KU LEUVEN

Engineering Sciences

Project Management [H04X2a]

Project Management Case

World of Wild Waters (WoWW) - Gamification of Natural Hazards

Amit Challana

KU Leuven

Academic year 2022-2023

Project Management Case

Amit Challana

Academic year 2022-2023

Contents

Objective and scope

Extreme weather events, natural disasters, and the inadequate mitigation and adaptation measures for climate change pose the highest likelihood and global impact risks (World economic forum, 2017). According to the natural perils pool, Norway alone has incurred direct compensations of 27 billion NOK over the past 10 years due to NH[1], with even higher costs for the public sector. The responsibility for developing adaptation strategies, risk mapping, and prevention efforts to mitigate threats and minimize damages is currently fragmented. Recent events have highlighted the pressing need for a comprehensive perspective and coordinated efforts across sectors. The objective of the World of wild waters project is to establish a holistic comprehension of the causes and consequences of natural hazards by creating an immersive user experience based on authentic data, realistic scenarios, and simulations. By providing stakeholders, planners, decision-makers, and emergency agencies with these experiences, they can develop proactive measures and emergency responses that safeguard lives and reduce costs.

To bolster society's readiness for a wetter and wilder climate, digital tools and methods were employed to transform how natural hazard risk assessment and management are approached. This encompasses analyzing risks and vulnerabilities, preventing damages, and responding during critical events and crises. By leveraging digital technologies, it aims to enhance efficiency and effectiveness, fostering a more resilient approach to address the challenges posed by changing climate conditions.

[1] Natural Hazards

Projects in contemporary organizations

The thesis was a task in larger scheme of things. It was performed under the work package called "Creating realistic flood simulations". This work package was a part of a project called "WoWW[2] - gamification of natural hazards". The WoWW project is one of the nine projects encompassed by the program called "The digital transformation". The structure of the program can be observed in figure 1.

The WoWW project embodies all the essential attributes of a project. It possesses a clearly articulated

