The hydrogen energy North Sea project
Schedule Risk Analysis (SRA)

1 Description

The joint venture of the Belgian companies NorthConstruct, a construction company, and HydroEnergy, an energy company, has won the bid for a new innovative and challenging project. They will construct an artificial island in the North Sea, in front of the Belgian coastline, to produce hydrogen energy using the nearby offshore wind parks (constructed in the past by NorthConstruct and currently owned by HydroEnergy) and, subsequently, transmitting this energy to the mainland. The island needed to house the facilities for the hydrogen production and storage as well as both the machinery and the network hardware needed for the energy transmission towards the mainland. Besides these main activities, the island will host an R&D center in order to boost the education on hydrogen energy and can be used by the shipping industry as a port in the North sea. These features were important in the successful project proposal of the joint venture.

The start of the construction works was only months ahead and a project team consisting of both project managers and engineers of NorthConstruct and HydroEnergy, together with officials from the local government, was meeting up to prepare the last stages prior to project execution. Given the innovative nature of the project and the potential positive media coverage related to this ambitious project, both companies had agreed to perform a thorough schedule risk analysis in order to avoid large delays or cost overruns during the project execution. Furthermore, the local government has requested a schedule risk analysis prior to starting the construction works. A group of project managers related to NorthConstruct and HydroEnergy had analysed documentation provided by the operators and technicians of their respective companies in order to determine the risk in the project schedule. They used the following approach:

(1) Use the baseline schedule as already presented in the project proposal,
(2) Model the uncertainty of the activities using distributions based on best guesses of the operators,
(3) Simulate the project execution multiple times using Monte-Carlo simulations,
(4) Report the criticality index (CI) and significance index (SI) of each activity (cf. Figure 2).

Dave's idea of the project

Dave, a project manager of NorthConstruct had listed the different activities of the project in Table 1, which also includes the successor activities, as well as the estimated duration and budgeted cost. In Figure 1, the project network is displayed. The engineers of NorthConstruct had come up with a list of four main risks and agreed upon actions that would need to be taken when these risks would occur. The risk proposals are listed here:

> **Proposal 1.** Important in hydrogen production is the uniform conduction of the high temperatures generated throughout the process and, therefore, the original project design consisted of a so-called heath reformer (activity F). The engineers proposed to put all focus during project execution on this activity. "From the moment that we start the reformer construction until the moment that we finish it, this should be the project team's number one priority", someone said.
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> **Proposal 2.** The compaction of the surface, in which the pipelines for the hydrogen are embedded, is crucial in order to avoid small explosions that might potentially deregulate the hydrogen transmission (activity L). As a result, Jack suggested to act upon every small delay or issue during this process.
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> **Proposal 3.** Building upon his remark, his colleague Sandra stated that any leakage in the system could also cause explosions since any outflow of hydrogen or inflow of other materials would result in a chemical reaction. She proposed to prioritise the construction of a 'filter layer' (activity H) and said: "We should follow-up, report and analyse each and every small step of this activity".
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> **Proposal 4.** An engineer who worked already for many years with Dave at NorthConstruct warned for the negative impact of the island construction on the marine environment. He was convinced that the project team should be completely devoted to advising and supporting the environmental experts during the 'environmental study' (activity D). "We might lose big if we do not get this environmental study right first time", he said.

Dave clearly understood the importance of each proposal and had put some pressure on the other team members in the room. They all knew that resources, budget and time were limited. However, they did not want to miss some major issues during the project execution, but neither did they want to invest a lot of time and effort in small problems.

Student assignment: Suppose you are a (young) team member of the project team of the joint venture, can you give advice to Dave for the following assignments?

