0	0.12	0	0	0.16	0.16	0.16	0	0	0	0	0
Spillway Bridges	0.12	0	0	0	0	0	0	0.04	0.08	0	0.08	0	0	0.08	0.24	0.08	0	0	0	0	0
Discharge Channel	0.12	0	0	0	0	0	0	0.04	0.08	0	0.08	0	0	0.08	0.08	0.08	0	0	0	0	0
Electrical Works Spillway	0	0	0	0	0.12	0	0	0.04	0.12	0	0	0	0	0.24	0.36	0.24	0	0	0	0	0
Substructure Intake/Powerhouse	0.12	0	0	0	0.08	0	0	0.04	0.12	0	0.12	0	0	0.08	0.08	0.16	0	0	0	0	0
Concrete Works Intake/Powerhouse	0.12	0	0	0	0.08	0	0	0.12	0.12	0	0.12	0	0	0.12	0.04	0.04	0	0	0	0	0
Steel Structure Intake/Powerhouse	0.12	0	0	0	0.08	0	0	0.04	0.12	0	0.12	0	0	0.12	0.24	0.08	0	0	0	0	0
Building and Architectural Works	0.12	0	0	0	0.08	0	0	0.12	0.08	0	0.12	0	0	0.08	0.08	0.16	0	0	0	0	0
Electrical Works Intake/Powerhouse	0	0	0	0	0	0	0	0.04	0.12	0	0	0	0	0.24	0.24	0.24	0	0	0	0	0
Turbines Erection	0	0	0	0	0.08	0	0.36	0	0.12	0.12	0.16	0.12	0	0.12	0.08	0.12	0.08	0	0	0	0.08
Generators Erection	0	0	0	0	0.08	0	0.36	0	0.12	0.12	0.16	0.12	0	0.12	0.08	0.12	0.08	0	0	0	0.08
Foundation - Preparation, Jet Grouting and Drainage (North Dam)	0.16	0.16	0	0	0.12	0	0	0.08	0.12	0	0.16	0	0	0.24	0.08	0.16	0	0	0	0	0
Elevation - Concrete Casting and Pouring (North Dam)	0.12	0.12	0	0	0.12	0	0	0.12	0.12	0	0.12	0	0	0.16	0.08	0.24	0	0	0	0	0
Structural Steel and Miscellaneous Metal (North Dam)	0.12	0	0	0	0.12	0	0	0.04	0.12	0	0.12	0	0	0.16	0.24	0.16	0.08	0	0	0	0
Electrical Work (North Dam)	0	0	0	0	0.12	0	0	0.04	0.08	0	0.12	0	0	0.24	0.24	0.24	0	0	0	0	0
Foundation - Preparation, Jet Grouting and Drainage (Central Dam)	0.08	0	0	0	0	0	0	0.04	0.12	0	0	0	0	0.08	0.04	0.12	0	0	0	0	0
Elevation - Concrete Casting and Pouring (Central)	0.08	0	0	0	0	0	0	0.04	0.08	0	0	0	0	0.08	0.08	0.16	0	0	0	0	0
Structural Steel and Miscellaneous Metal (Central)	0.08	0	0	0	0	0	0	0.04	0.08	0	0	0	0	0.08	0.16	0.08	0.08	0	0	0	0
Electrical Work (Central Dam)	0	0	0	0	0	0	0	0.04	0.08	0	0	0	0	0.12	0.12	0.24	0	0	0	0	0
Foundation - Preparation, Jet Grouting and Drainage (South Dam)	0.12	0.12	0	0	0	0	0	0.04	0.12	0	0	0	0	0.16	0.08	0.12	0	0	0	0	0
Elevation - Concrete Casting and Pouring (South)	0.12	0	0	0	0	0	0	0.04	0.12	0	0	0	0	0.16	0.12	0.16	0	0	0	0	0
Structural Steel and Miscellaneous Metal (South)	0.12	0	0	0	0	0	0	0.04	0.12	0	0	0	0	0.16	0.24	0.08	0.08	0	0	0	0
Electrical Work (South Dam)	0	0	0	0	0	0	0	0.04	0.08	0	0	0	0	0.24	0.24	0.24	0	0	0	0	0
Connection to Switchyard and Cornverter Station	0	0	0	0	0.12	0	0	0.08	0.12	0	0	0	0	0	0.36	0.36	0	0	0	0	0
Commissioning and Testing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.24	0	0	0
Project Management	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.12	0.12
Site Management	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.12	0.12
Demobilization	0.04	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0	0	0

As can be seen in the manual computing mode, we have to choose between different risk states, and we cannot consider all the occurrences. So we're just deciding the worst cases for each task. Then we look at the impacts of budget and time given that the selected risks will occur.

3. Analysis with RiskyProject

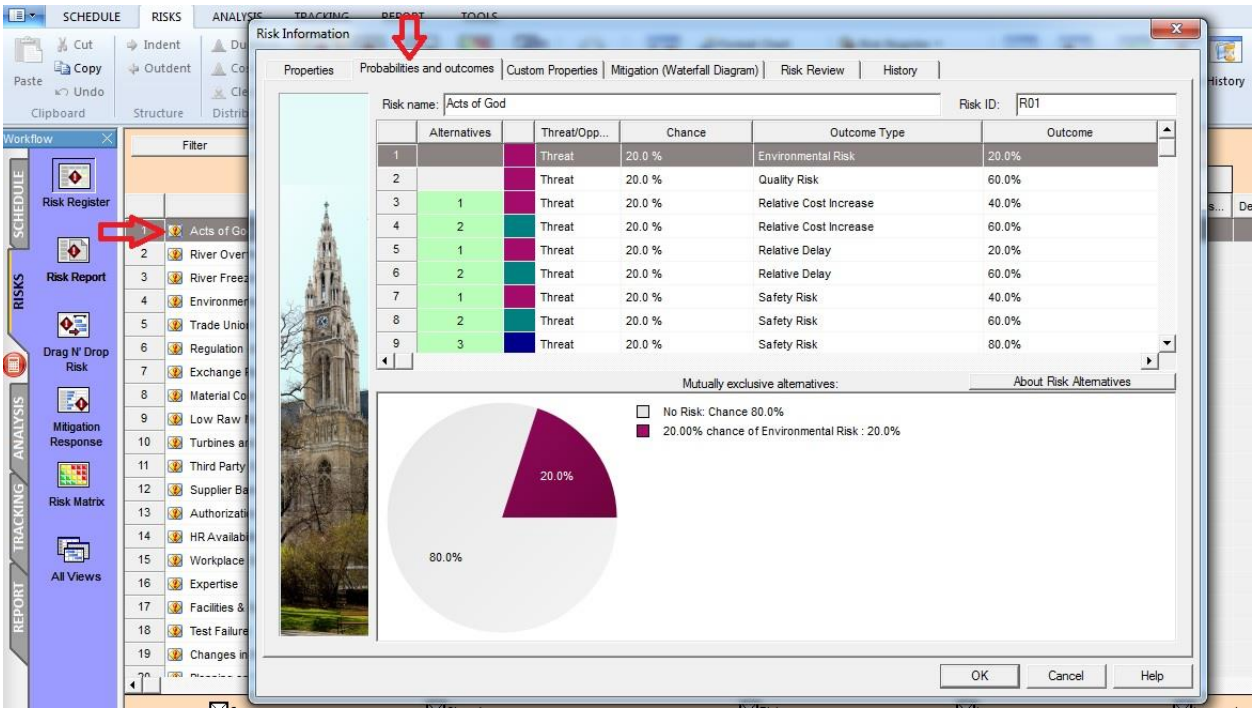
3.1 The trend of working with RiskyProject Software

