Trinity College Dublin
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PROJECT MANAGEMENT
CASE STUDY REPORT

Department of Electronic and Computer Engineering (TCD)

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1. Project Objective

To objective is to develop an electronic handheld medical device for use by emergency medical technicians and paramedics in emergency situations. The team aims to produce 30 working models in time for MedCON; the biggest medical equipment trade show, being held on 16th October 2023. Due to rumours of a similar product being developed by competitors, meeting the project deadline is a top priority.

Project Stakeholder Groups

a. **Product Design and Development Teams**: they are responsible for designing the product and developing a rough prototype that will help in estimating the cost per unit associated with that design. They also test the product design and make adjustments to it.
b. **Medical Technicians and Paramedics**: they are the end-users of the product. Positive feedback from them is vital to the project, and the design team must ensure that the project design includes all the core functionalities required.
c. **Investors**: they provide the funding/budget for the project. They must be well-informed of the time and budget estimates of each of the project phases, and of any changes that may occur. Their finances and reputation are on the line.
d. **Medical Organizations/Association**: they approve medical products based on pre-existing medical standards and policies. They must be consulted to ensure the product (design) does not violate any policies. Any changes to the product design and/or functionality must be approved by them too.

Project Priority Matrix:

	Time	Scope	Cost
Constraint		•	
Enhance	•		
Accept			•

Table 1: Project Priority Matrix

Constrained scope: The project scope is very limited. All the core functionalities identified by the stakeholders must be implemented. There are rumours that competitors are considering developing a similar product; thus, it is most imperative that the project's scope is constrained.

Enhanced time: The project completion date cannot extend beyond 16th October 2023 for any reason. The project completion time needs to be enhanced to ensure the scope is met before this date. This can be done through the use project crashing and lag introduction.

Accepted Cost: The project cost is a major project priority. However, management have made funding contingent, meaning that the budget can be increased to ensure time and scope are met or enhanced.

2. Project Management Software Packages

- **Ease-of-use:** MS Projects is easy to use, especially for people who may not be experts at project management.
- **High Level of Integration:** the Microsoft Office 365 software family is the most popular productivity software family. This means that we can integrate MS Project with other projects on other Microsoft tools, such as Excel, Word, PowerPoint, Teams, and Outlook. The user interface is also more familiar to us as MS Office 365 users.

- **Baselining:** the baselining feature in MS Projects is very useful in measuring the effects of changes to our current project plan on our original plan. This is very useful in measuring our progress.

3. Project Layout and Crashing

a. Initial Project Plan/Schedule:

Based on the initial parameters given; the holiday calendar, 8-hour workday 5 days a week, no overtime and project completion date for 16th October 2023, the following Initial Project Schedule and Initial Gantt Chart were generated:

	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		Architectural decisions	10 days	Mon 02/01/23	Fri 13/01/23	
2		Internal specifications	20 days	Mon 16/01/23	Mon 13/02/23	1
3		Feature specifications	16 days	Mon 16/01/23	Tue 07/02/23	1
4		External specifications	18 days	Mon 16/01/23	Thu 09/02/23	1
5		Voice recognition	16 days	Tue 14/02/23	Tue 07/03/23	2,3
6		Speaker output jacks	4 days	Tue 14/02/23	Fri 17/02/23	2,3
7		Screen	2 days	Tue 14/02/23	Wed 15/02/23	2,3
8		Case	2 days	Tue 14/02/23	Wed 15/02/23	2,3
9		Tape mechanism	2 days	Tue 14/02/23	Wed 15/02/23	2,3
10		Database	40 days	Fri 10/02/23	Fri 07/04/23	4
11		Microphone/soundcard	4 days	Fri 10/02/23	Wed 15/02/23	4
12		Alarm clock	5 days	Fri 10/02/23	Thu 16/02/23	4
13		Barcode reader	3 days	Fri 10/02/23	Tue 14/02/23	4
14		Pager	5 days	Fri 10/02/23	Thu 16/02/23	4
15		Computer I/O	4 days	Fri 10/02/23	Wed 15/02/23	4
16		Review design	10 days	Tue 11/04/23	Mon 24/04/23	5,6,7,8,9,10,11,12,13,14,15
17		Price components	5 days	Tue 11/04/23	Mon 17/04/23	5,6,7,8,9,10,11,12,13,14,15
18		Integration	15 days	Tue 25/04/23	Tue 16/05/23	16,17
19		Document design	35 days	Tue 25/04/23	Wed 14/06/23	16
20		Procure prototype components	20 days	Wed 17/05/23	Wed 14/06/23	18
21		Assemble prototypes	10 days	Thu 15/06/23	Wed 28/06/23	20
22		Field test prototypes	20 days	Thu 29/06/23	Wed 26/07/23	19,21
23		Lab test prototypes	15 days	Thu 27/07/23	Thu 17/08/23	22
24		Adjust design	20 days	Fri 18/08/23	Fri 15/09/23	23
25		Order custom parts	2 days	Mon 18/09/23	Tue 19/09/23	24
26		Order stock parts	15 days	Mon 18/09/23	Fri 06/10/23	24
27		Assemble first production unit***	5 days	Wed 18/10/23	Tue 24/10/23	25FS+12 days,26FS+7 days
28		Test unit	12 days	Wed 25/10/23	Fri 10/11/23	27
29		Produce 30 units	10 days	Mon 13/11/23	Fri 24/11/23	28
30		Train sales representatives	10 days	Mon 27/11/23	Fri 08/12/23	29

