Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

4E1 Management for Engineers

Project Management – Nightingale Case Study

Department of Electronic and Computer Engineering

(e-Report submission)

Table of Content

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Declaration: This is my own work. The reference material has been acknowledged in the resources.

1. Project Objective

The objective of the project is to develop an electronic handheld device designed to be used by medical paramedics and technician in the situation of medical emergency as a medical reference guide. The team must develop 30 working units of the product by 2nd October 2021 to meet the deadline of the event MedCON. It is essential to the complete the project by the deadline as it is critical to success. It is very important to keep the project objective in accordance with the stakeholders.

Stakeholders -

i. Product Designer & Design Team – The engineering behind the design is laid out by them. They must act quickly. The head engineer works out the details and develop a balanced design – he/she must be consulted to any primary change to the product.
ii. Medical Operators – They are the end-user of the product – to be successful, the project design and ergonomics should be in accordance to them. The design team should be well informed by them.
iii. Investors – The sponsors of the project must be in sync with the details as they decide the budget to keep the development going. They must be consulted for any change in respect to time frame or budget update.
iv. Medical organizations, authorities and associates – to meet the criteria of technology used to be medically approved – they must be consulted and certified from directly. The set of policies laid by them is what must be followed for deploying the product into the market.

Project Performance Matrix

As the deadline of 2nd October 2021 is very important to be met, the time is constrained. As for the scope, it's well laid and is accepted – no change is needed. As for the factor of budget, the cost can still be adjusted based on the updated parameters – it's enhanced.

	Time	**Scope**	**Cost**
Constrain	☑		
Enhance			☑
Accept		☑	

Table 1.1: Project Performance Matrix

2. Why Use MS Project?

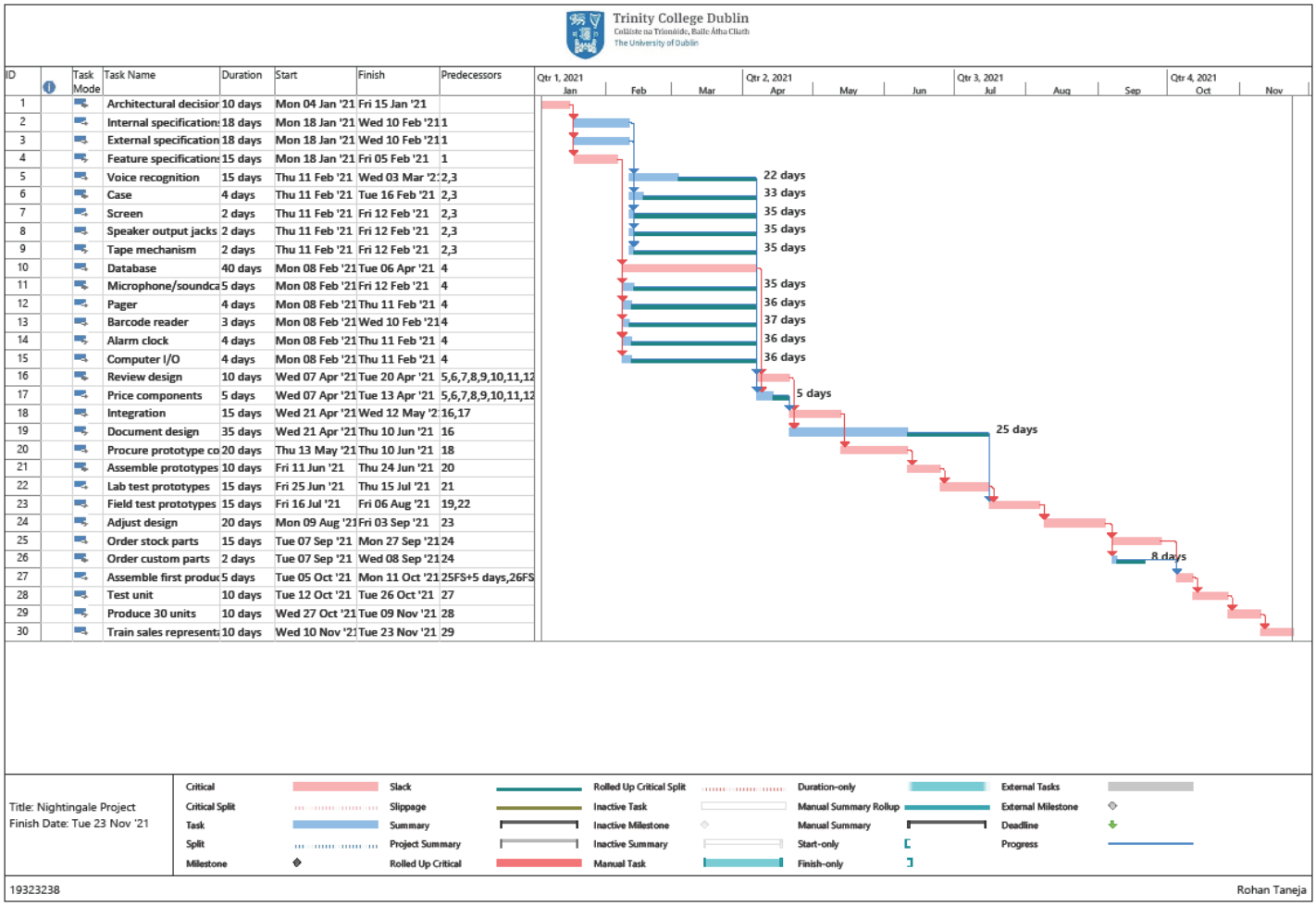
Microsoft Project Professional was provisional to us using Azure for Education scheme. The specific software used in our case was MS Project 2016. It provides seamless project management approach and well documentation can prepare as the entire project can be printed and retain various other features which work in easy collaboration with other MS Office 365 software like Word, and Excel. The migration of important details can be done easily retaining all the formatting and exporting into multiple Windows supported formats.