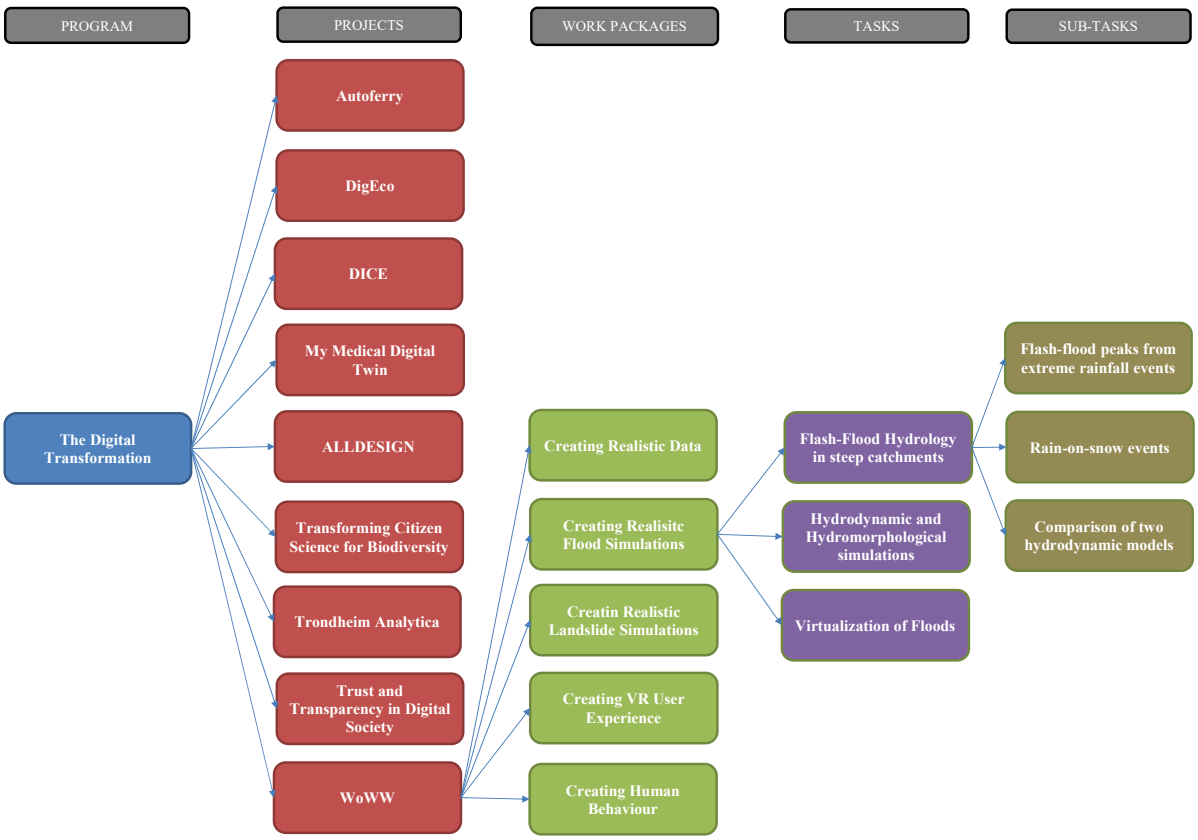

Figure 1: The Program Structure

objective: to craft immersive user experiences utilizing genuine data, lifelike scenarios, and simulations. This achievement is realized through the fusion of proficiency in the physical and statistical aspects of natural hazards with insights into digital storytelling and human behavior. It has a well defined life cycle of five years as defined by NTNU[3]. There are multiple work packages and tasks in the project that are fiercely interdependent on each other. In terms of uniqueness it is a part of one of the very few initiatives of digital transformation.

[2]World of wild waters.
[3]Norwegian university of science and technology.

Chapter 1

Project Initiation

1.1 Strategic Management and Project Selection

In 2018, NTNU launched the digital transformation initiative with the objective of conducting groundbreaking research focused on the advancement and practical implementation of digital transformation technology. This initiative encompasses a total of 48 doctoral positions distributed among nine interdisciplinary projects, spanning diverse fields and potential impact areas. The advent of digital transformation brings forth numerous possibilities, while also presenting us with various societal challenges. NTNU strives to contribute research-based knowledge to enhance the competitiveness of both established and emerging industries in Norway, improving public sector operations, and ensuring societal development aligning with the expectations of norwegian citizens.

Each of the nine projects within the program pursue different objectives that align with the program's overarching goal. For eg., the goal of "Autoferry" is to pioneer innovative concepts and methods that will facilitate the development of urban water transport ferries with groundbreaking capabilities. "MyMDT[1]" platform acts as a transformative solution for implementing patient-specific hypertensive interventions. In similar manner the WoWW project aims to create a tool for virtually testing and optimizing solutions for any construction or installation exposed to natural hazards.

The primary focus of the WoWW project is to gamify natural hazards, combining expertise in the physical and statistical behavior of natural hazards with knowledge in digital storytelling and human behavior. The objective is to develop immersive user experiences that utilize real data, realistic scenarios, and simulations. These experiences will serve as a foundation for implementing preventive and emergency measures that prioritize saving lives and reducing costs. WoWW strives to become a future tool for analyzing and communicating the causes and effects of potential natural hazards such as floods and landslides. The project was allotted in total of four years started from the month of October 2019. Thus, it is supposed to be concluded by November 2023.

The scope and length of the project is huge which understandably led to multiple conflicts. For example, the task of creating flood simulations that resemble the reality in terms of creating an immersive audio and visual experience was a multidisciplinary task. It created a work push-pull dynamic between the work packages "Creating VR experience" and "Creating realistic flood simulations". This was because the task was not completely in domain of any work package. Eventually the conflict had to be resolved by outsourcing the work to a third party.

There are numerous stakeholders of the program as well as the project including Trondheim municipality, the Norwegian board of technology, the Norwegian data protection authority, NTNU Brussels office and NTNU sustainability department. NTNU was the sole funder as well as the owner of the entire program and the project.

[1]MyMDT: My Medical Digital Twin.

1.2 The Project Manager

The professor who was the team leader/functional manager for the work package II i.e. "Creating realistic flood simulations" was also the project manager of the entire WoWW project (figure 1.1).