Figure 2: Initial Project Schedule

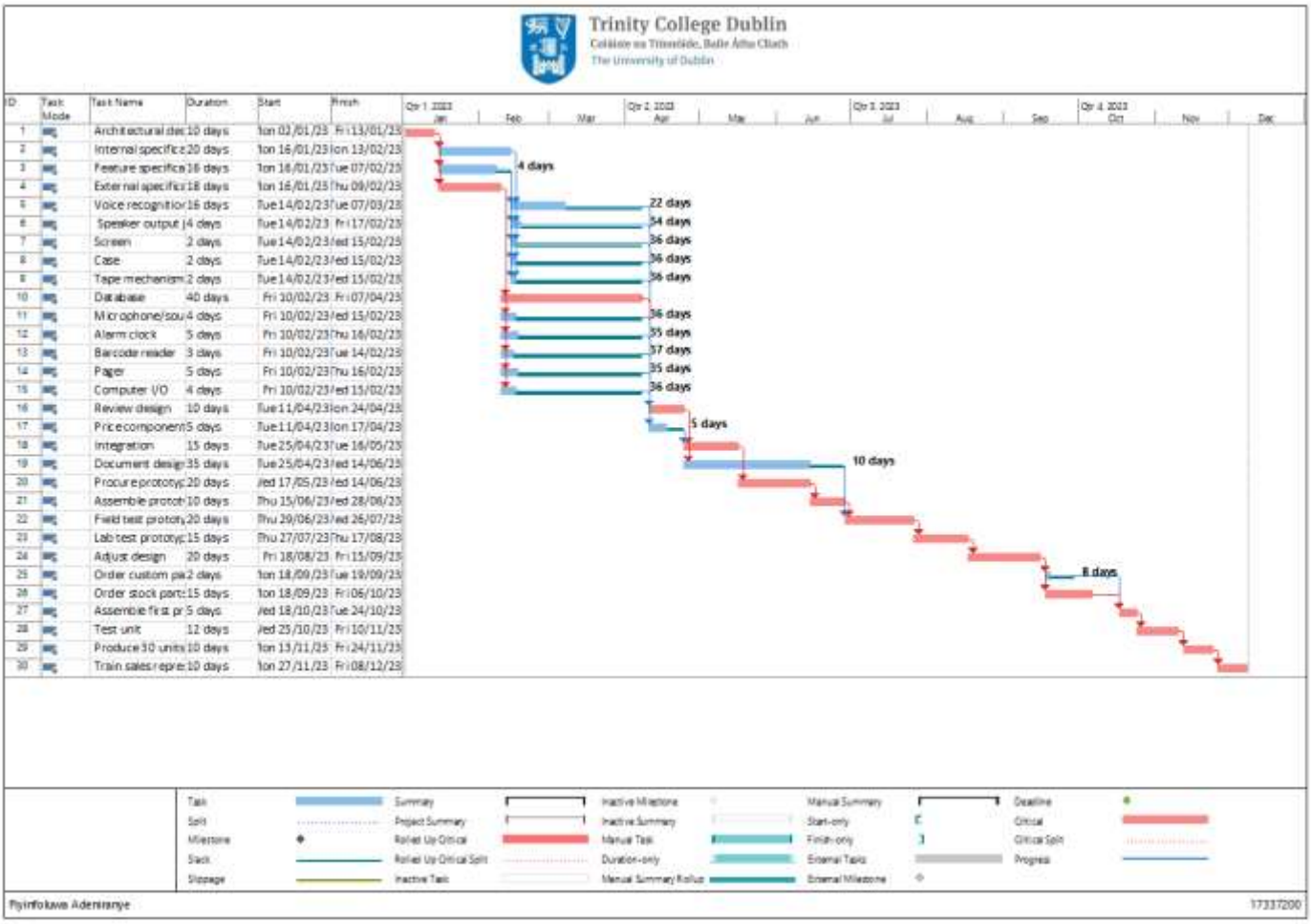

Figure 3: Initial Project Gantt Chart

The Initial Gantt Chart above shows the initial project schedule based on the default activities and the various parameters assigned to them. The expected delivery date of this approach was **8th December 2023**, **exactly 53 days** past the deadline. The **critical path** is highlighted in red and the tasks on the critical path are listed below:

Task No.	Task Name
1	Architectural decisions
4	External specifications
10	Database
16	Review design
18	Integration
20	Procure prototype components
21	Assemble prototypes
22	Field test prototypes
23	Lab test prototypes
24	Adjust design
26	Order stock parts
27	Assemble first production unit***
28	Test unit
29	Produce 30 units