Also, as for the MS Project in use the models generated is attached in the Google Drive as provided. The network model for the given project. Also, as for the late start and finish start view is not included instead the total stack is pointed in the Gantt Chart to reduce redundancy.

3. Project Layout & Crashing

Initial Approach

The initial parameters as suggested by the case study resulted in following layout of the project. This projects how the project was initially scheduled with expected completion and default activities involvement. The activities are result of the work breakdown structure and the developed network for occurrence of activities based on it.



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		Architectural decisior	10 days	Mon 04 Jan '21	Fri 15 Jan '21	
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3		External specification	18 days	Mon 18 Jan '21	Wed 10 Feb '21	1
4		Feature specifications	15 days	Mon 18 Jan '21	Fri 05 Feb '21	1
5		Voice recognition	15 days	Thu 11 Feb '21	Wed 03 Mar '2	2,3
6		Case	4 days	Thu 11 Feb '21	Tue 16 Feb '21	2,3
7		Screen	2 days	Thu 11 Feb '21	Fri 12 Feb '21	2,3
8		Speaker output jacks	2 days	Thu 11 Feb '21	Fri 12 Feb '21	2,3
9		Tape mechanism	2 days	Thu 11 Feb '21	Fri 12 Feb '21	2,3
10		Database	40 days	Mon 08 Feb '21	Tue 06 Apr '21	4
11		Microphone/soundca	5 days	Mon 08 Feb '21	Fri 12 Feb '21	4
12		Pager	4 days	Mon 08 Feb '21	Thu 11 Feb '21	4
13		Barcode reader	3 days	Mon 08 Feb '21	Wed 10 Feb '21	4
14		Alarm clock	4 days	Mon 08 Feb '21	Thu 11 Feb '21	4
15		Computer I/O	4 days	Mon 08 Feb '21	Thu 11 Feb '21	4
16		Review design	10 days	Wed 07 Apr '21	Tue 20 Apr '21	5,6,7,8,9,10,11,12
17		Price components	5 days	Wed 07 Apr '21	Tue 13 Apr '21	5,6,7,8,9,10,11,12
18		Integration	15 days	Wed 21 Apr '21	Wed 12 May '2	16,17
19		Document design	35 days	Wed 21 Apr '21	Thu 10 Jun '21	16
20		Procure prototype co	20 days	Thu 13 May '21	Thu 10 Jun '21	18
21		Assemble prototypes	10 days	Fri 11 Jun '21	Thu 24 Jun '21	20
22		Lab test prototypes	15 days	Fri 25 Jun '21	Thu 15 Jul '21	21
23		Field test prototypes	15 days	Fri 16 Jul '21	Fri 06 Aug '21	19,22
24		Adjust design	20 days	Mon 09 Aug '21	Fri 03 Sep '21	23
25		Order stock parts	15 days	Tue 07 Sep '21	Mon 27 Sep '21	24
26		Order custom parts	2 days	Tue 07 Sep '21	Wed 08 Sep '21	24
27		Assemble first produc	5 days	Tue 05 Oct '21	Mon 11 Oct '21	25FS+5 days,26FS
28		Test unit	10 days	Tue 12 Oct '21	Tue 26 Oct '21	27
29		Produce 30 units	10 days	Wed 27 Oct '21	Tue 09 Nov '21	28
30		Train sales representa	10 days	Wed 10 Nov '21	Tue 23 Nov '21	29