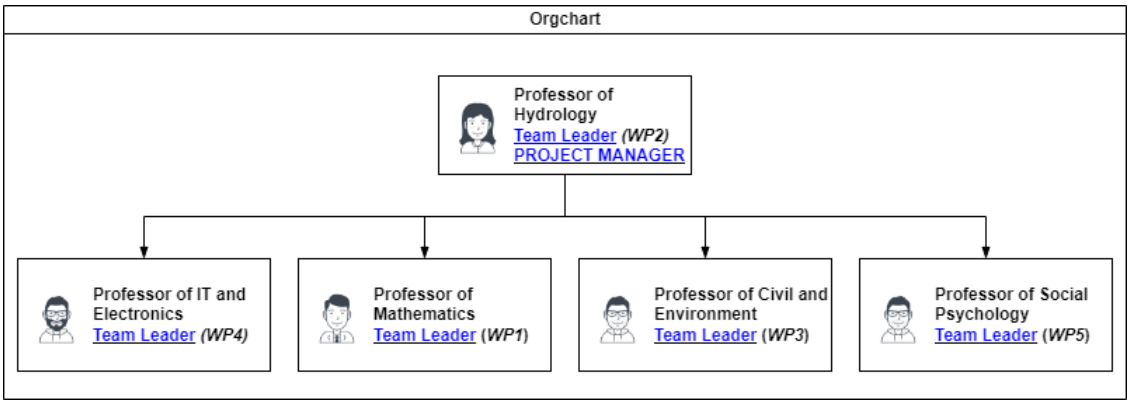

Figure 1.1: The Project Manager

The project manager was responsible for conveying quarterly updates to the management including the program coordinator. His job was to communicate the goals achieved so far, the tasks that are being carried out currently and the tasks that are next in the pipeline.

In addition to overseeing the coordination of work packages, his role involved effectively communicating the project's objectives and program goals to the leaders of other work packages. He was also responsible for managing human resources within each team, ensuring adequate staffing while adhering to the project's budget constraints. Furthermore, he closely monitored and provided justifications for the expenses incurred by the project's PhD candidates. Besides working on this project, the professor was involved in teaching multiple courses to the bachelor and master students in the department of civil engineering.

Managing this project involved almost all the skills required in a project manager. Listening and understanding the goals of the management and then persuading the team to work and execute those goals required strong interpersonal and **communication skills**. Managing and tracking the documentation of the entire project while ensuring sufficient coordination between various multidisciplinary teams involved constant **organization** and planning of the project.

After the initial setback of a PhD dropping out in the third year of the project, the project manager ensured that the team members in his work package did not loose motivation and at the same time, they were not overburdened with the work. It required showing respect and **empathy** towards their work-life balance. Since the project manager was also a team leader of a work package, he **led by example** by always being present and involved whenever the team went through any bottleneck.

The project experienced a couple of setbacks such as a PhD candidate dropping out in the third year of the project and another team member taking a sick leave for an entire year during some crucial stages of the project. In such situations, the project manager ensured even delegation of work among the other team members. He kept the work flowing by covering up for the lost time using the rest of the team. It was important for the project to **cop with these setbacks** with persistence and patience by doing the hard miles and without taking any shortcut.

The project involved seven PhD candidates that belonged to seven different nations and cultures. The project manager saw that the differences did not become a problem for the team members. Rather, all the team members did not just respect and acknowledge but also celebrated the differences and diversity of the office.

1.3 Managing for stakeholders

As mentioned in 1.1, there were numerous stakeholders of the entire program and hence, the project. These stakeholders were bifurcated in four categories based on the parameters and interest over the project (figure 1.2).