30	Train sales representatives

Table 2: Tasks on the Critical Path(s)

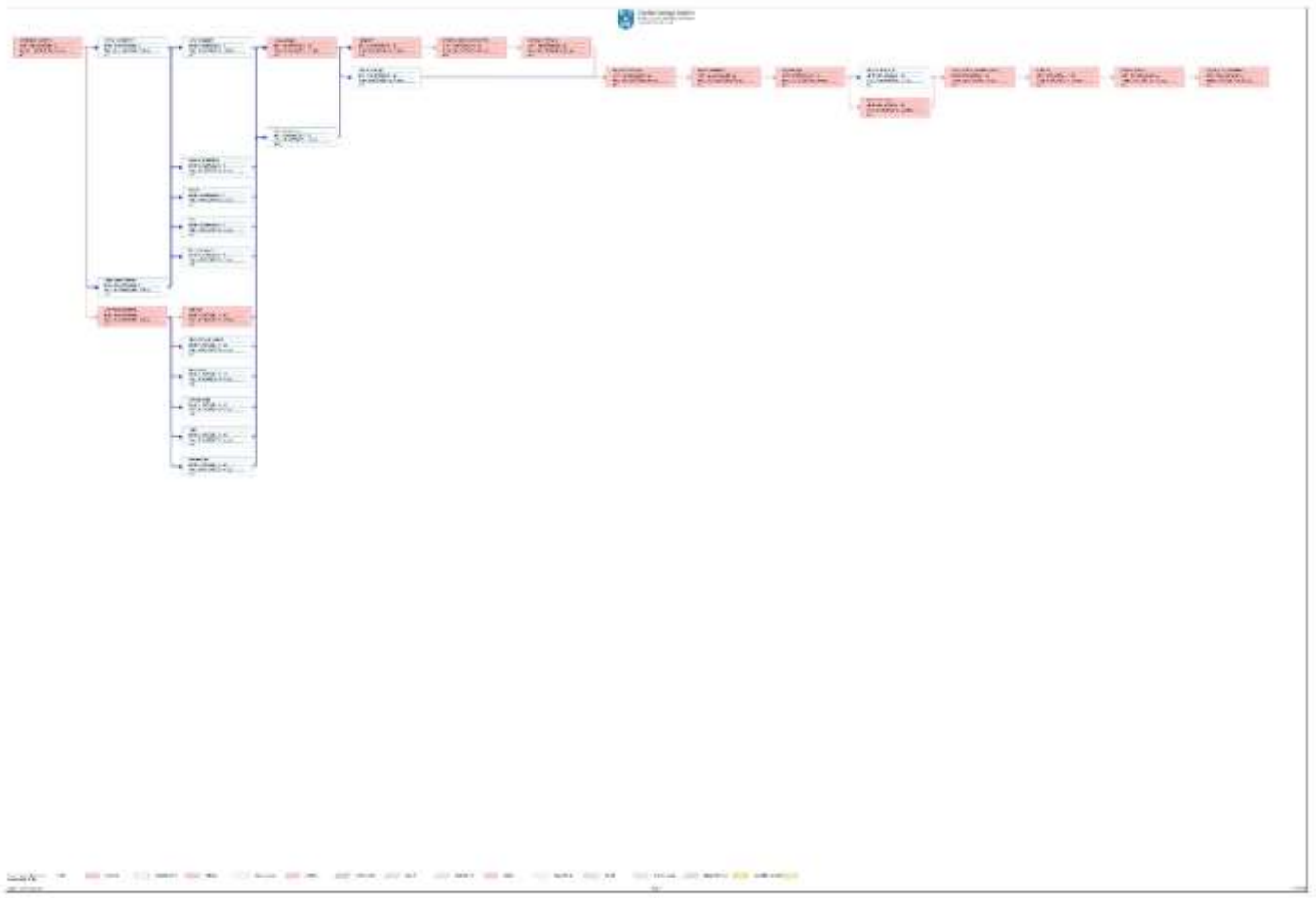

Figure 4: Initial Network Diagram

Total Slack

The table below shows the free and **total slack** associated with every activity in the initial approach:

Task Name	Free Slack	Total Slack
Architectural decisions	0 days	0 days
Internal specifications	0 days	22 days
Feature specifications	4 days	26 days
External specifications	0 days	0 days
Voice recognition	22 days	22 days
Speaker output jacks	34 days	34 days
Screen	36 days	36 days
Case	36 days	36 days
Tape mechanism	36 days	36 days
Database	0 days	0 days
Microphone/soundcard	36 days	36 days

Alarm clock	35 days	35 days
Barcode reader	37 days	37 days
Pager	35 days	35 days
Computer I/O	36 days	36 days
Review design	0 days	0 days
Price components	5 days	5 days
Integration	0 days	0 days
Document design	10 days	10 days
Procure prototype components	0 days	0 days
Assemble prototypes	0 days	0 days
Field test prototypes	0 days	0 days
Lab test prototypes	0 days	0 days
Adjust design	0 days	0 days
Order custom parts	8 days	8 days
Order stock parts	0 days	0 days
Assemble first production unit***	0 days	0 days
Test unit	0 days	0 days
Produce 30 units	0 days	0 days
Train sales representatives	0 days	0 days

Table 3: Free and Total Slack for all tasks/activities in Initial Approach

b. Optimal Approach

There are two parts to the optimal approach towards meeting the deadline for the project:

i. Redundancy Consultation with Ken Clark (Development Engineer); and
ii. Project Crashing through Increased Budget.

