DESIGN AND DEPLOYMENT OF A PREDICTIVE MODEL FOR DISEASE OUTBREAK DETECTION

PROJECT MANAGEMENT PLAN

Version *2.0*

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VERSION HISTORY

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1 INTRODUCTION

The Design and Deployment of a Predictive Model for Disease Outbreak Detection is a new approach to global health issues. Such forecasts have been crucial in managing of various diseases at large and specifically due to the recent global outbreaks such as coronavirus. This model attempts to transform current health systems in terms of ability to predict, prepare, or respond to outbreaks by employing technologies including AI, machine learning, and real time data analytics. Perhaps, the COVID-19 pandemic has hurried the need for such systems because delayed responses have had devastating effects in different parts of the globe. This project seeks to address such delays, empower governments, healthcare institutions and communities with an efficient tool of early identification and interjection. Further down the line, it becomes apparent how important this approach is. New diseases and changes of existing pathogen types, along with increased dependence, make future epidemics all but guaranteed. These are the challenges that are well-covered by the proposed model which, in addition, may act as a protective shield that anticipates threats and prepares societies for what they cannot foresee. As history revealed pandemics pose social and economic effects and the need for better predictive tools cannot be overemphasized.

In this case, this revolutionary concept was created by Vedad Kruho together with the team of biologists, specialists in artificial intelligence, IT, and business. These sections rely on cooperation across disciplines to produce a comprehensive range of perspectives from within the subject area and in technology. Primary supporter from the medicine sector (Pfizer, Moderna), digital technology (Microsoft, Google), and business (Deloitte, McKinsey) are main contributors here. This model's core customers are governments who will use it in defending the public health, healthcare facilities to enhance functionalities and common promoter groups hoping for easy and usable health informatics. This predictive model looks different, it brings up a new era, merging human and computer power as has never happened before. Healthcare workers, such as doctors and nurses, along with data scientists will work hand in hand with the modern AI to create a formidable force that will deliver with methods of improved accuracy and coherent insights. In contrast from previous tools, this model will include different data sets, continuously improve the forecast, and be easily scalable across the globe and industries.

Economically, opportunities in this innovation are many for stakeholders involved in its implementation. An excellent example of this is the health sector, where the sector, manufacturers of vaccines, and technology suppliers could generate very healthy incomes during the COVID-19 pandemic while meeting crucial societal needs. This model takes that potential a step further by being available to the entire world as a mobile app and web app. These civil bodies, across governments, business, and health sectors, will have economic advantages as health systems that stand to decrease healthcare costs, to increase their willingness, and hence decrease potential economic shocks. In this way the health security model becomes a profitable and socially relevant investment of the sustainable ecosystem.

Finally, the call to participate is urgent. The risks and costs of delay are just too high because history has always shown that the world will not sit idle. Outbreaks themselves present very complicated problems that go way beyond the medical field; restrictions disrupt work, school, and social life. It is more than just a project; it is an idea much closer to one's ethos; as diseases are a part of life, and one cannot rule out possibilities of being affected by them. In investing now, we will minimize the costs in the future, increase our ability to mobilize quickly and effectively and map a strategy that can be copied around the world. It's time to get involved, and we have never mattered more, as a generation, as a nation, as a people. The time to act is now. This must be the change that people will see our organizational commitment to give preventive, creative and life preserving interventions.

1.1 PURPOSE OF PROJECT MANAGEMENT PLAN

The main goal of making the Project Management Plan (PMP) is to provide unique work for the efficient implementation of the Design and Deployment of a Predictive Model for Disease Outbreak Detection project. It identifies and outlines approaches, steps and methodologies which will be applied in the successful delivery of a project based on the project objectives, constraints and quality standards. This plan gathers all the aspects of a project, such as specifications and scope, product breakdown structure (PBS), work breakdown structure (WBS), milestones, network diagrams, and risk management plans. It provides clarity on the lifecycle of the project through its distinct phases: activities of planning, organizing, leading and controlling. The Project Management Plan is created with the following stakeholders in mind: The project sponsor, senior management, team members as well as other stakeholders. The project sponsor then has an approval authority over the certain phases and deliverables to ensure conformity with programmatic objectives of the organization. The top management reviews and approves the strategic plan, guaranteeing that all department heads stay on the same course and allocate the resources correctly; other employees use the plan to perform their duties efficiently. The stakeholders know how the project goes and its performance to ensure that it delivers what they want. This document serves as a dynamic reference document that gets amended as the project unfolds and the field is modified to meet emerging complications or expanded in size.

In addition, the Project Management Plan guarantees compliance with the strategic direction of the project and overall organizational goals and objectives. In as much as the document describes how the project is being implemented, the plan formulates from a monitoring and evaluating tool against laid down standards as the project unfolds. This allows early intervention to be taken where needed in order to keep the project on schedule, in terms of time, cost and quality. The ability to provide change is inherent in the PMP model because it can be beneficial to address any such complications, on one hand, and to control stakeholder expectations and the nature of the project's results as the scope, on the other hand. Through the constant use and revision of the plan, the project team is equipped with profound tools by which it is possible to manage the undertakings; avoid potential risks; and manage changes that might occur within the project's setting—a recipe for the success of the project.