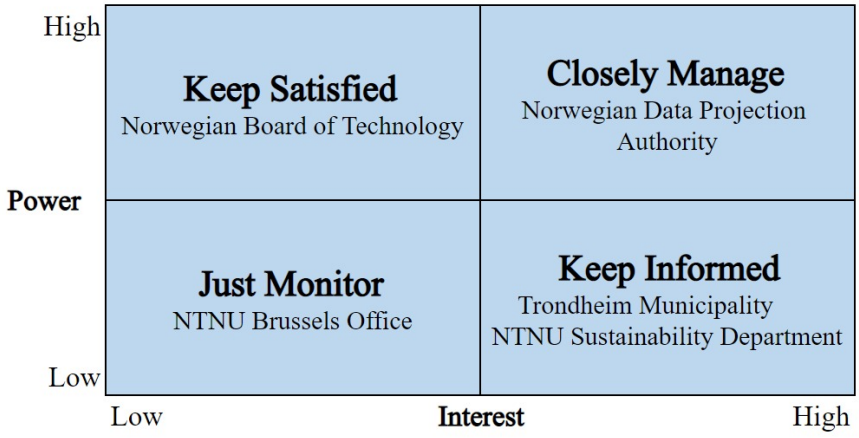

Figure 1.2: Category of stakeholders

The **Norwegian board of technology** is a body of central government of Norway that issues advisories to the government on the latest technology in the world. Clearly, it is a bureaucratic body with high power but the transformation program and the WoWW project in specific is just one of the many projects that the body monitors and has stakes in. Thus, the strategy of the project manager would be to just keep them satisfied. Similarly, **NDPA**[2] is another powerful government body that ensures that the sensitive data of the state and its citizens is in safe hands and the privacy of its residents is secure. Since the program is entirely build on creating digital twins of various aspects, the NDPA must be closely managed and catered to. The **Brussels office of NTNU** operates under the direct authority of the pro-rector for research and dissemination at NTNU. The primary objective of the office is to actively support the attainment of NTNU's goals as outlined by the university. But this office barely holds any significant power or interest in this project. The objective of **Trondheim municipality** is to enhance the quality of life for its residents and promote sustainable development within the municipality. This includes ensuring a well-functioning infrastructure, providing high-quality public services, fostering a vibrant and inclusive community, and protecting and preserving the natural environment. Thus the municipality can benefit greatly from this project as it can help the municipality in ensuring better safety of its citizens but since the project is owned by a central university, the municipality does not hold high power in the project. Similarly NTNU sustainability department is one of the many departments of the university that works in the project. Therefore, it is important to keep both these stakeholders informed about the progress of the project as frequently as possible.

1.4 The Project in the organizational Structure

The usual organization structure of academia is somewhat more close to a lightweight project matrix organization than the other organization structures. Every professor is a functional manager that the PhD candidates report to. These PhD candidates work specifically in the field that the functional manager is specialized in. Thus they essentially operate in the same field. But every professor supervises the work of multiple PhD candidates that may have been working on different projects.

[2]Norwegian data protection suthority

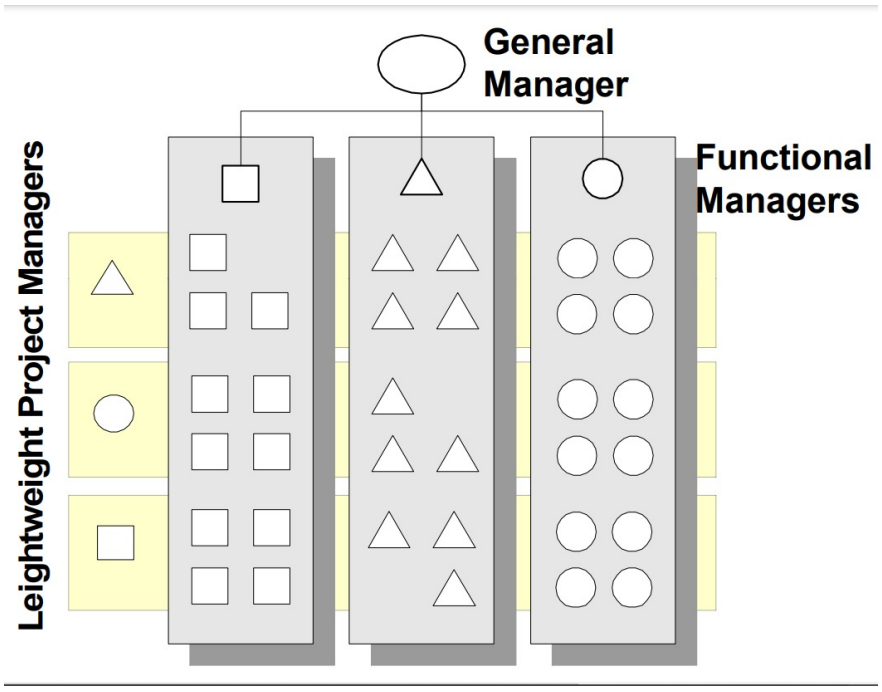

Figure 1.3: Lightweight Project Matrix Organizational Structure

For eg. in the WoWW project, the professor of civil and environmental is responsible for work package III i.e. creating realistic landslide simulations. In total the professor has four PhD candidates that report to him but only one of them is working dedicatedly on the WoWW project. The rest three of them are part of some other project.