There is no change to working hours **(no overtime)** and all public holidays are still to be observed.

I. Redundancy Consultation with Ken Clark (Development Engineer)

The follow-up meeting revealed that converting the finish-to-start relationships of the following activities to start-to-start lags could shorten the project **without incurring any additional costs**. The table below shows the changes made to the project parameters based on the development engineer's suggestions:

Task No.	Activity	Predecessors	Lag Introduced
19	Document design	16 – Review design	16(start-to-start) + 5 days
24	Adjust design	23 – Lab test prototypes	23(start-to-start) + 10 days
25	Order custom parts	24 – Adjust design	24(start-to-start) + 5 days
26	Order stock parts	24 – Adjust design	24(start-to-start) + 5 days
30	Training sales representatives	29 – Produce 30 units	29(start-to-start) + 5 days

Table 4: Project Optimal Approach Phase A–Lag introduction

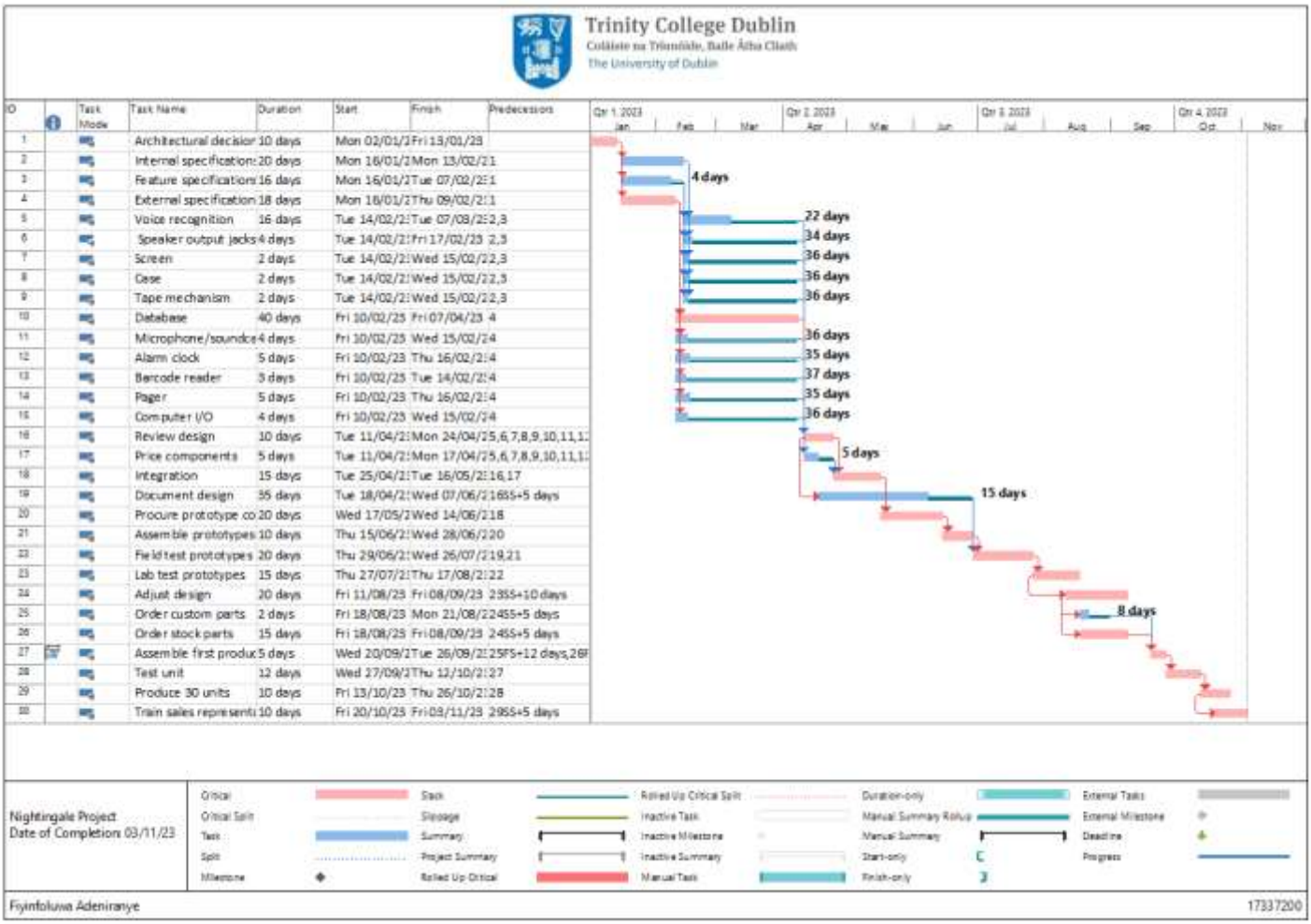

Figure 5: Project Optimal Approach Phase A - Gantt Chart

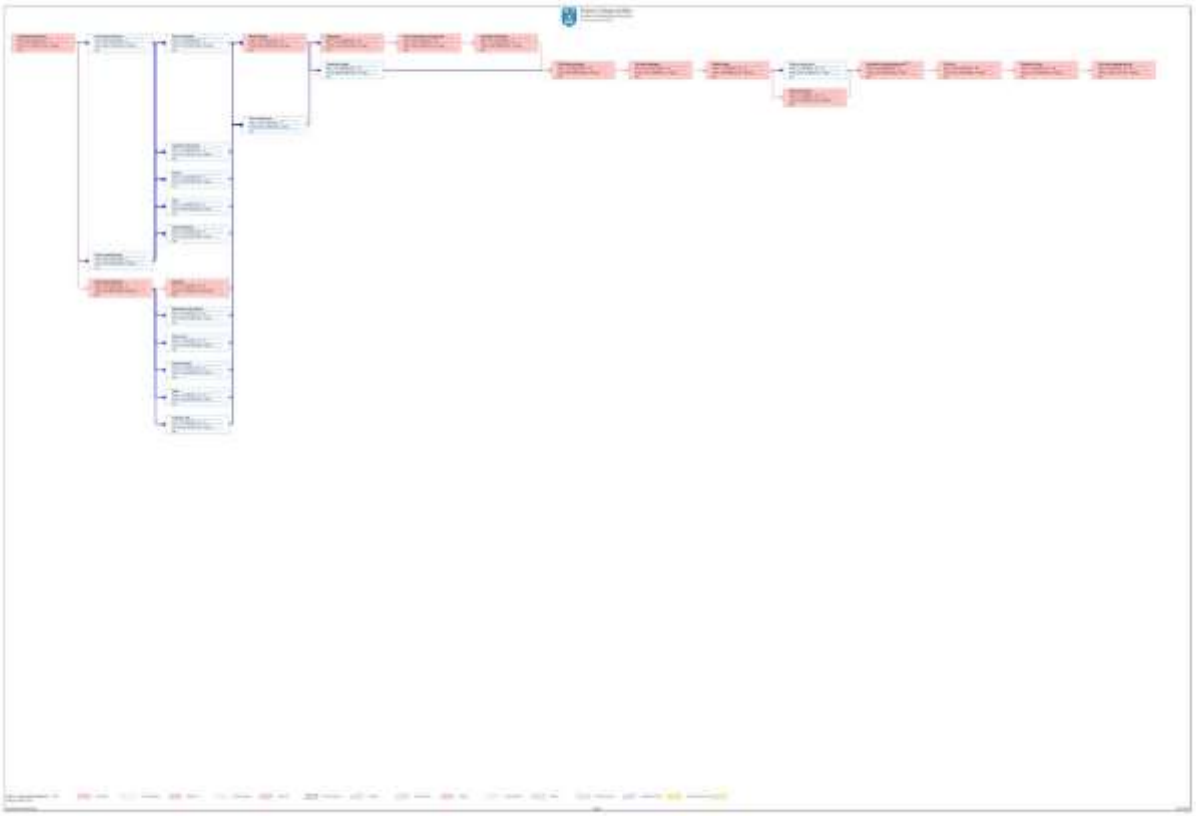

Figure 6: Project Optimal Approach Phase A - Network Diagram

This optimization reduced the estimated completion date from 8/12/23 to **3/11/23 (36 days).**

II. Project Crashing by Discretionary Fund.

During a follow-up meeting, the Project Manager proposed a discretionary fund of €200,000, half of which was to be used to crash the project by reducing the completion time of activities:

Task No.	Task Name
1	Architectural decisions
4	External specifications
10	Database
16	Review design
18	Integration
20	Procure prototype components
21	Assemble prototypes
22	Field test prototypes
23	Lab test prototypes
24	Adjust design
26	Order stock parts
27	Assemble first production unit***
28	Test unit
29	Produce 30 units
30	Train sales representatives

Table 5: Optimal Approach – Tasks on Critical Path

The table below shows all the activities that could be crashed, the cost of crashing and the amount of time that could be saved because of this:

Task No.	Activity	Cost Incurred	Time Reduction
4	External Specifications	€30,000	8 days
5	Voice Recognition System Development	€10,000	4 days
10	Database Creation	€100,000	20 days
19	Document Design	€50,000	10 days
20	Procure prototype components	€40,000	5 days
26	Order stock parts	€10,000	4 days

Table 5: Crashed Activities, Cost Incurred and Overall Time Reduction

The table below shows the free and **total slack** associated with every activity in the optimal approach. An analysis of the Project Timeline revealed that **only** activities with **no Total Slack** had an impact on project crashing. Investing on activities with total slack did not affect the completion date of the project. Activities 4, 20 and 26 were crashed and the **additional cost** of this approach was **€80,000.**