Furthermore, due to the flexibility of the Project Management Plan, the document can be updated regularly as the project progresses, ensuring it remains aligned with the evolving needs and circumstances. This adaptability allows the plan to respond to new challenges, emerging risks, and opportunities that may arise throughout the project lifecycle. As such, the plan becomes a living document that evolves alongside the project, enabling timely adjustments to be made in response to unforeseen changes, such as shifts in external conditions or sudden emergencies. These updates are crucial in preventing the project from deviating from its primary objectives and ensuring that all aspects of the project remain on track. By proactively addressing these changes, the project team can continue to focus on the end goal while making course corrections where necessary.

Additionally, the ongoing updates ensure that stakeholders are kept informed of any modifications to the plan, their roles, and their involvement in the project's evolution. Finally, the continuous updating of the Project Management Plan serves as the foundation for the effective and efficient implementation of the project, ensuring that it ultimately delivers value to both the organization and society, fulfilling its intended impact in a sustainable and meaningful way. Making and Following Project Management Plan enables clear idea and meaningful project implementation, inside standards and providing professional path for making project.

2 EXECUTIVE SUMMARY OF PROJECT CHARTER

Project charter for the Design and Deployment of a Predictive Model for Disease Outbreak Detection is a document that formally recognizes the existence of the project and defines its major purpose and plan. It is a strategic plan, which focuses on increasing public health readiness by the use of technologies point. This project supports a larger vision of developing Healthcare Systems that can predict the occurrence of these incidents and therefore respond in time. The mission is centered on the creation of a unique intelligent application based on original research by constantly emerging data science advances in research, development, and design for governments, healthcare organizations, and communities. To this end, structure of the project entails a pure project organizational structure in that resources are dedicated to the project and there is a manager leading the entire process. This structure is however best suited for hugely capital demanding projects that require specialized skills, decision and authority. Democratic and, at the same time, delegative approach to leadership is being used for stimulating idea generation and effective teamwork and at the same time for ensuring responsibility and administrational control. In this academic project the mechanical organization will be applied in organizing the mechanical setup of the project since it is a systematic project where the research development involves mechanical engineering prototypes and mechanical test loops hence making the results of the project very reliable due to the repetitive testing and conclusion production.

The lifecycle of the project spans four phases: phases like planning, such as execution, control and finally closure. In the planning phase, the use of requirement gathering for data sources, understanding of epidemiological patterns and identification of potential technology solutions will help to identify project requirements for deliveries and will establish the basis for the implementation. The execution phase includes: algorithm creation, system integration and fine tuning of the features in order to provide a stable and usability-oriented product. During control phase compliance to the quality triangle elements, namely, scope, schedule and budget, will therefore have to be checked from time to time by way of reviewing the status, use of variance reports and measures aimed at correcting such variance as may arise from time to time. Last of all, the closure phase will complete the development of the product, ensure the acquisition of necessary licenses and accreditation and share the necessary knowledge with the stakeholders, through training techniques and documentation. Predictive quality characteristics like reliability, durability and compliance to standards will define this project's results. The resources management approach used in the project is a breakthrough on the innovation process, starting from discovery ends up in functional design with most consideration given to the probability of an invention receiving intellectual protection. There is a proper combination of collection techniques that can be used to capitalize on the available data and facilitate technological enhancements. Also, the implementation of the Pareto Principle (80/20 rule) is applied to provide straightforward and prioritized order on features that brings most benefit guaranteeing the optimal usage of resources and focusing on critical functions.

In other words, the content of this project charter can be described as the project's strategic and operational plan for accuracy of disease outbreak early warning system. It also emphasizes on intense, client based and innovative approaches to develop a solution, which, in addition to serving the needs and wants of the industry participants, enhances world health safeguard. This project focuses on filling the gap between the latest developments in technology and how they can be deployed for the benefit of health-related systems in cases of disasters. This project is a focal project, which fosters advancement and improves the state of world health and improves quality of living.

2.1 ASSUMPTIONS/CONSTRAINTS

According to the work description in the project charter, the creation of the predictive model entails the availability of different data types such as epidemiological, environmental, and behavioral data, among others, in real, valid, and timely manners. This is critical to ensure the accuracy and reliability of the model. The project also prescribes the use of advanced computational technologies, especially AI and machine learning, which are expected to perform optimally within the defined architectures of the project. The successful integration of the model into real-world settings also relies heavily on the support from sponsors and health organizations, along with cooperation from government institutions and end users. These early assumptions remain crucial to the development and execution of the project. Their continued relevance ensures that the model will be well-received and effectively implemented.

Despite the unchanged assumptions, the constraints introduced during the project chartering phase still play a significant role in shaping the project's execution. A major constraint is the tight budget, which necessitates careful selection of the latest, innovative approaches for research and development while also prioritizing cost-effective solutions. Time is another critical constraint; with a potential surge in diseases, there is an urgent need for the development of tools that can address such a situation promptly. Additionally, legal requirements regarding data protection and privacy have gained increased importance as the project advances. These emerging concerns highlight the necessity for rigorous planning, constant monitoring, and stringent control measures. Ensuring that all the goals and objectives of the project are met within these constraints requires careful strategic management, making it essential for the team to navigate these challenges while adhering to project specifications.