Since we first want to do quality analysis with software, we do not need to have a WBS project. We need to identify the risks and their importance and the likelihood of them happening as we can see in the above tables. For this work, we should use the Risks Tab after opening the software and doing steps of creating a new project and saving its name like other office software. We will go inter all of the names of the risk according to our list from the Qualitative table based on the steps of registration of risks in RiskyProject that we explained it before and with using of its tools.



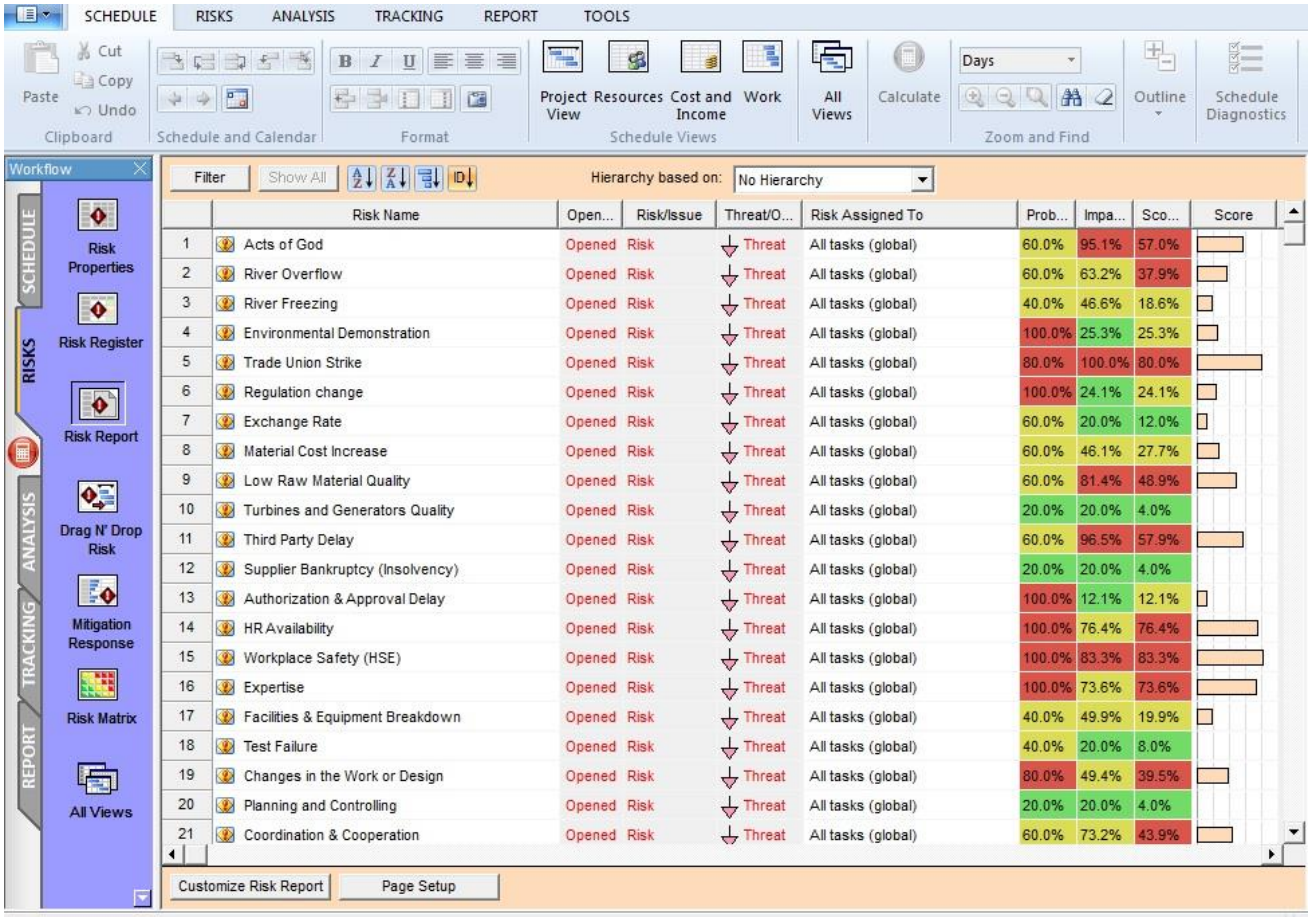
3.2 Qualitative Analysis

When we registered all risks, we will continue to add the attributes of each risk, such as their all types of chances and outcomes. For example, for the first risk, "Acts of God," we have around ten scenarios, and we should add them one by one. We will do it for all the risks.