Task No.	Activity	Free Slack	Total Slack
4	External Specifications	0	0
5	Voice Recognition System Development	22	22
10	Database Creation	0	0
19	Document Design	15	15
20	Procure prototype components	0	0
26	Order stock parts	0	0

Table 6: Optimal Approach - Total Slack

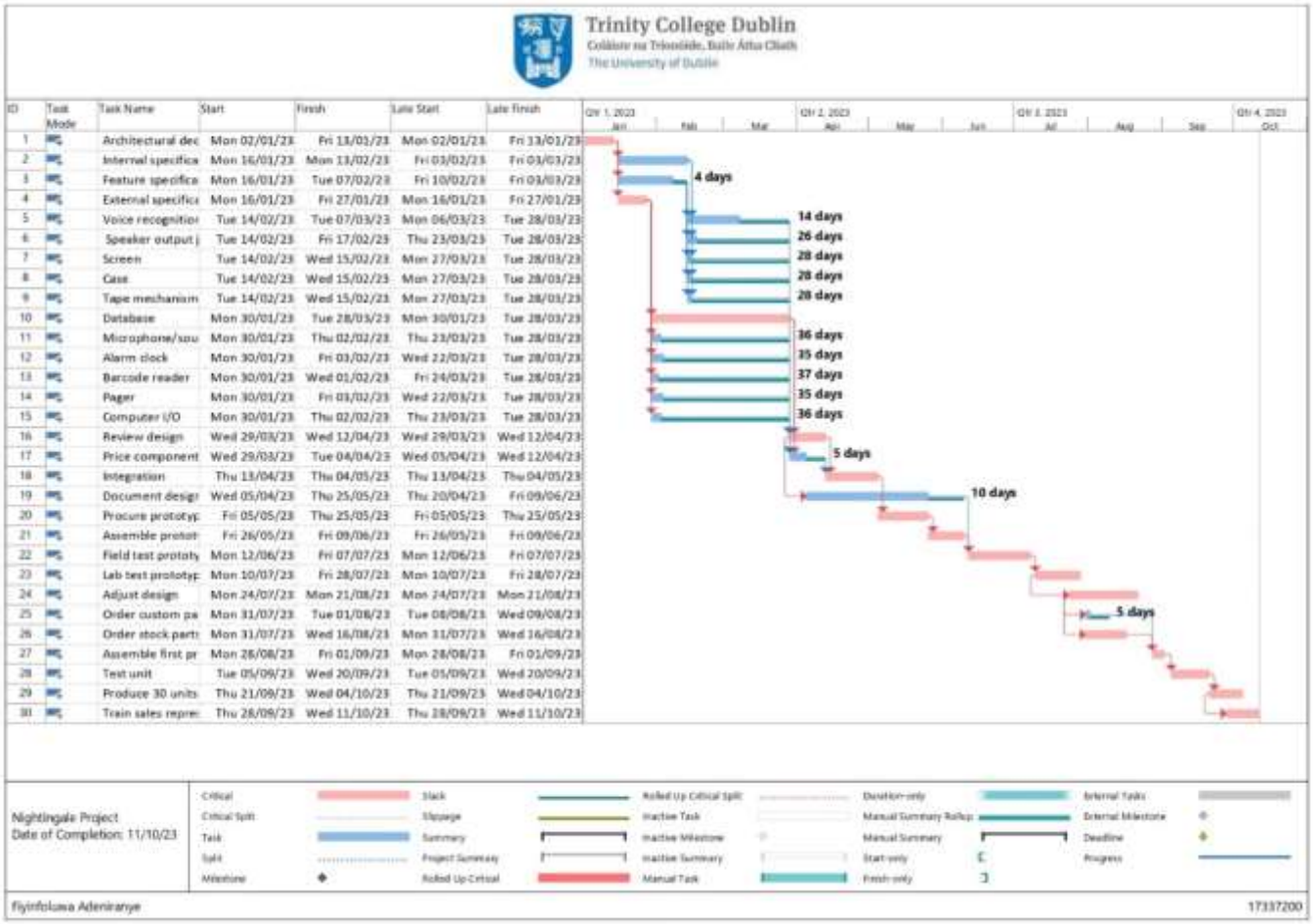

Figure 7: Optimal Approach Final Gantt Chart

As a result of this approach, a final project completion date of **11th October 2023** was achieved. The total cost was €80,000 which was below the discretionary budget allocation of €100,000. The benefit of the project being ahead of schedule is that it leaves room for unexpected events which are quite likely to occur during the project life cycle.