Figure 3.1: Initial Project Layout – Gantt Chart

As in the figure attached above, we can observe that for the initial laid out plan schedules originally at almost 2 months (52 days exactly) of lag from the expected deadline. The results are very disappointing for the initial plan. As the chart predicts the project would finish in the last week of the month November given that the project goes smoothly as planned without any risk considered. The working time as described is 8 hours daily of five working days every week. And several holidays are included in this planned schedule. Although the holidays are not visible in entire project view – they are included in extended view as grey column added to that date. There is no overtime included – keeping the working shifts as per the norm. Every parameter is kept intact as defined in the case study while developing this chart. A detailed Gantt chart view is considered to show the free slack available (on which we work as we proceed).

Optimal Approach

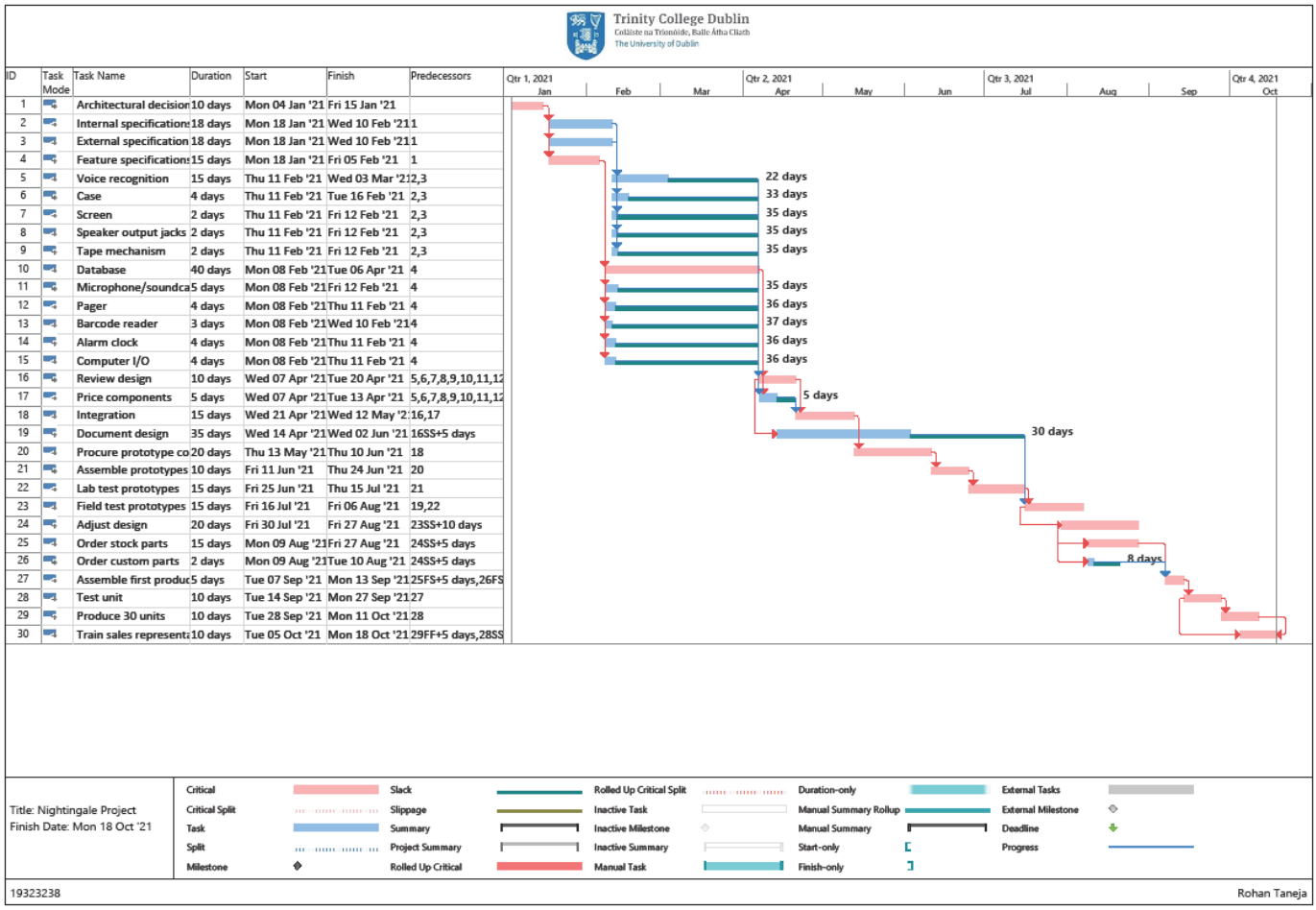
The optimal approach breaks down into two segments to achieve the constraint deadline. The segments are discussed as - **a) Redundancy Consultation** with Ken Clark (Development Engineer) - followed by **b) Budget Increment to Crash the Project** involving additional available funds. Now that we start with optimization of project – few parameters would remain same as before – *no overtime* and *no interference with holidays.* We continue to find the most optimized timeline to complete the project as follows -4