> **Assignment 1.** Prioritise the four proposals from a schedule risk analysis point of view by considering and interpreting the values of the two sensitivity metrics (CI and SI). Which of the four presented proposals would you support and motivate why?
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> **Assignment 2.** Each proposal largely focuses on one activity of the project, and alternative proposals could be recommended. Can you think of another proposal (for another activity) that requires the project team's attention? Motivate why.
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> **Assignment 3.** Someone from Dave's team noticed that the uniform conduction of heat in proposal 1 (activity F) could also be relevant for activity J (Pipe installation). However, currently, no risk proposal is presented for activity J. Can you come up with a compelling argument for constructing this risk proposal for activity J too? Should you rely on the current sensitivity metrics (CI and/or SI) or can you propose better ones?
> Hint: The CI and SI sensitivity metrics are used to measure the "time sensitivity" of activities.

Jane's idea of the project

Jane started her career 13 years ago at HydroEnergy, and has a totally different background than Dave. Ever since the merge of her company with NorthConstruct, Jane kept her own way of managing projects. While she never had a close bond with Dave, the two could nevertheless act in a very professional way, but insiders knew that their background - coming from two different companies - was the seed of their genuine competitiveness. From time to time, this rivalry has driven Jane to come up with original ideas of managing her projects. While being five years younger than Dave, Jane was considered as an experienced project manager with a strong technical background, and she was highly appreciated by her colleagues. Some even said that the way projects are managed by the joint venture was more like the continuation of the entrepreneurial HydroEnergy spirit nourished by the maturity of NorthConstruct, but Dave, of course, disagreed with that nonsense.

As a matter of fact, Jane had been silent throughout the entire meeting, however, suddenly she spoke up. "I have already worked on a similar project with a similar scope. In this project, the surface compaction (activity L) was only started after the roads construction (activity K) and it was followed by carbon capture and storage (activity M). This change will have no impact on the duration and cost of the activities. I think it might be a good approach for this project as well." Nobody was enthusiastic about changing Dave's network logic of the project so close to the project start, but Jane was an experienced project manager and, at least, they had to consider her idea.

Dave was the first to react: "This is going to impact our schedule risk analysis, and make the previous four proposals worthless". Jane quickly interrupted him, and said in her friendly voice: "Let's first take a coffee, Dave, and then we'll see. These four proposals might be valid for my network logic too. And if not, we just have to perform a new schedule risk analysis, and look at the new sensitivity graphs. They might look somewhat similar."

Student assignment (continued)**:**

> **Assignment 4.** Discuss the efficiency of using schedule risk analysis for the project given the new network logic proposed by Jane (of course, no new schedule risk analysis should be carried out since that would require a Monte Carlo simulation). Draw the new network of Jane, and think how it would (and probably will) change the values for the sensitivity metrics CI and SI. Table 1 shows the successor activities of Jane's idea. The time and cost estimates are identical to Dave's numbers.

2 Project data

ID	Activity description	Successor activities (Dave's idea)	Successor activities (Jane's idea)	Duration (weeks)	Cost (€)	Risk proposal
A	Site survey	B,C	B,C	1	20,000	No
B	Engineering study	D	D	10	3,000	No
C	Geotechnical study	D	D	12	3,000	No
D	Environmental study	E,L,M	E	2	16,000	Yes
E	Breakwaters	F,H	F,H	7	65,000	No
F	Heath reformer	G	G	15	50,000	Yes
G	Flame detector system	J	J	12	50,000	No
H	Filter layer	I	I	10	250,000	Yes
I	Primary sand layer	J	J	21	540,000	No
J	Pipe installation	K	K	22	820,000	No
K	Roads construction		L	1	156,000	No
L	Surface compaction		M	12	25,000	Yes
M	Carbon capture and storage			18	9,000	No

Table 1. The network logic and time and cost estimates for Dave's and Jane's idea of the project

3 Project network

(for Dave's idea of the project)