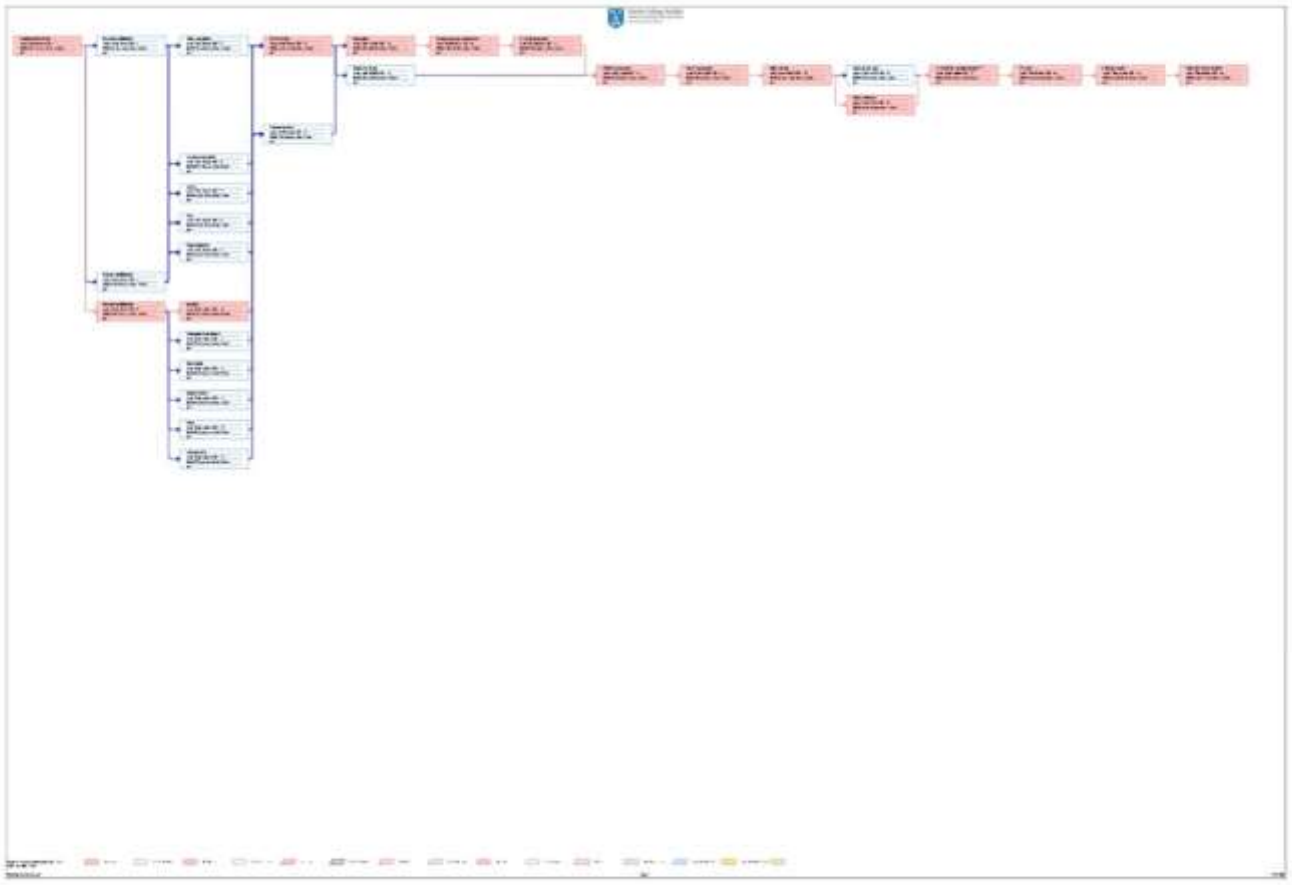

Figure 8: Optimal Approach Final Network Diagram

III. Sensitivity Analysis of the Network:

Due to the **single critical path** of the network, it is classified as **insensitive**. The network diagram above shows this clearly.

4. Risk Analysis and Assessment

When planning a project, it is important to assess the likelihood of unforeseen events occurring and the impact this would have on the project parameters: scope, time, and cost. This allows us to remain ahead of these problems when they arise and have a well-thought-out plan for resolving them as efficiently as possible.

There are four stages of Risk Management:

- **Risk Identification:** identifying all the possible risks that could affect the project.
- **Risk Assessment:** assessing/ranking the risks in terms of their likelihood and the potential effect on the project.
- **Risk Response Development**: developing a strategy and multiple contingency plans to mitigate these risks.
- **Risk Response Control:** Implementing these strategies and monitoring and adjusting the plan for new risks that may arise.

I. Risk Identification

Potential risks associated with Nightingale Project fall under the following categories:

- **Technology risks** – these risks arise if the team members lack the required skillset to design and develop a fully-functional product that has all the required functionalities.
- **Performance risks** – these risks arise when the product prototype is tested in real-world conditions. Until the prototype is built and tested, it is impossible to know how functional and reliable the product really is.
- **Market risks** – these risks arise when the timing of the product launch is not optimal. In this case, a late release of the product may result in losing out to competitors.
- **Organization risks** – these risks are associated with human resources involved in the project: team members, managers, stakeholders, etc. If internal conflicts are not resolved efficiently, they can have adverse effects on the project
- **Supply chain risks** – these risks are associated with sourcing materials and/or parts from external vendors. While doing so can reduce costs, there is a chance that the suppliers are unable to fulfil their contractual obligations.
- **Financial risks** – issues could arise that cause the project to over-extend its financial budget. In the same vein, inadequate funding can make it almost impossible for the project scope and deadline to be achieved.