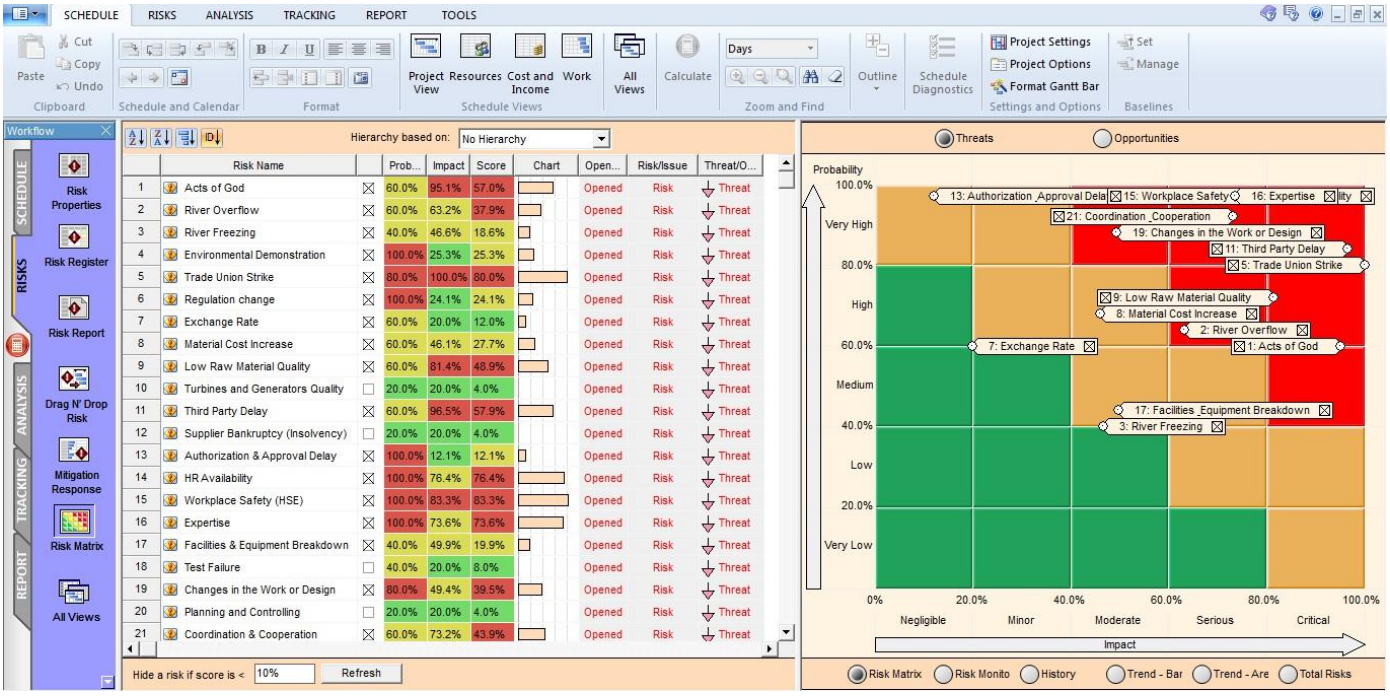


After finishing entering data of all risks, the software will start to analysis the conditions with click on the calculation Button. You can see the result of the qualitative analysis in the next picture.

In the software calculations, the terms are quite different. Firstly, we analyzed the project qualitative without regard to the tasks. As mentioned before, qualitative analysis is suitable for small and simple projects, and since we have chosen a large project for review, we cannot be obtained perfect results in this type of analysis section. In the next picture, we can see that the colors can show the importance and the accumulation of the risks.



	Risk Name	Open...	Risk/Issue	Threat/O...	Risk Assigned To	Prob...	Impa...	Sco...	Score
1	Acts of God	Opened	Risk	Threat	All tasks (global)	60.0%	95.1%	57.0%	
2	River Overflow	Opened	Risk	Threat	All tasks (global)	60.0%	63.2%	37.9%	
3	River Freezing	Opened	Risk	Threat	All tasks (global)	40.0%	46.6%	18.6%	
4	Environmental Demonstration	Opened	Risk	Threat	All tasks (global)	100.0%	25.3%	25.3%	
5	Trade Union Strike	Opened	Risk	Threat	All tasks (global)	80.0%	100.0%	80.0%	
6	Regulation change	Opened	Risk	Threat	All tasks (global)	100.0%	24.1%	24.1%	
7	Exchange Rate	Opened	Risk	Threat	All tasks (global)	60.0%	20.0%	12.0%	
8	Material Cost Increase	Opened	Risk	Threat	All tasks (global)	60.0%	46.1%	27.7%	
9	Low Raw Material Quality	Opened	Risk	Threat	All tasks (global)	60.0%	81.4%	48.9%	
10	Turbines and Generators Quality	Opened	Risk	Threat	All tasks (global)	20.0%	20.0%	4.0%	
11	Third Party Delay	Opened	Risk	Threat	All tasks (global)	60.0%	96.5%	57.9%	
12	Supplier Bankruptcy (Insolvency)	Opened	Risk	Threat	All tasks (global)	20.0%	20.0%	4.0%	
13	Authorization & Approval Delay	Opened	Risk	Threat	All tasks (global)	100.0%	12.1%	12.1%	
14	HR Availability	Opened	Risk	Threat	All tasks (global)	100.0%	76.4%	76.4%	
15	Workplace Safety (HSE)	Opened	Risk	Threat	All tasks (global)	100.0%	83.3%	83.3%	
16	Expertise	Opened	Risk	Threat	All tasks (global)	100.0%	73.6%	73.6%	
17	Facilities & Equipment Breakdown	Opened	Risk	Threat	All tasks (global)	40.0%	49.9%	19.9%	
18	Test Failure	Opened	Risk	Threat	All tasks (global)	40.0%	20.0%	8.0%	
19	Changes in the Work or Design	Opened	Risk	Threat	All tasks (global)	80.0%	49.4%	39.5%	
20	Planning and Controlling	Opened	Risk	Threat	All tasks (global)	20.0%	20.0%	4.0%	
21	Coordination & Cooperation	Opened	Risk	Threat	All tasks (global)	60.0%	73.2%	43.9%	



