

MS-E2177
Seminar on Case Studies in Operations Research
Expert judgements for cost assessment in risk management
Project Plan for Inclus

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1 Background

Our client Inklus is a Finnish technology start-up company founded in 2012. Inklus develops user-friendly, visual and interactive cloud software for risk management. Their methods consist of multicriteria and network analysis and their software is used world-wide in different fields such as risk management for large-scale construction projects, trend and competence analysis in public sector organizations and conflict prevention in international crisis management.

Risk management means coordinated activities to direct and control an organization with regard to risk [1]. It includes analyzing the risks and the means to deal with the risk appropriately. Risk analysis consists of a process of assessing the likelihood of an adverse event occurring as well as its potential impact. Risk management can be qualitative or quantitative and it often involves the use of mathematical models or expert opinions or both. Qualitative models give an explanation of the risk and relating factors whereas a quantitative model tries to quantify the risk and assign a numerical value to it. The construction of both models require information the accuracy of which significantly affects the model's performance.

Information for risk analysis and management is often collected by eliciting it from experts. It is common to use two criteria for the elicitation, impact and probability. Impact of an event can be expressed by for example a Likert-based classification such as an integer value between 1 and 4 or by the financial cost the event causes. Probability describes how likely it is that the event will occur. The two criteria are often multiplied together for a given risk factor by some convention and the resulting value will correspond to the seriousness of the given risk factor. Having only these two values for the analysis of risk, however, is limiting as it causes models to fail at capturing some aspects of risk.

Another common problem in eliciting information from experts is that they usually tend to give only one value per criterion. A single value per criterion implies that the impact and probability are known for certain. This is rarely the case since the information consists of predictions and estimates of the experts and thus have uncertainty in them. Failing to take uncertainty into account can be detrimental to the model's performance.

These limitations of the information make it hard to create simulations of risk and estimations of the total risk of a project. Also, the absence of knowledge of any correlation or interrelations between risks further hinders simulations. Clients in the field of risk management need more advanced and robust tools for managing risk without losing user-friendliness in the process. Our project explores ways to incorporate uncertainty and interdependencies of risk into the risk managing model within the Inklus context.

2 Objectives

Our aim is to give sound and scientifically founded suggestions for improving the elicitation process used by Inklus. The objective is not to develop a working code base that achieves this, but to conceptualize our suggestions, which may later be implemented by Inklus.

Our project can be divided into two distinct parts: in the first part we develop an approach on how to best capture the uncertainty related to the risks. Single-value probability-impact estimates have their flaws as they leave out interesting and useful information. Thus we demonstrate and adapt the well-known three-point estimation procedure from scientific literature to elicit more information about the distributions. We also try and experiment more visual alternative to the three-point estimates.

In the second part our aim is to conceptualize an approach on how to elicit information about the interdependencies of different risks. All the risks involved are rarely independent, and treating them as such makes some amount of oversimplification, reducing the accuracy and correctness of analysis. An example is a personal injury on a construction site, which naturally increases the probability of a sub-project to be delayed, which in turn could delay the whole construction project. For this purpose we conceptualize an approach reminiscent of a mind-map with a graph structure, although this may evolve throughout the project.

Besides eliciting information from individual experts we suggest an approach to effectively aggregate various expert judgements. This process is essential for both distinct parts of the project, as Inklus is almost always working with multiple-expert teams, and means of aggregating judgements is necessary.

Our objectives also take account the specific needs of Inklus. For example the codes of the current software version needs to run locally on the user's web browser, limiting the complexity of the

calculations, as it is required that user can run the software on mobile device. Also Inclus has focused more on simpler, easier-to-interpret methods rather than heavy Bayesian Network approaches more typical to safety critical systems. Thus our aim is to complete the objectives so that Inclus can easily incorporate them to its existing workflow.

As a whole the product would yield a systematic approach to eliciting uncertainties about the studied system in a meaningful way that acknowledges the interrelations of different risks.

3 Tasks

- Meet with Inclus
- Benchmark Inclus product
- Meet with Skanska end-user contact
- Conduct a literature review on expert knowledge elicitation in risk management
- Create a Python demo on three-point estimates
- Conceptualize how risk correlations could be integrated into the Inclus product
- Write and prepare course deliverables (interim report, final report, presentations)

After completing the project plan and presenting it to the other teams and course personnel on the 11th of March, the next action is to communicate the project plan to our client Inclus. We are planning on having a meeting with them on the week following the presentation, to make sure that they agree on the project scope and focus. This meeting will allow us to validate the project deliverables and, if need be, alter the focus of the project.