II. Risk Assessment

Task No.	Task Name	Cause of Failure	Probability	Impact	Detection	Risk Value
1	Architectural decisions	Faulty design or unrealistic scope	2	5	3	30
4	External specifications	Design fails to meet standards	3	8	3	72
10	Database	Errors and delay in DB creation	3	6	3	54
16	Review design	Core functionalities not included	4	7	2	56
20	Procure prototype components	Components out of stock	1	5	1	5
21	Assemble prototypes	Incompatible parts	2	6	1	12
22	Field test prototypes	Prototype fails tests	4	6	2	48
23	Lab test prototypes	Prototype fails tests	3	5	2	30
24	Adjust design	Lots of adjustment required	3	3	2	18
25	Order stock parts	Parts out of stock	1	5	1	10
27	Assemble first production unit***	Incompatible parts	1	8	2	16
28	Test unit	Unit fails testing	2	8	3	48
29	Produce 30 units	Insufficient units produced	1	4	1	4
30	Train sales representatives	Bad sales representatives	2	2	1	4

Table 7: Risk Assessment Table

III. Risk Response Development

Risk Response Development Table		
Event	**Response**	**Contingency Plan**
Design fails to meet standards	Hire a highly skilled designer/engineer	Have alternative designs that meet required standards
Components out of stock	Find another parts supplier	Place orders well ahead of schedule
Incompatible parts	Purchase required parts	Rigorously design testing in he initial stages to ensure all parts are compatible
Prototype fails field tests	Test extensively in the lab before field	
Undersized team	Advertising required roles immediately	Allow employees to work overtime to ensure tasks completed
Insufficient units produced		Aim to produce slightly more than the required number of units
Organization risks	Promote effective communication between team members	Establish a good feedback system to ensure conflicts are identified and resolved before they escalate

Table 8: Risk Response Development Table

5. Team Dynamics and Team Building Approaches

Rassy Brown should consider following Tuckman's model for team building. Bruce Tuckman described 5 stages of team development which must be followed to have a well-functioning team:

a. Forming:

In this stage, the project scope is identified. Team cohesion is low as members are still getting accustomed to each other and allocation of tasks and roles is ongoing. Team-building exercises such as member introductions and other group activities should be conducted primarily in this stage. This will build trust and rapport among the team members. This stage is crucial for getting the project off to a good start.

b. Storming:

This is the most crucial stage in team building; conflicts tend to arise as members begin speaking their minds and solidifying their places within the team. Reality sets in and the initial hype and feelings of excitement turn to frustration and anger with the team's progress/process. At this stage, breaking down the seemingly daunting tasks into smaller, bit-sized tasks will help relieve some of the stress on the team and reassure them that the project is indeed doable.

c. Norming:

At this stage, conflicts between members have been resolved. Individual roles and responsibilities have been assigned. Team cohesion is on a rise as the team members start to bond well. Regular meetings should be scheduled by the project manager in this stage to encourage members to share ideas (conflicting or non-conflicting) as members may be wary of disrupting the newfound peace, which could prevent **effective communication**.

d. Performing:

In this stage, the team is at its peak in terms of satisfaction and task-efficiency. The initial differences between members that threatened to disrupt the team are appreciated and start to fuel the team's performance. Any problems/conflicts that arise in this stage are resolved quickly and efficiently. It is the responsibility of the project manager to keep morale high and monitor the stress levels of members to this end.

e. Adjourning:

In the stage, most of the team's tasks/goals have been accomplished. The final remaining tasks should be wrapped up and the project manager should debrief the team. A final farewell meeting (or party) should be organized to end the project on a good note and give the team closure.

Aspects of team building for the Project Lead to consider:

- **Shared Vision** – having shared values and vision helps the team members work more smoothly towards a common goal/objective.
- **Effective Work Practices** – ensuring that seemingly mundane tasks are conducted smoothly and effectively will massively boost team performance and morale. Day-to-day tasks should be optimised to ensure they occur without hitches.
- **Trust and Mutual Respect** – having trust and respect for each other's talents/skillset creates a strong bond between the team members, which allows the team members work more cohesively. Encouraging active listening will help build trust.
- **Open Communication** – a by-product of trust and mutual respect, honest communication between team members, the Project Manager and stakeholders will only serve the team positively. To achieve this, the team can be encouraged to discuss non-work-related topics and engage in non-work-related activities. This will help the members form more authentic bonds and encourage them to have honest conversations with one another.
- **Diversity:** diversity in a team is very important. Team members should be chosen who strengths complement one another. If everyone on the team is good at the same thing, they will likely possess similar skills and viewpoints, leading to a lack of unique ideas and contributions in the team.
- **Good Feedback Culture** – promoting timely, constructive feedback will benefit the team greatly. This is dependent on the level of trust and mutual respect the team members have for each other. It is also essential for conflict management.

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