a) Redundancy Consultation

This was later discussed in the case study – after the follow up meeting which took place two days after the kicking off the Project Nightingale's schedule. The revision to activity occurrence was done creating start-to-start lag between the occurring activities as pointed by the development engineer – Ken Clark. The following table summarises the changes made based on the engineer's suggestions –

No.	Activity	Preceding Task(s)	Lag Introduced
19	Document design	Review design (16)	16 (start-to-start) + 5 days
24	Adjust design	Field test prototypes (23)	23(start-to-start) + 10 days
25	Order stock parts	Adjust design (24)	24 (start-to-start) + 5 days
26	Order custom parts	Adjust design (24)	24 (start-to-start) + 5 days
30	Training sales representatives	Test unit (28), Produce 30 units (29)	28 (start-to-start) + 5 days, 29 (finish-to-finish) + 5 days

Table 3.2 (a): Adjusting lag in the activities



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
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4		Feature specifications	15 days	Mon 18 Jan '21	Fri 05 Feb '21	1
5		Voice recognition	15 days	Thu 11 Feb '21	Wed 03 Mar '21	2,3
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10		Database	40 days	Mon 08 Feb '21	Tue 06 Apr '21	4
11		Microphone/soundca	5 days	Mon 08 Feb '21	Fri 12 Feb '21	4
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14		Alarm clock	4 days	Mon 08 Feb '21	Thu 11 Feb '21	4
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19		Document design	35 days	Wed 14 Apr '21	Wed 02 Jun '21	16SS+5 days
20		Procure prototype co	20 days	Thu 13 May '21	Thu 10 Jun '21	18
21		Assemble prototypes	10 days	Fri 11 Jun '21	Thu 24 Jun '21	20
22		Lab test prototypes	15 days	Fri 25 Jun '21	Thu 15 Jul '21	21
23		Field test prototypes	15 days	Fri 16 Jul '21	Fri 06 Aug '21	19,22
24		Adjust design	20 days	Fri 30 Jul '21	Fri 27 Aug '21	23SS+10 days
25		Order stock parts	15 days	Mon 09 Aug '21	Fri 27 Aug '21	24SS+5 days
26		Order custom parts	2 days	Mon 09 Aug '21	Tue 10 Aug '21	24SS+5 days
27		Assemble first produc	5 days	Tue 07 Sep '21	Mon 13 Sep '21	25FS+5 days,26FS
28		Test unit	10 days	Tue 14 Sep '21	Mon 27 Sep '21	27
29		Produce 30 units	10 days	Tue 28 Sep '21	Mon 11 Oct '21	28
30		Train sales represent	10 days	Tue 05 Oct '21	Mon 18 Oct '21	29FF+5 days,28SS

Figure 3.2 (a): Optimization in Segment A – Gantt Chart

Also, it was pointed out that introducing lag **won't cause any additional cost** on the project. With the given optimization we have achieved almost 36 days ahead of the original schedule. Initially the activities started after the completion of the preceding activity that is finish-to-start approach. The *figure 3.2 (a)* reflects the changes made to the project after completion of first optimization approach. Now we head onto segment b) for additional crashing of the project.