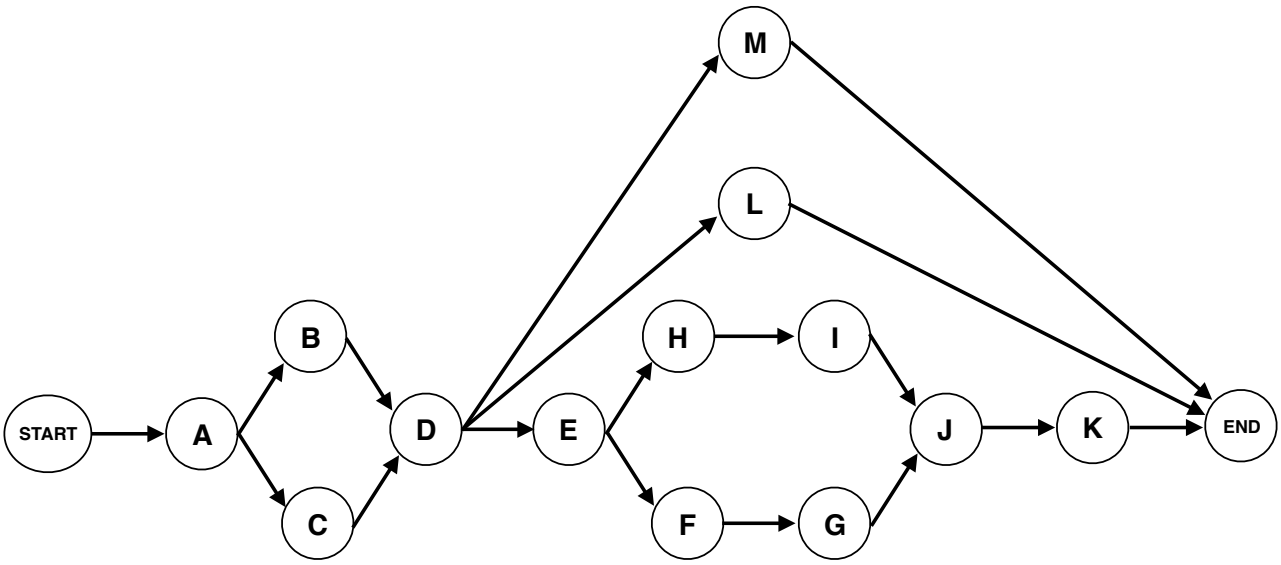

Figure 1. The project network logic of Dave for the project

4 Sensitivity metrics

(for Dave's idea of the project)

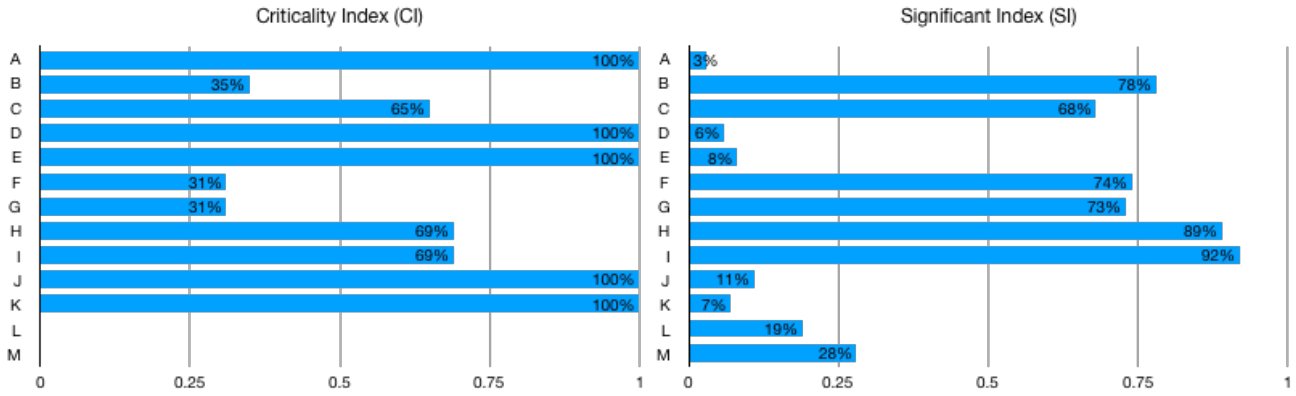

Figure 2. The sensitivity metrics CI and SI of the schedule risk analysis for Dave's idea of the project
(no value means 0%)

For more information about offshore projects, download and read the article "Optimised scheduling for weather sensitive offshore construction projects" on http://doi.org/10.1016/j.omega.2016.01.011.