The differences from the standard lightweight project matrix organizational structure is that in this case the functional managers are also responsible for some work package. Also, the project manager is also a functional manager who supervises the work package II i.e. creating realistic flood simulations. Interestingly, the project manager had three PhD candidates working for him and all of them are involved in the same WoWW project.

Chapter 2

Project planning

2.1 Project activity planning

The project had been incorporated into NTNU's strategic project portfolio, which focused on conducting transformative research in the development and application of digital transformation technology. Considering the multidisciplinary nature of the project, the positions within WoWW were allocated across four departments spanning three faculties. The foundation of WoWW was built upon the collaborative partnership between the PhD research fellows and their respective departments. NTNU created seven three year PhD positions for the project in order to cater the work packages as shown in the figure 2.1.

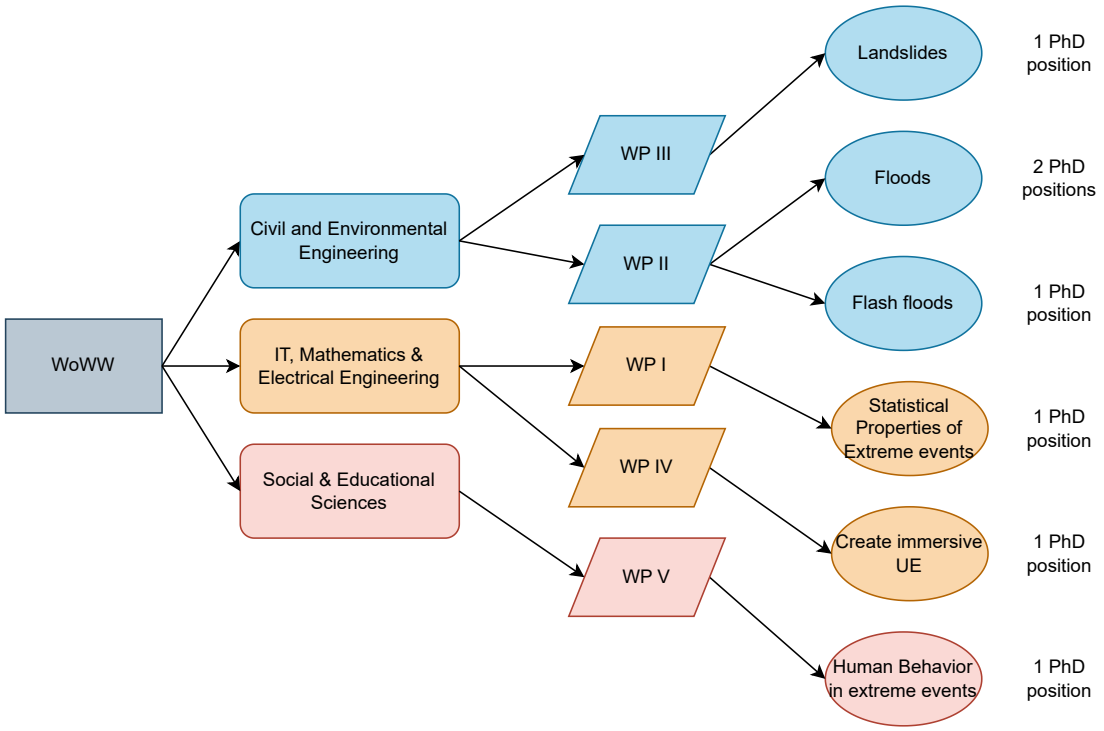

Figure 2.1: Planning of activities

Ideally, the project would have worked the best in a waterfall approach because the output of one team

member (PhD candidate) was the input for the next team member. For example the output of the member working on simulations of floods would be an input for the member who creates the user experience of these floods. But that would mean the project taking 21 years, 3 years for each activity. Thus, to reduce the dependence of activities on each other, certain data assumptions were made that would facilitate the simultaneous working on all the activities.