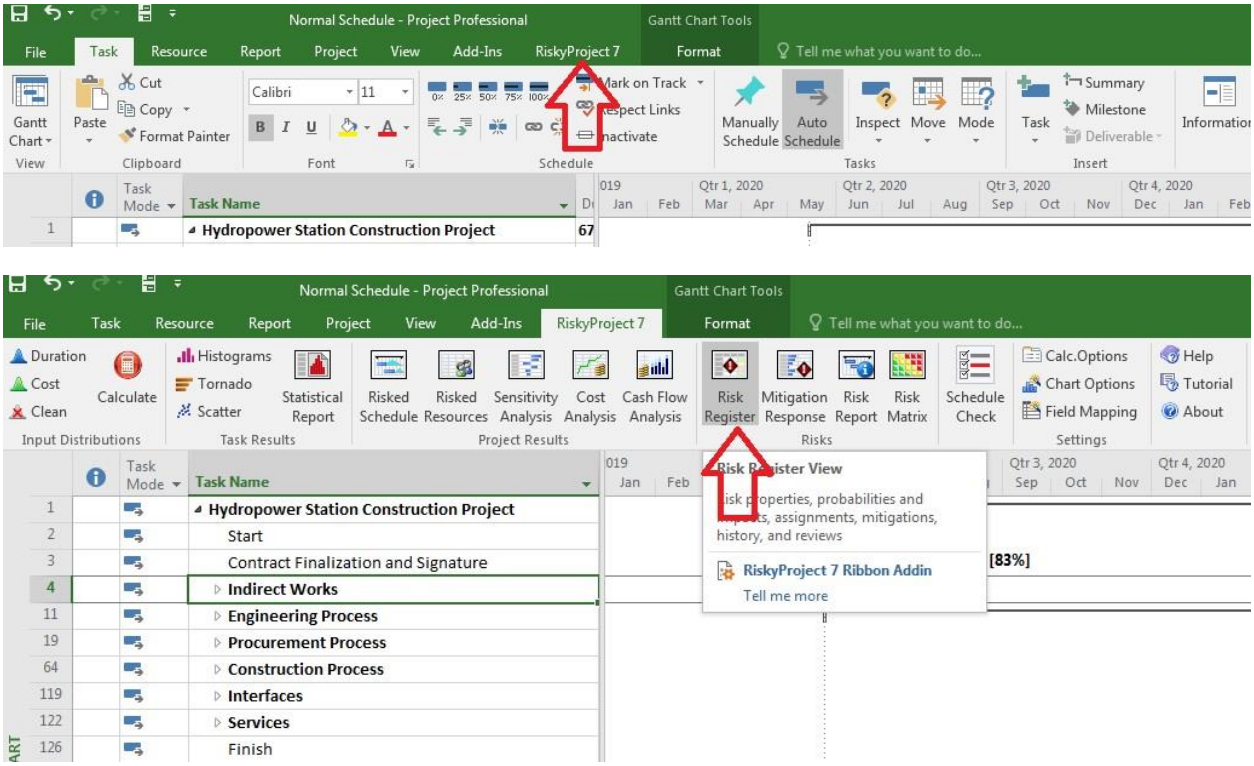
	Risk Name		Prob...	Impact	Score	Chart	Open...	Risk/Issue	Threat/O...
1	Acts of God	☒	60.0%	95.1%	57.0%		Opened	Risk	Threat
2	River Overflow	☒	60.0%	63.2%	37.9%		Opened	Risk	Threat
3	River Freezing	☒	40.0%	46.6%	18.6%		Opened	Risk	Threat
4	Environmental Demonstration	☒	100.0%	25.3%	25.3%		Opened	Risk	Threat
5	Trade Union Strike	☒	80.0%	100.0%	80.0%		Opened	Risk	Threat
6	Regulation change	☒	100.0%	24.1%	24.1%		Opened	Risk	Threat
7	Exchange Rate	☒	60.0%	20.0%	12.0%		Opened	Risk	Threat
8	Material Cost Increase	☒	60.0%	46.1%	27.7%		Opened	Risk	Threat
9	Low Raw Material Quality	☒	60.0%	81.4%	48.9%		Opened	Risk	Threat
10	Turbines and Generators Quality	☐	20.0%	20.0%	4.0%		Opened	Risk	Threat
11	Third Party Delay	☒	60.0%	96.5%	57.9%		Opened	Risk	Threat
12	Supplier Bankruptcy (Insolvency)	☐	20.0%	20.0%	4.0%		Opened	Risk	Threat
13	Authorization & Approval Delay	☒	100.0%	12.1%	12.1%		Opened	Risk	Threat
14	HR Availability	☒	100.0%	76.4%	76.4%		Opened	Risk	Threat
15	Workplace Safety (HSE)	☒	100.0%	83.3%	83.3%		Opened	Risk	Threat
16	Expertise	☒	100.0%	73.6%	73.6%		Opened	Risk	Threat
17	Facilities & Equipment Breakdown	☒	40.0%	49.9%	19.9%		Opened	Risk	Threat
18	Test Failure	☐	40.0%	20.0%	8.0%		Opened	Risk	Threat
19	Changes in the Work or Design	☒	80.0%	49.4%	39.5%		Opened	Risk	Threat
20	Planning and Controlling	☐	20.0%	20.0%	4.0%		Opened	Risk	Threat
21	Coordination & Cooperation	☒	60.0%	73.2%	43.9%		Opened	Risk	Threat