After verifying the project scope and focus with the client, we can start working towards the goals. Near the beginning of the project we benchmark the Inclus product with other similar tools in the market to grasp how other companies have solved similar issues that we are facing. We should also make use of our end-user contact at Skanska soon after verifying the project focus. It is paramount to understand what the possible points of improvement and problems that end-users face are, to make sure we don't create a solution for a problem that doesn't need solving.

After ensuring that the project deliverables respond to the needs of Inclus and ensuring the problems are of interest to the end-users, we create the actual solutions. The precise tasks will depend on how the meetings will alter the project focus, but there are some core elements that will be included in the project regardless. We need to familiarize ourselves with expert knowledge elicitation and conduct a literature review on the subject. The emphasis will most likely be directed towards forming a deep understanding on assessing risks with three-point estimates (minimum, most likely, maximum) instead of a single point estimate, and formulating conceptual lightweight methods for identifying relationships between risks.

It is probable that we will create a small demo with Python to illustrate how the three-point estimate would work in reality. On the other hand, we will not start coding a front-end implementation on how, for example, mind-mapping could be used to formulate relationships between risks. However, we should look for existing mind-mapping (or other) tools for a possible demo. We should also assess how correlations between different risks affect the total risk of a project, and how the front-end solution could be developed. This would include answering questions such as: with what scale the end user would select the level of correlation (e.g. mutually exclusive, small negative correlation, strong positive correlation, ect.) and how can these levels be converted to numerical values, and how we could combine the correlation estimates of several experts.

Consistent communication with Inclus and with Skanska is expected to continue throughout the project.

From the standpoint of course deliverables, there are two after this project plan: interim report with presentation, and final report with presentation. The interim report consists of the summary of completed activities and updates to the initial project plan. The final report, which should be about 25-30 pages in length, consists of reporting the main results of the project and doing a two-page self-assessment of the execution of the project.