2.2 Budgeting and cost estimation

Since the WoWW project is a research project, it is really difficult to do the budget estimation with a bottom up strategy. During a research project, bottlenecks may appear at really unexpected places and can even lead to dead end many times. Thus, it is a project with a large amount of uncertainty in its inheritance. Then there is huge uncertainty because of the human factor. The main resource of this project are humans working in it. Hence, the budget estimation is done using the ball park top-down strategy. There were seven full time PhD candidates working dedicatedly on the project. Also there were five professors working as team leaders with one of them being the project manager as well. But the professors were not solely working on the WoWW project as they were also involved in their other academic duties. Let us assume that the team leaders took 20% of their time for the project and the rest of their time for teaching and making courses etc. Since one of the team leaders is the project manager as well, let us assume that he devoted 30% of his time to the project. Using the ballpark salary figures, the total cost of project would be as per the figure 2.2.

	Salary	**Duration**	**Time Devoted**	**Units**	**Overhead**	**Personal Time**	**Total Project**
	per/year/unit	*years*	*%age*	*number*	**Factor**	**Allowance**	**Salaries**
PhD Candidates	NOK 400,000	3	100%	7	1.25	1.12	NOK 11,760,000
Team Leaders	NOK 850,000	3	20%	4	1.25	1.12	NOK 2,856,000
Project Manager	NOK 850,000	3	30%	1	1.25	1.12	NOK 1,071,000
	Total						NOK 15,687,000

Figure 2.2: Budget for the project

Since NTNU is an esteemed university with campus in multiple countries, the overhead budget factor was assumed as 1.25. The personal time allowance factor accounts for the times when the employee is not working during the office hours.

In addition to the salaries, every PhD candidate was given a fixed extra allowance of NOK 50,000 for travel, attending international conferencess, buying gadgets/sotwares other than default supplies(laptop) etc.

$$Allowances = NOK50,000/year/Candidate * 3years * 7candidates = NOK1,050,000 \tag{2.1}$$

Thus, the total budget of the project (salaries + allowances) would be:

$$Salaries + Allowances = NOK15,687,000 + NOK1,050,000 = NOK16,737,000 \tag{2.2}$$

As mentioned, the estimated time allocated to the project is three years but being a research project, there are a lot of activities in the project that can run into a bottleneck or a dead end. Also, there were human factors involved in real when a candidate dropped out of the PhD. All these factors lead to a creating a buffer (contingency) of one year around the project. Thus the time allocated to the project was four years.

2.3 Scheduling

Since the project was too large to break every activity individually for the assignment, the WBS[1] was created for the thesis of a specific PhD candidate under work package II as can be observed in figure 2.3.

ACTIVITY PLAN		
Deliverables	Develop methodologies for risk assessment of flash floods in steep terrain were high water velocities, erosion and deposition creates an imminent danger to settlements and infrastructure	
Measure(s) of Accomplishment	An appropriate model that takes extreme rainfall as input and spits out the hydrological properties of the flood generated by the extreme rainfall.	
Key Constraints and assumptions	Only two models available, Lack of data availability	
TASKS	**Precedence**	**Time**
• **Flash-flood peaks from extreme rainfall events**		
a. Selecting an appropriate model(s) for the task	-	5 months
b. Select a location with steep terrain and prone to flash flood	-	3 months
c. Selecting an historical extreme rainfall event	b	1 month
d. Calibrate the data on model	c	4 months
• **Rain-on-snow events**		
e. Snow melting calculate	a,c	4 months
f. Input precipitation calculation	d	2 months
g. Calculate combined precipitation data	e, f	2 months
• **Comparison of two hydrodynamic models**		
h. Formatting/ Cleaning/ Preprocessing the data	d	5 months
i. Calibrate all models	h	4 months
j. Compare all models	i	3 months

Figure 2.3: Work Breakdown Structure for an activity

The activity had three primary tasks and further sub-tasks. It involved gathering the historical data on flash-flood rainfall from a suitable terrain, adding the rain on snow data and then comparing the results with the model results. Every task involved further sub-tasks with certain precedence. The activity on arc method was used to draw the network (fig. 2.4).

The CPM[2] was used on the activity to identify the estimated time required for the activity, the critical path and the variance of the project. From figure 2.5, it was found that the critical path (marked in red) included the subtasks b,c,d,h and i. The standard deviation of the project was calculated as 17.85 (table 2.1). Using the obtained standard deviation, the time estimate of the critical path (708 days), it could be concluded that there was almost 90% probability that the project would finish under the deadline of two years of working days (730 days).