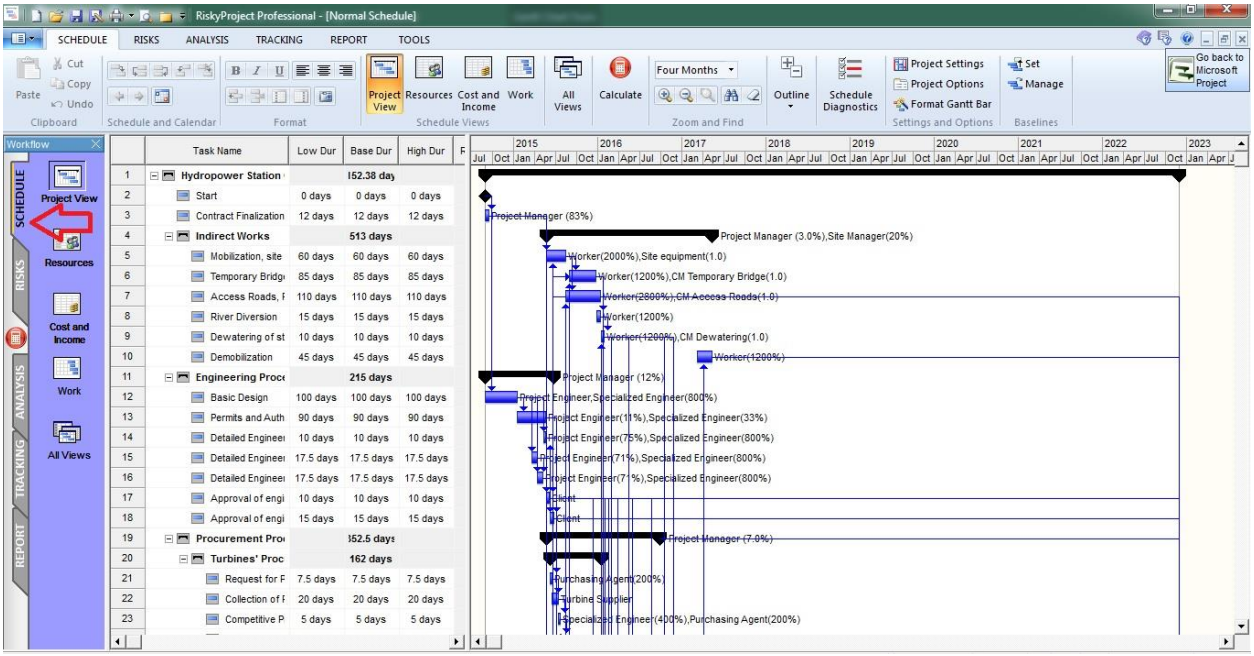
3.3 Quantitative Analysis

In this section, we start with tasks, considering budget and timing, and assign a variety of risk scenarios to different tasks based on the forecast. Then, we can see the results obtained by the software based on Monte Carlo simulation. It is clear that there is no limit to analyzing the high volume of risk situations anymore, and also, by using the different types of reports the software offers us, we can make any necessary adjustments at any time during the project. Also, we can see budget and duration changes according to previous modifications or performs of response plans.

We will explain a summary of the steps that we did for this part as follow text:

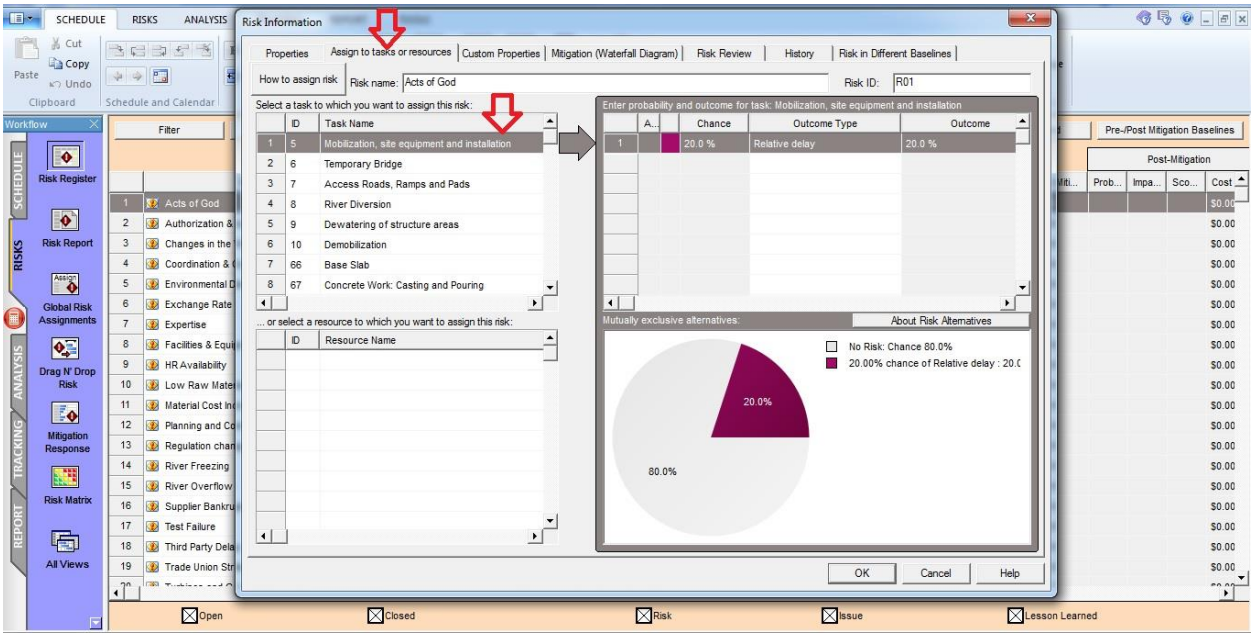
In the first step, we have two ways to opening the software as to be mentioned before: using the Ms project (Using our prepared WBS in Ms project) or working with Riskyproject directly. We used the first. As you can observe in the next figures we could to open Riskyproject in this way.



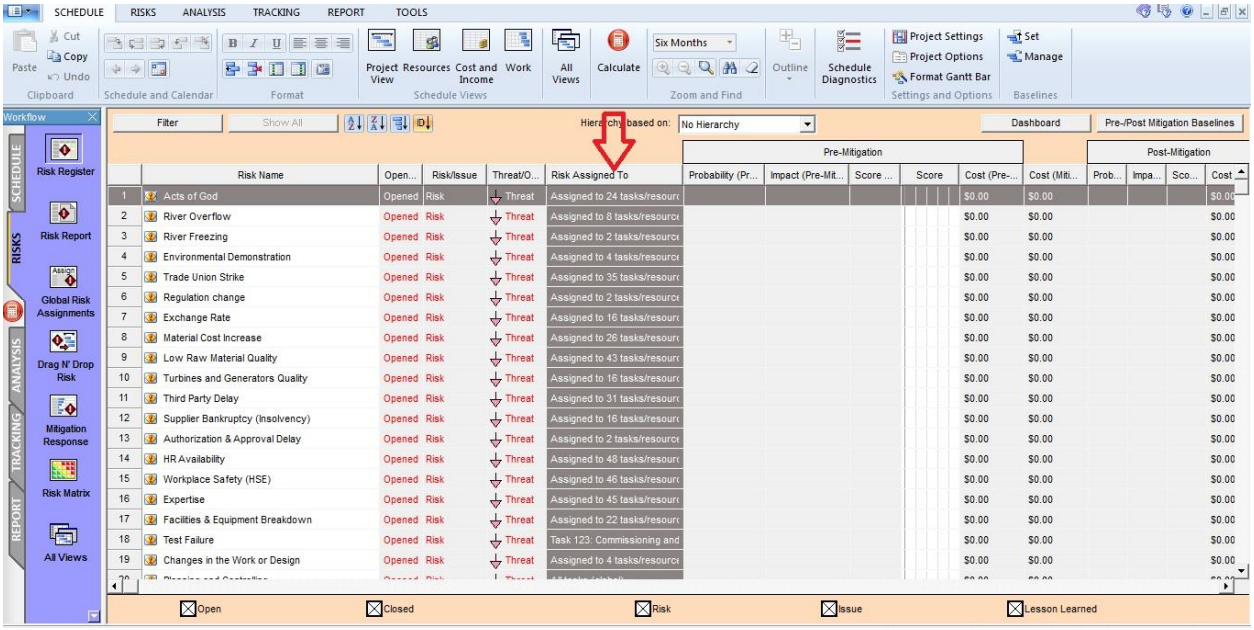


We can access our project's schedule with Schedule Tab. Continuously, as we did in the quantitative analysis steps, we choose the Risk Tab and add the name of risks like before.