b) Budget Increment to Crash the Project

This approach is followed by the segment a) optimization. In the follow up meeting, the project manager – Rassy Brown, brought in the discretionary fund of which half could be used to accelerate the activities of the project summing up to €100,000 for increased budget. The options discussed in the meeting are summarised as follows –

No.	Activity	Cost Increment	Completion Time Reduced
3	External specifications	€20,000	6 days
5	Voice recognition	€15,000	5 days
10	Database	€40,000	8 days
19	Document design	€20,000	10 days
20	Procure prototype components	€35,000	4 days
25	Order stock parts	€10,000	3 days

Table 3.2 (b).i: Crashing activities v/s budget

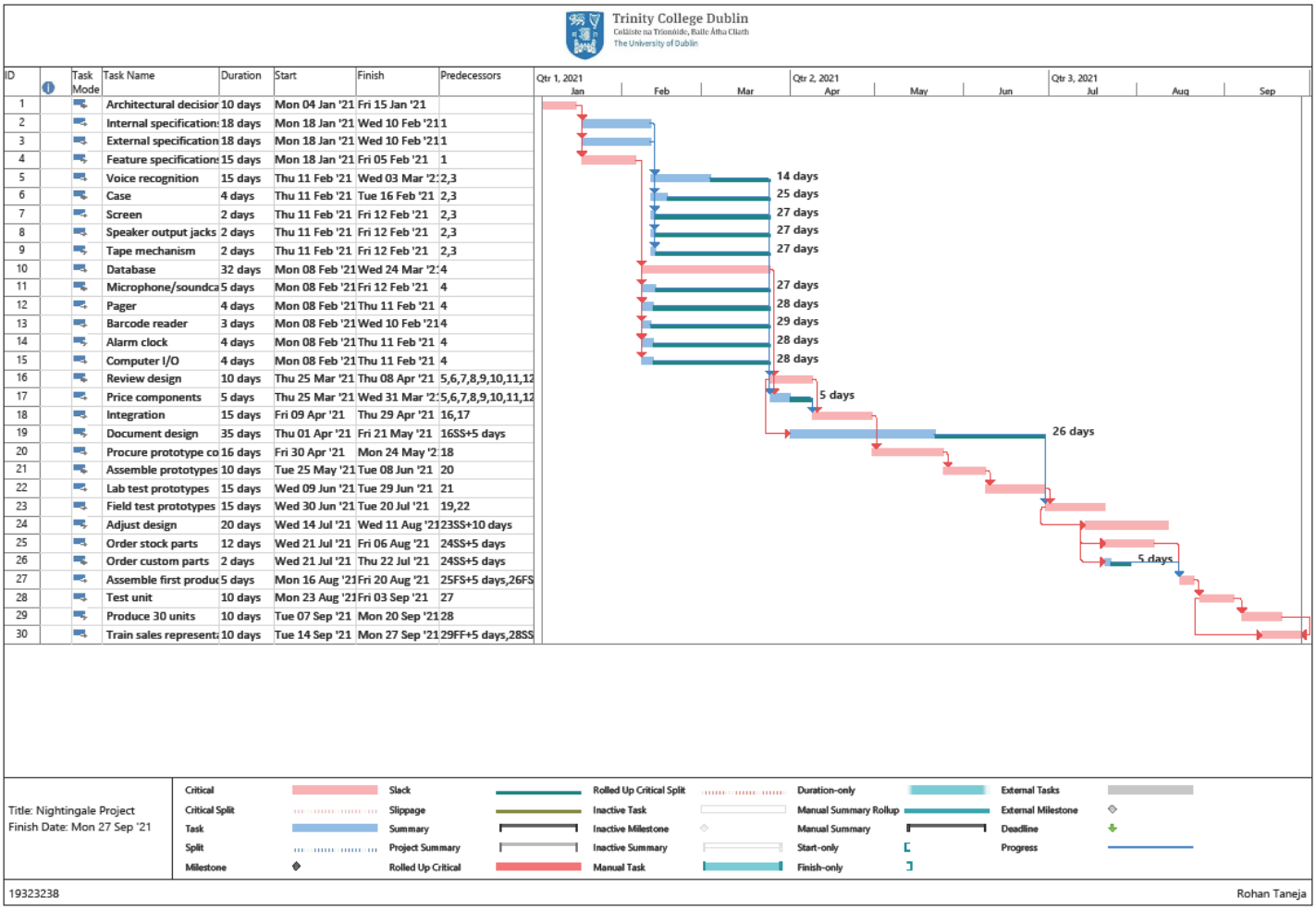
After further analysis of the timeline, we figured out that the activities with no slack would effectively reduce the completion of the project. The following table summarises the total slack of each activity –