[1]Work Breakdown Structure
[2]Critical Path Method

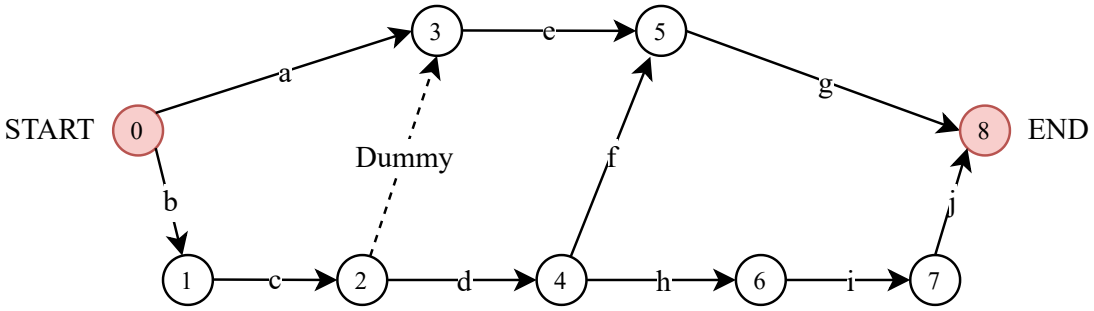

Figure 2.4: Activity on arc network

Table 2.1: Time Estimates, Predecessors, and Variance

Subtasks	**Optimistic,** a_i	**Most Likely,** m_i	**Pessimistic,** b_i	**Predecessor**	**Estimated,** TE_i	**Variance,** σ_i^2
a	135	150	180	-	153	-
b	160	180	220	-	184	100.00
c	15	30	45	b	30	25.00
d	105	120	140	c	121	34.03
e	100	120	135	a,c	120	-
f	40	60	70	d	59	25.00
g	30	60	75	e,f	58	-
h	140	150	185	d	155	56.25
i	110	120	145	h	123	34.03
j	85	90	125	i	95	44.44
				Total Variance of the critical path		318.75
				Standard Deviation		17.85

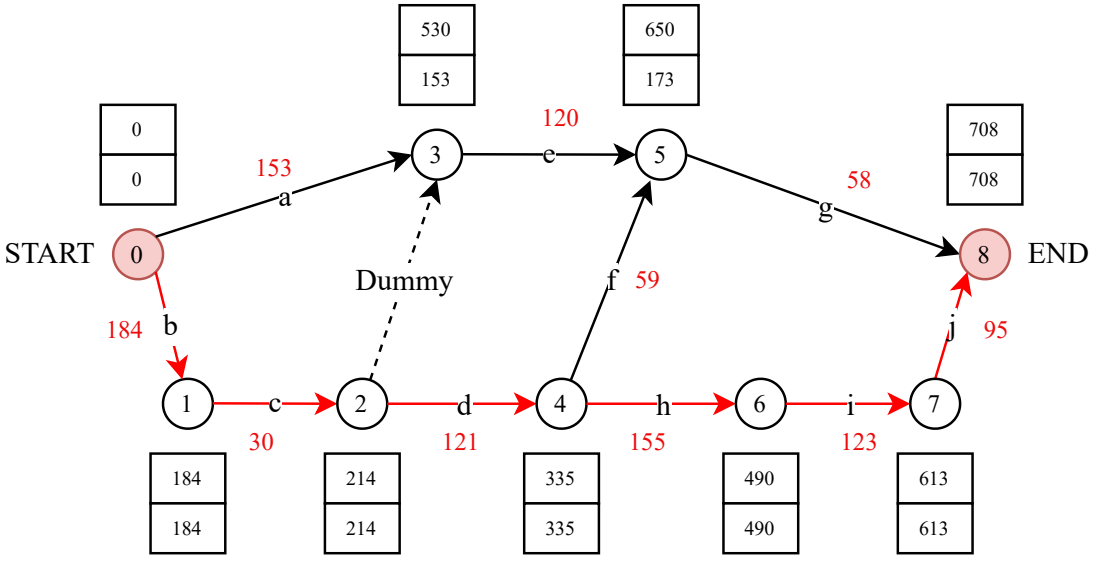

Figure 2.5: The critical path

Chapter 3

Project execution

3.1 Monitoring and information systems

In such a research project, it was important to monitor that the research designs and models aligned well with the objective of the project. Since it was a multidisciplinary project, it was important to monitor sufficient collaboration and communication between the team members. It was important to ensure the quality of deliverables while maintaining the motivation of the employees. The feedback from upstream stakeholders was consistently conveyed to the people responsible for the quality. This feedback was used to set the target outputs. The difference between the outputs and project status was monitored with sufficient frequency. Obviously, being a digital transformation project, it was quite challenging to clearly define the boundaries of targets.