The next step that is adding risk's attributes is a little different with a part we did in the quantitative analysis. In the following picture, it is clear that we have another tab with the name of "Assign to Tasks or Recourses." We should assign tasks to any risks one by one according to past tables and for each task, enter the outcome and chances based on our data in the charts.

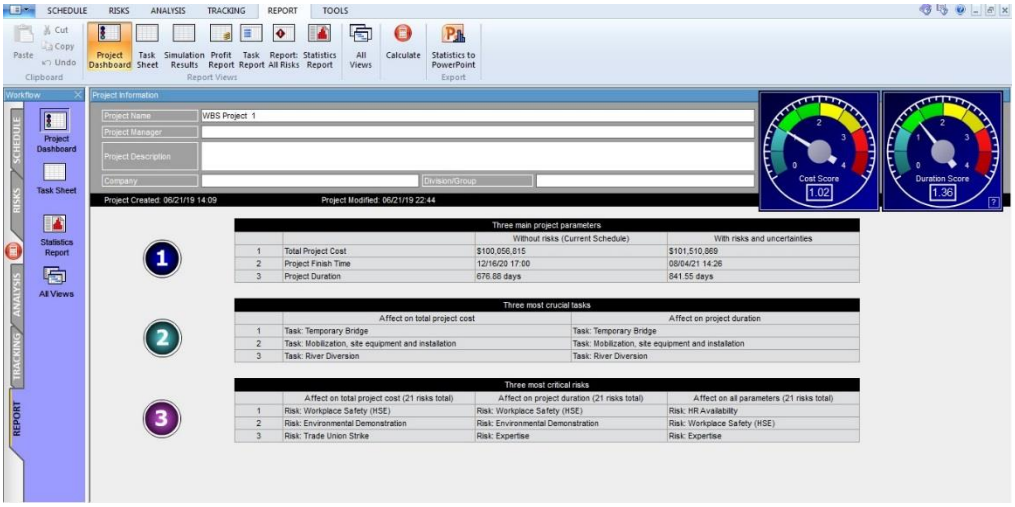


After you finish importing all risk data and assigning it to each task, on the main screen, there is a column that shows the number of tasks assigned to each risk.

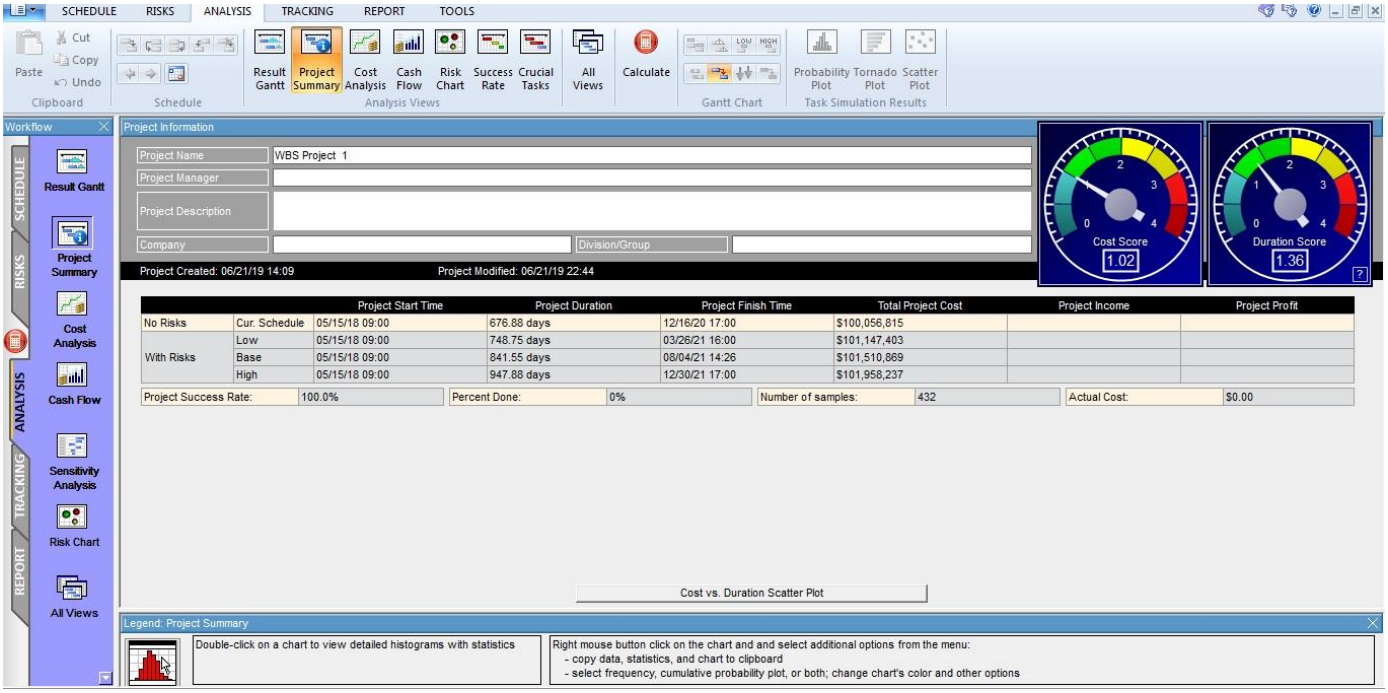


Like before, with click on the calculation button, we can access to all results and reports that we need for quantitative analysis. Some of the output reports are as follow:

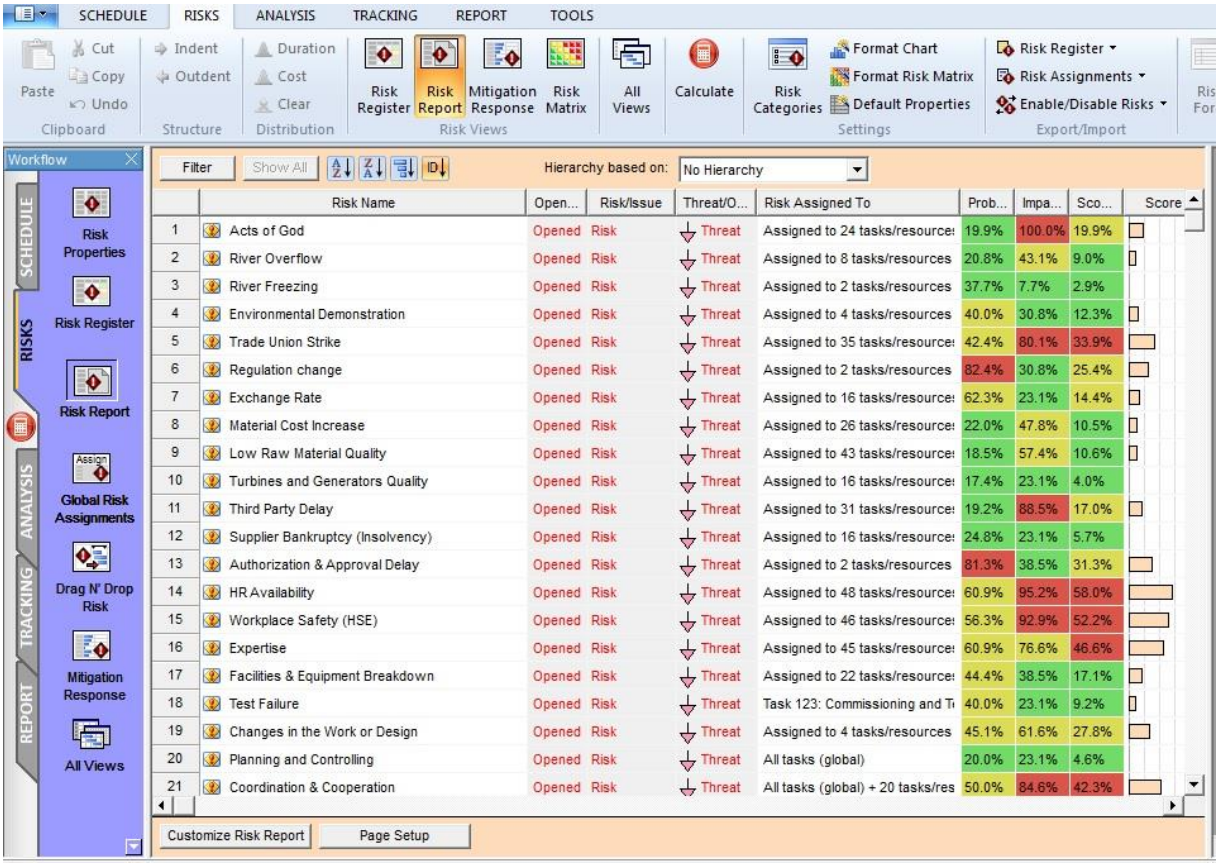
A. General Report



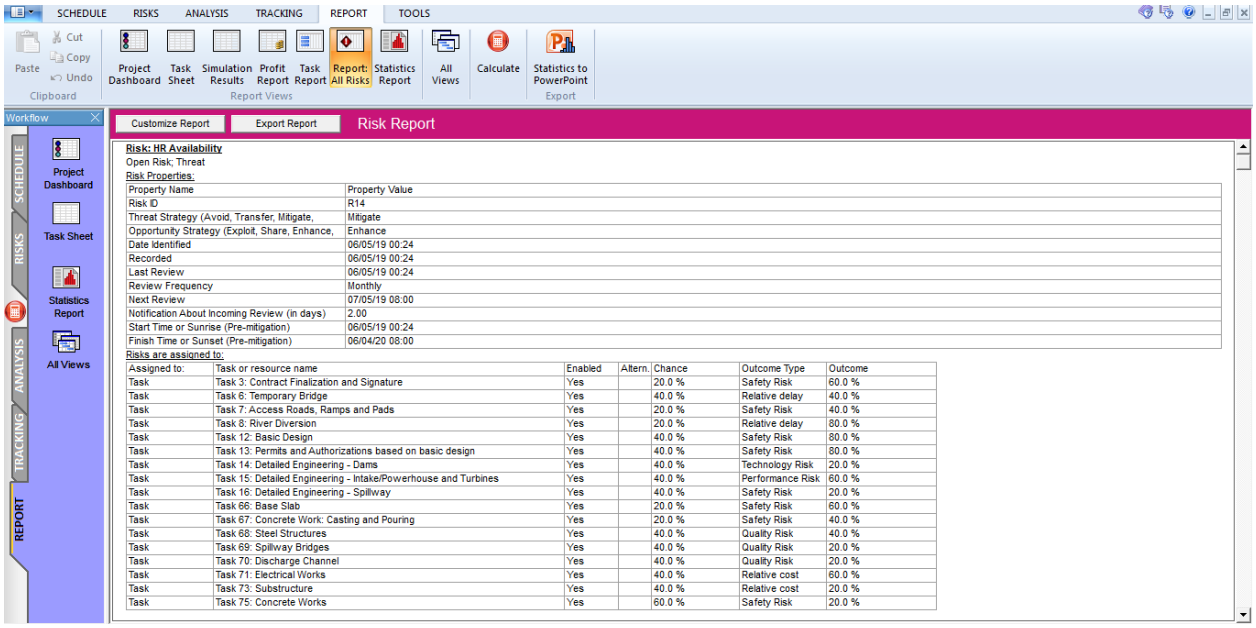
B. Project Summary:



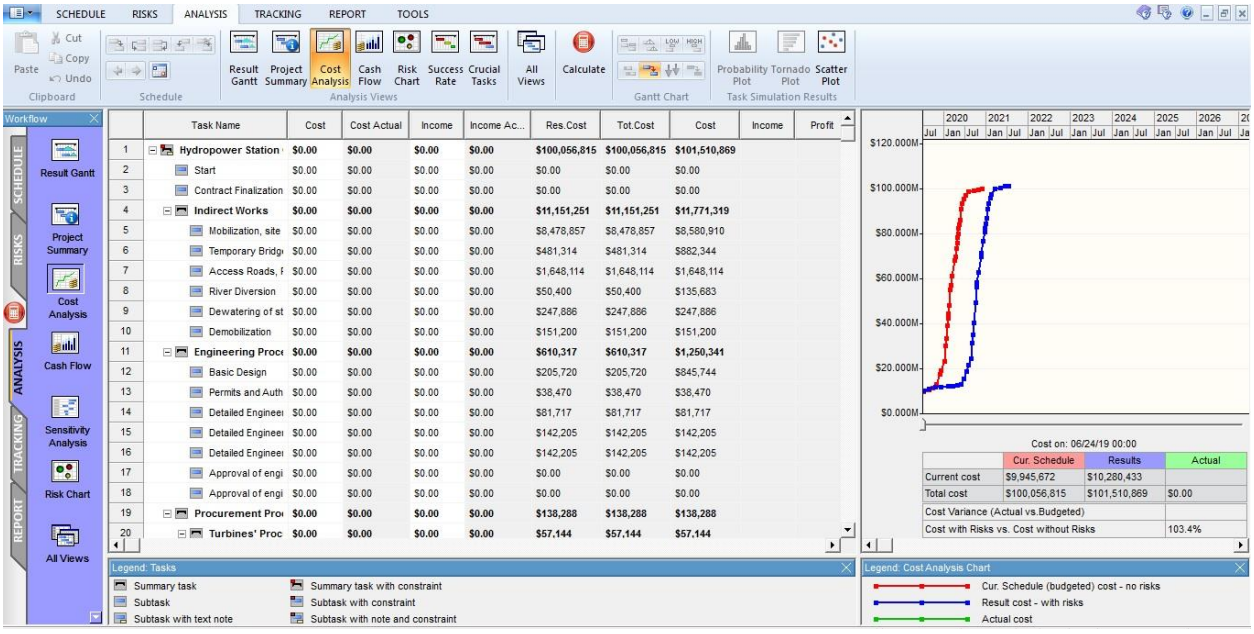
C. Risk Report



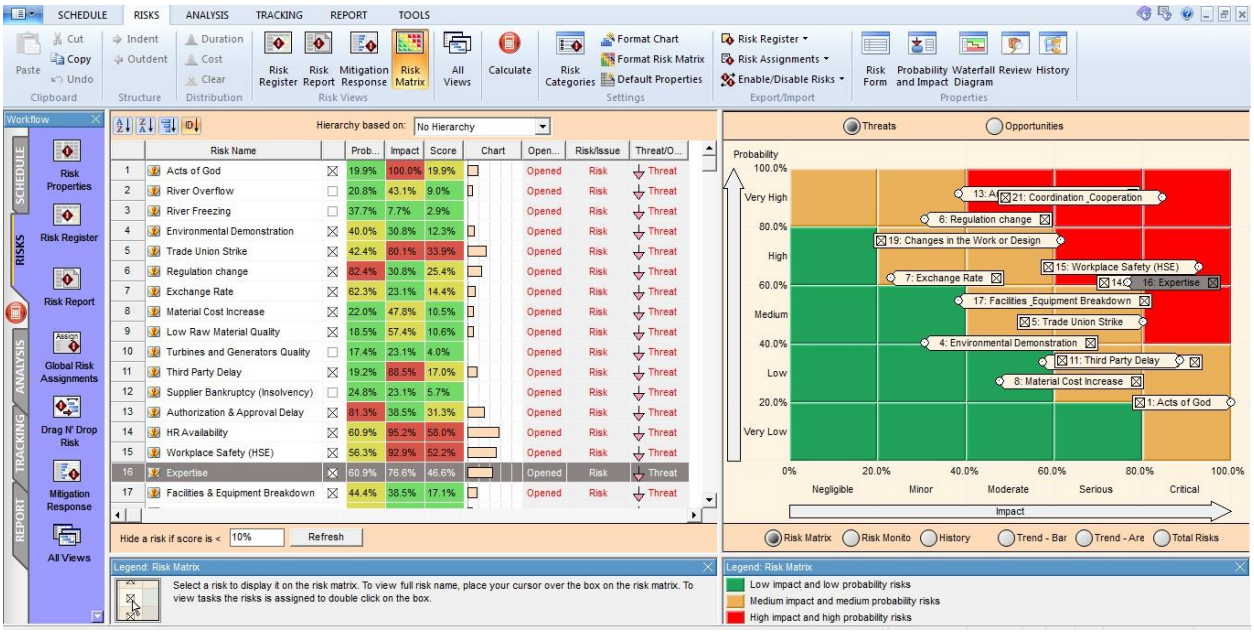
D. Another format of risk report in summary



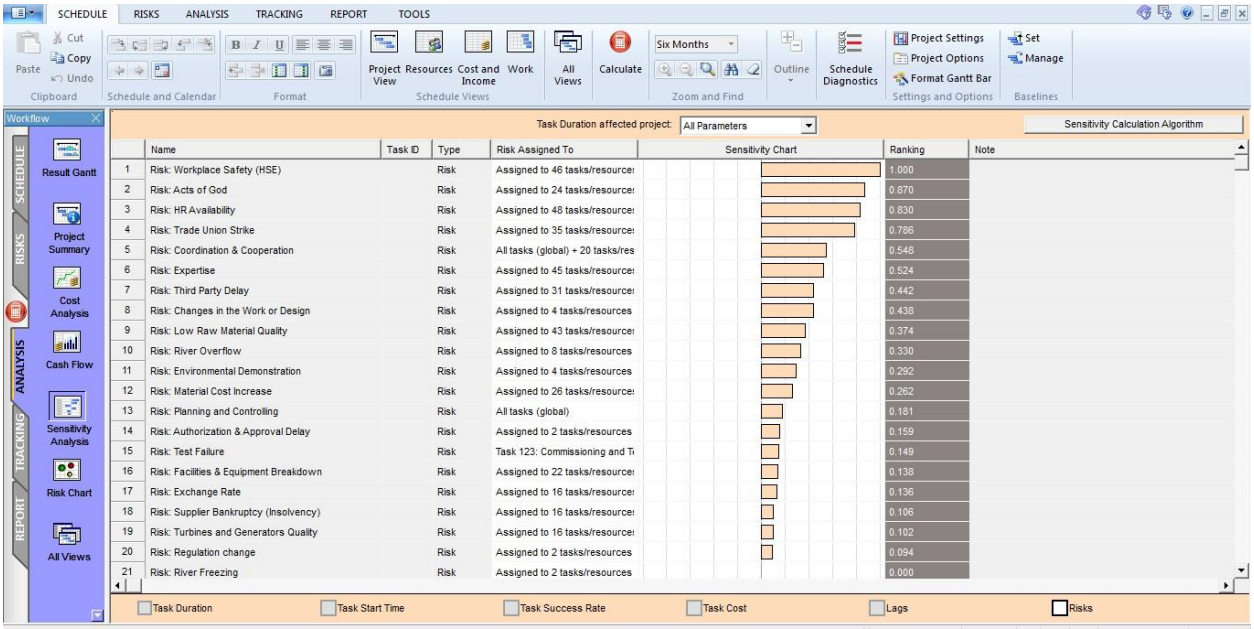
E. Cost Analysis:



F. Risk Matrix



G. Sensitivity Analysis



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