No.	Activity	Free Slack	Total Slack
3	External specifications	0 days	14 days
5	Voice recognition	14 days	14 days
10	Database	0 days	0 days
19	Document design	30 days	30 days
20	Procure prototype components	0 days	0 days
25	Order stock parts	0 days	0 days

Table 3.2 (b).ii: Total Slack for Crashing Activities

From the table above, we can see that only activity 10, 20, and 25 would have an actual impact on crashing the project. So, we move on by experimenting on finding the most optimal approach by crashing the activities as mentioned.

The optimization takes place by using the budget for all three mentioned activities 10, 20, and 25. We achieve the following result in the completion of project –



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10		Database	32 days	Mon 08 Feb '21	Wed 24 Mar '2	4
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20		Procure prototype co	16 days	Fri 30 Apr '21	Mon 24 May '2	18
21		Assemble prototypes	10 days	Tue 25 May '21	Tue 08 Jun '21	20
22		Lab test prototypes	15 days	Wed 09 Jun '21	Tue 29 Jun '21	21
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25		Order stock parts	12 days	Wed 21 Jul '21	Fri 06 Aug '21	24SS+5 days
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30		Train sales represent	10 days	Tue 14 Sep '21	Mon 27 Sep '21	29FF+5 days,28SS

Figure 3.2 (b).i: Optimization in Segment B – Gantt Chart

Voila! This is what we needed. We've achieved a much shorter finish date of **27th September 2021**, starting from 23rd November 2021 followed by 18th October 2021. The cost involved sums up to €85,000 with still being under the available additional budget. From expected deadline of 2nd October 2021, we are 5 days ahead of the schedule which leaves room for any emergency or risk involved which must be tackled head on based on its severity. The changes made are in accordance with the activities free of slack.

Reaching this optimal solution, the project objective is fulfilled with meeting the accepted scope, constrained time and enhancing the cost under the budget. As defined in the performance matrix of the project – the project proceeds accordingly.

The relative impact of crashing the activities v/s introducing the lags – helped reduce the time frame of the occurrence of that activity and initiating the activities earlier of the later. Reducing the time frame by increasing the budget on the critical activities helped in extensive crashing of the project as seen transitioning from segment A optimization to segment B – we notice that between both almost reduction of **22 days** which had additional 7 days slack reduction to non-critical tasks. Also, when introduced start-to-start lag the initiation of critical task reduced the duration of completion as observed in segment A for various activities.

Also, the *figure 3.2 (b).ii* shows the network diagram for the project proceedings attached as follows:

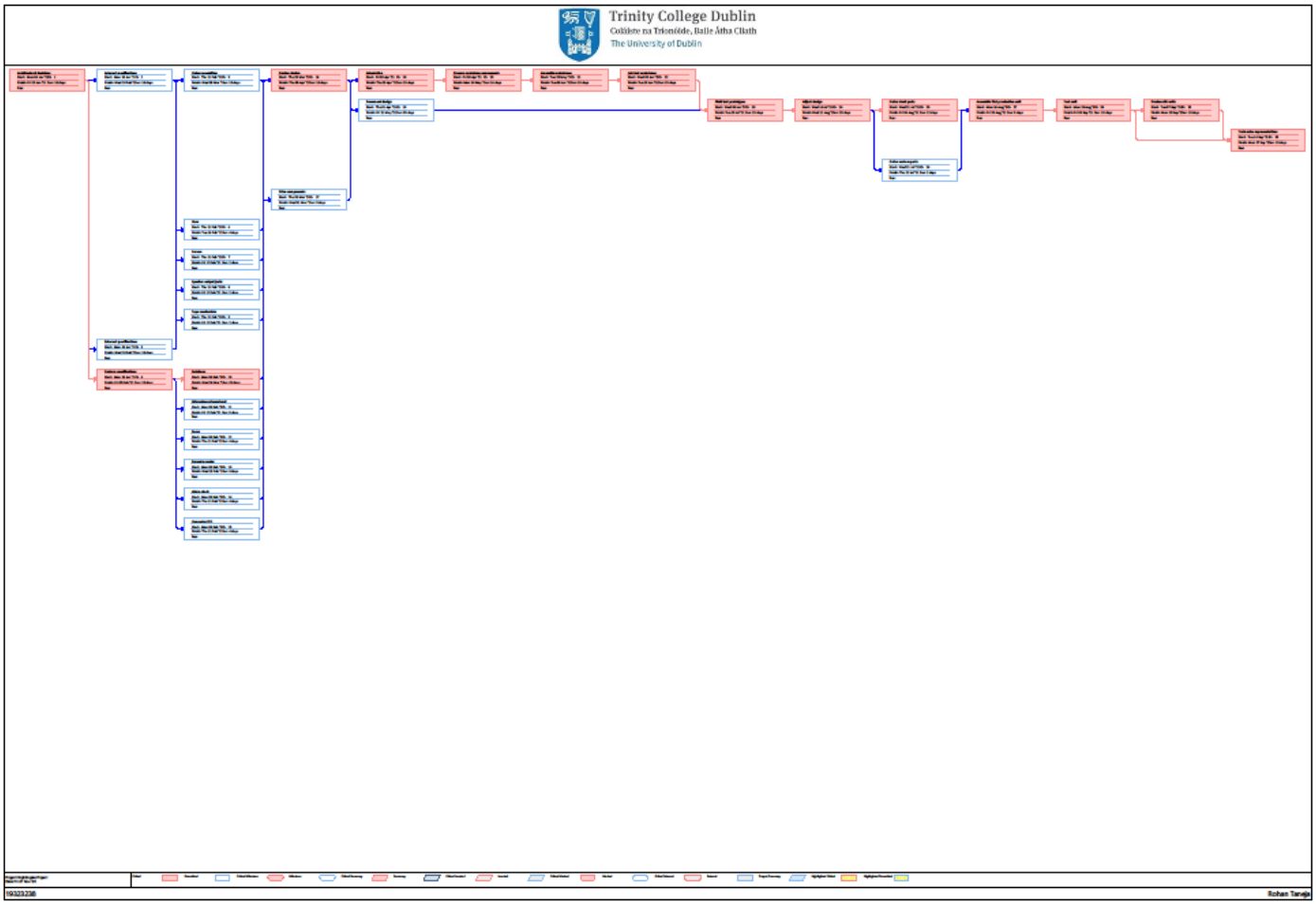

Figure 3.2 (b).ii: Optimization in Segment B – Network Diagram – Full View (click to retrieve)

Now that we are meeting the deadline – we move forward to analysing the risks involved and further team building approach that can be considered being the project manager.

As for the sensitivity of network, it's **insensitive** due to the **single critical path** followed as seen the network diagram above. Any changes made to critical activity would affect directly to complete project duration other than that would contribute to the slack of other non-critical tasks.

4. Risk Analysis

Even achieving the constrained time frame by crashing the project – any uncertain event is likely to occur. To assess such risks, we need to analyse various possibilities that could affect the progress and continuity of the project. Any such event would have either or both negative and positive impact on the project. This involves developing critical strategy to deal in occurrence of any such event, assessing the parameters involved and its identification, in the reverse order.

a) Risk Identification

The source of any unlikely event to occur must be figured out by analysing the project. As the manager on brainstorming the identified risk for the project in progress are listed as follows –

i) Product Design Incompetency
ii) Resource Availability
iii) Quality Deficient
iv) Testing Issues
v) Undersized Team (or Staff Shortage)
vi) Management Failure (or Lack of Communication)
vii) Procurement Risk
viii) Act of God (accidents, death, etc)

b) Risk Assessment

Event	**Likelihood**	**Impact**	**Detection**	**Risk Value**
Product Design Incompetency	3	5	6	90
Resource Availability	5	8	3	120
Quality Deficient	3	8	8	192
Testing Issues	5	5	7	175
Undersized Team	3	5	8	120
Management Failure	5	8	5	200
Procurement Risk	4	5	5	100
Act of God	5	8	2	80