There must be a complete track of the problems and bugs faced over the duration of the project. As the project moved through different stages over time, the task of analysis and monitoring moved towards efficiency. Therefore, not just the number of bugs reduced in the product but the cost of identifying these bugs through analysis also kept reducing.The reporting process was transparent and well defined for each team member. It was important for the project manager to identify and highlight the problems and/or bottlenecks of the project and make them common knowledge among the responsible team members. In fact, it was encouraged to point towards the deficiencies of the project. These analysis enhanced the mutual understanding of the goals of the project which is really important in a multidisciplinary project such as WoWW. Also, it constantly informed the important stakeholders about the whereabouts of the project and if the results were aligned with their expectations. It helped the project manager to have a bird eye view of the situation and sometimes even enabled them to foresee a potential bottleneck. It is very important in a multidisciplinary project that the results are compatible and seamlessly combine with the results of other disciplines. It is important to not just throw the results over the fence but to handle the report and deliverables via face to face meetings, so that the project does not get delivered as a black box but in the form of interactive, sensitive and understandable interface.

In the WoWW project these kind of analysis were mainly made in the routine reports with the right level of detailing. The meetings were mostly done in person with clear agenda. Itwas made sure that everyone involved was sufficiently aware about the agenda and minutes of the meeting. The progress was constantly compared against the time available to have an aggregate performance measure called earned value. For example if task 'a' from the activity plan in figure 2.3 was 60% complete. Then the earned value of the task would be 60% x 5 months i.e. 3 months. This is the earned value of the task performed. This is the amount of time that must have been spent on this task so far.

3.2 Controlling project execution

In WoWW there was not any budgeting control problem as the majority of the resources were predefined. But being the state of the art project, there were a lot of control required in terms of the time budget. Several bottlenecks appeared in terms of a researcher running into a dead end, a researcher dropping out of the project, multiple team members going out of the project for long durations due to medical leave. All of these bottlenecks were controlled by ensuring that other team members were motivated enough to fill in for their team members. The primary understanding of the team members and their work requirements was really important.Therefore, the employees were encouraged to give feed backs of the working conditions and communicate any problems that they were potentially facing.

3.3 Project evaluation

Currently the WoWW project is still in progress and is close to termination. Since the project was built around creating life-like simulations of catastrophic events due to flooding, the project has been build using the historic data and is iteratively caliberated around that. The standard procedure will be followed to audit the project where the model will be run against a past event which is alien to the model. The simulations created by project will be compared with the actual impacts of the event. This is also known as testing the simulations. A certain KPIs[1] must be defined to compare the output of the simulations and real-life impacts. Dor eg;, the area impacted, settlements destroyed and/or impacted etc.

3.4 Project completion

The project under consideration is a digital transformation project and there is nearly no limit to the amount of realism that can be incorporated into a simulation. The level of detailing can be beyond limits. Therefore, the marginalised improvement must be compared with the effort required. It is important to identify the point beyond which improvements in the project do not outweigh the effort being put into it. The project will be terminated at point when further progress will not be possible or too expensive.

The death of the WoWW project can most suitably categorized as termination by addition. It is one projct out of a portfolio of projects that aim towards digital transformation of various aspects of the society. Once, WoWW achieves its simulation goals successfully, it will be part of a larger group. It is important that the project will not be terminated by integration as most of the human resource working on the project (PhD candidates) will meet with termination in their employment as they were specifically hired and contracted to work on this project. The termination decision will certainly be only taken after ensuring the degree to which the project meets the goals and expectation of the important stakeholders.

The implementation process would involve ensuring the completion of all the activities included in the project and informing the higher management that the model successfully simulate the natural hazards with the required level of realism. The project will be delivered to the concerned offices with the complete documentation. The professor (the project manager) would also submit any pending bills or reimbursements that incurred while working on the project. It would also involve terminating the contract of the PhD candidates when it expires and maintaining a proper record of all the paperwork that is to be maintained and kept.

[1]Key Performance Indicators

List of Figures


UNIVERSITAS STUDII BURDIGALENSIS
1425