4 Schedule

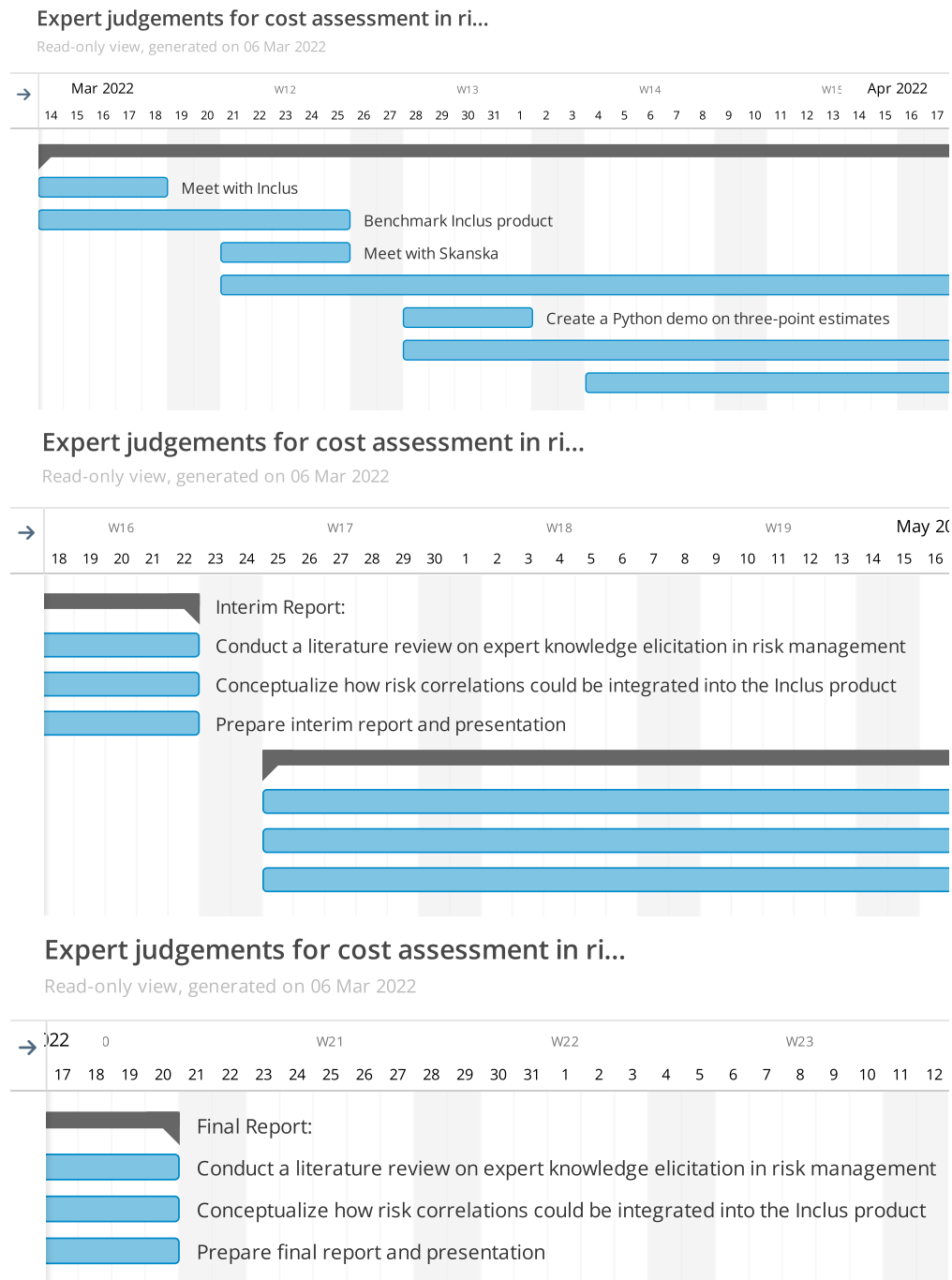


Figure 1: Gantt chart of the project.

5 Resources

The project is knowledge-based and has no physical components. Thus the resources needed are rather few, namely consisting of the time and efforts of our four project members as well as contact person at Inklus and one interviewee from Inklus' clients. Also basic office tools, computers, internet access are at our disposal. One important factor is the access to recent scientific literature provided by Aalto

University. The software used in the project consists of Overleaf Online Latex editor and possibly Python for small demonstrations.

6 Risks

The risks concerning this project are important to be acknowledged and further investigated in order to mitigate their effects. For this project, each team member performed a probability-impact estimation for 12 mutually selected risks, that were categorized in four different classes. The four main risk categories are communication, technical problems, scheduling and personal problems. The categorization might not be perfect or by no means standardized, but it helps the project team to structure the process of analysing risks.

Communication risks include insufficient communication between the project team, Inclus and the clients as well as the lack of communication between the team members. This can lead to misunderstanding about the scope of the project and creating something, that doesn't fulfill the desired requirements. Too specific requirements and unexpected changes of the needs of clients are also included in this category.

Technical problems comprise the risk that IT-tools stop working for some reason. An implementation that is computationally too demanding also falls into this category. By the estimation of the team members, technical problems is the category with smallest risk, since the probability of the occurrence is very low.

Scheduling problems refer to issues where the schedule of the project team is delayed, either caused by team members' common scheduling fails or team members' individual disability to obey the desired schedule. Scheduling is also strongly related one of the most significant risks of this project, limiting the scope of the project. The scope needs to be predefined and specific enough in order to stick with the schedule without complications. Too broad scope easily leads to excessive amount of research and time, which have a tendency to postpone the team's schedule.

The last category is personal problems. They include such events, that for personal reasons prevent a team member to fully commit to the project or comply with the team's schedule. These events can be excessive amount of studies or work, sickness, or any other reason that leads the interruption of this course.

According to the individual estimation of risks, it seems that the members of the project team roughly agree on the magnitude of each risk. Scheduling problems are the most significant risk type measured by probability and impact. Communication risks are the broadest class, comprising in total of 5 of our selected risks. Personal and technical problems were relatively less significant based on our estimations. However, it is important to acknowledge that the risk categories can overlap with each other, and a single risk can have characteristics of multiple different classes. The class division should be critically evaluated and treated more like as a spectrum. Figure 2 also points out a natural negative correlation between probability and impact, and if we were to select all possible existing risks, the correlation would become even more obvious. Thus the risks that deviate strongly to the up and right from the trendline, should have the primary concentration of the project team.



Figure 2: Risk chart

References

- [1] International Organization for Standardization. Iso 31000:2018 - risk management — guidelines - iso. 02 2018.