Table 4.(b): Assessing the probability of occurrence of risk events

The above table predicts the occurrence of any risk event to take place based on the probability of their likelihood to happen, followed by their impact on the project proceeding and how probable it is to determine their occurrence. The course of actions taken requires a proper response it. For the same the risk response development table is as follows for the events listed –

c) Risk Response Development

Event	**Response**	**Contingency Plan**
Product Design Incompetency	Highly skilled engineer should be hired	Must have an alternative prototype available
Resource Availability	Order resources from trusted supplier and keep a backup vendor	Review or take a market survey of the suppliers – stay in loop with them
Quality Deficient	Define standards of accepted project quality	Regular quality check of the material should take place
Testing Issues	Software – roll out updates responsively Hardware – replace with similar better-quality chip	Make set of tests to be passed for both software and hardware functioning
Undersized Team	Promote vacancy for the job in the market	Allow overtime accordingly
Management Failure	Change strategy, train employees well, and effectively communicate	Keep a team balance and update them on the progress regularly
Procurement Risk	Take legal advisory and signup agreements in accordance	Revise the decisions with a team vote
Act of God	Hire or replace the employee with a new member	Train the new employee extensively and keep them posted of the project status. Schedule the project around to prevent any delays.

Table 4.(c): Response development to occurring risk event

After going through each identified risk in the project, assessing their affects and sources of cause, and later developing effective methodology to responding to such events occurrence. Such risk prevention and management strategy would come into play when required.

5. Team Dynamics and Building

As studied in the class – similarly, the project manager Rassy Brown should follow the approach of Tuckman's Model for development of team dynamics. This approach is very efficient to attain a strong, balanced and effective team play. The five stages of taking this approach and implementing into this project is as follows –

a) Forming –

This is the initial stage when the project objective is laid. While building the team it's crucial to the team to get acquainted to each other. Understand the scope of the project. Various tasks and small activities can take place to build the trust among the team and make them aware about how their contribution to the project is going to be. This stage puts up with setting a baseline for the team morale.

b) Storming –

This is the second stage to building a team and involves the most difficulties as during this phase the teammates compete for their position on the team. There might be various opinions and conflicts may arise. The members develop standards to workflow - establishing norms and set a level of performance. All these issues must be resolved by keeping the team members interactive about the project and tackle any conflicts that comes in their way.

c) Norming –

By this stage, the teams have established their roles and responsibility required to move ahead with the project. Most of the conflicts have been resolved. The team has settled on the common goal. As we move ahead – now there will be more team meeting and the team starts bond well and become more effective. Now the team understanding has increased – their mental model matches.

d) Performing –

This is a staged that is aimed to be achieved as earliest as possible. Now, that the team has settled and started to proceed on making the project happen. This stage continues with having the team at their peak of efficiency – being task-oriented, committed and delivering results. As the trust is built, cooperation and coordination among the team brings the best output. If any conflict takes place, they are resolved as quickly as possible. The team is much more communicating and working on the solution.

e) Adjourning –

Finally, the time arrives when the project must be wrapped up. Majority of project has been completed by this point. Now, as the manager it's time to redirect the team from their focus on the task to building relationship with each other. This keeps the project come to an end with a positive note and bring new relationship which last out of the work.

After discussing the model in concern – the team building requires a list of following parameters to be considered by the project lead –

- Vision – This should be consistent throughout the team
- Talent – Each individual skills and expertise should come into play
- Balance – the roles of each teammate must be balanced, no one should feel stressed
- Problem Solving – this should come into effect collectively by the team and their vote
- Opinions – every input from the team should be taken care of and encouraged to be expressed
- Identity – as an individual and as a team should be there
- Performance – though collaborative, high standards for self should be set to accomplish and grow

Conclusion

Finalising with the case study, crashing the project requires a lot of constraints considered. It's a tedious job to reduce the duration of a schedule laid out. This comes at cost of many resources involved be it financial or managerial. The case study being a project manager of an IT Project in Healthcare helped me understand the functioning and laying out of plan. Every change account for activities to take be hindered, and when working on a long schedule it is important to consider various parameters involved in making the project happen. As for this study we managed to achieve our goal with availability of additional financial support. Which might not be the case for any other project taking in real world – but a clear idea is given. It's important to manage the team, keep the composure and tackle any conflicts that occurs. Crashing itself is a risk – and a risk requires a proper methodology to be dealt with. Hence, concluding being successful with achieving the required goal.

Resources

- ✓ Risk Management in HIT Projects – PMI.org
- ✓ Lecture Slides (1-10)
- ✓ Project-Management.com – various references
- ✓ Various Model Designed added on my Google Drive – Click Here