However, due to these constraints, and the nature of the problem, there is need to ensure that the whole process is well articulated as follows: The work of a project team requires the proper allocation of all the resources that are required for the success of the project and for that, all the work that the team is to do, has to be prioritized in a way that would allow for the achievement of those goals that are most important to the completion of the project. As such, monitoring and evaluation will be carried out continuously to detect any divergence from the plan and correct this early. In addition, perpetual and open communication with all the stakeholders including the sponsors, health organizations and government agencies will enable the parties to have a one voice and therefore make quick decisions when faced with any challenges. Finally, it is crucial to notice that all these challenges must be addressed by the team in order to achieve the project’s goals and deliver a high quality of a predictive model which might be a real help for the public health stakeholders fighting against the diseases.

For the project to produce the expected results, the project team must also ensure that risk management is inputted into the process in all the phases. This includes evaluating possible risks, evaluation of risks possibility and adoption of preventive measures to overcome the risks at an early stage. Of course, there can be certain issues on the way like data protection problems, technological constraints, and other unexpected situations, but having the contingency plan ready will help to avoid significant disturbances.

Moreover, further communications and feedback loops are going to be carried out as necessary that would help in identifying new requirements of the stakeholder in the public health sector and aid in keeping up with expectations against the predictive model developed. Understanding the dysfunctions and getting a solution that will help avoid them will be an important factor for the impact and success of the team’s solution in the prevention and management of disease outbreaks. It is for big importance to keep look through the project work on predefined assumptions and constraints, and come back if they really happen as predefined.

3 SCOPE MANAGEMENT

The scope management plan of the Predictive Model for Disease Outbreak Detection defines what is included and excluded in the project, the deliverables and how scope changes will be addressed. They ensure that at every stage of the project's lifecycle it achieves its directed goals while considering change if it is essential. The focus of this plan is to allocate resources, maintain timelines to the identified goals and objectives of the project. The project is therefore considered to include the creation of a data supported tool that will predict disease outbreaks based on epidemiological, environmental and behavioral info. This will be factored in by the use of technologies including AI, machine learning and statistical modelling, for real-time data processing to facilitate timely insights. These are functional predictive model, interactive dashboard for different stakeholders, mobile app for ease of use. Others additional components, for instance, the possibility of setting up individual notifications, advanced security measures belonging to data protection, and user interface layout, are also included in the discussed area. In order to obtain these ideas, the project will operate within a paradigm lifecycle of research, development and design phases. Specific research activities will aim at defining disease and potential data repositories relevant to their detection, using approaches that combine theoretical and applied research for data quality and discovery. Development will be carried out as constructions of the infrastructure, algorithms, and prototypes of the constructions and the devices, testing from alpha to beta phase for the improvement of functionality. Design phase will involve making sure that the model developed can easily be understood by various people thus the need to make it friendly.

Scope management process comprises of methods of creating, approving and regulating the scope. This involves engaging the stakeholder in the planning stage to ensure that they approve the goals and objectives to be set then engaging the stakeholders again during the implementation phase to check on scope entrance. The change management system will be structured, and thus any changes that will be made to the scope of the project will be made to conform to the following triangle – scope, schedule and budget. What it seems important for the project is to keep up with these set performance and reliability criteria and achieve quality attributes such as durability, serviceability, and perceived value. These factors guarantee the model can satisfy the stakeholders and will remain useful in the future. Both time and resource availability will be allocated according to the Pareto Principal rule where features with the largest impact will be given ahead of those with a smaller effect. Overall, the scope management plan explained in this paper establishes the Predictive Model for Disease Outbreak Detection goals, necessary outcomes, and boundaries to maintain project cohesiveness, continuity, cost-effectiveness and relevance to stakeholders' needs. Due to the fact that the plan has incorporated clear processes for scope validation and control, the project offers the possibility of the realization of the goals and objectives set when beginning this project.

3.1 PRODUCT BREAKDOWN STRUCTURE

The Product Breakdown Structure or PBS is an organizational model that in a hierarchical structure arranges the major components that are needed to successfully complete the project. It helps to make sure that every element of the project is managed effectively because they have enough ideas on how to communicate with the various stakeholders and share resources. For the development of the predictive model for disease outbreak detection, the PBS is divided into four main components: Data Management which is about sourcing, collecting and verifying quality data; Application Development focused on the platform used by the greatest number of users and the architecture behind this system; the Prediction Model Development is about the creation of an AI model for outbreak prediction; System Infrastructure & Hardware for reliable, expandable and fast hardware.

Following PBS figure (Figure 1: PBS – Product Breakdown Structure), the structure arranges all elements in hierarchical order keeping structure clear. The fact that each element is approached systematically ensures long-term resource flexibility and helps to coordinate projects successfully.

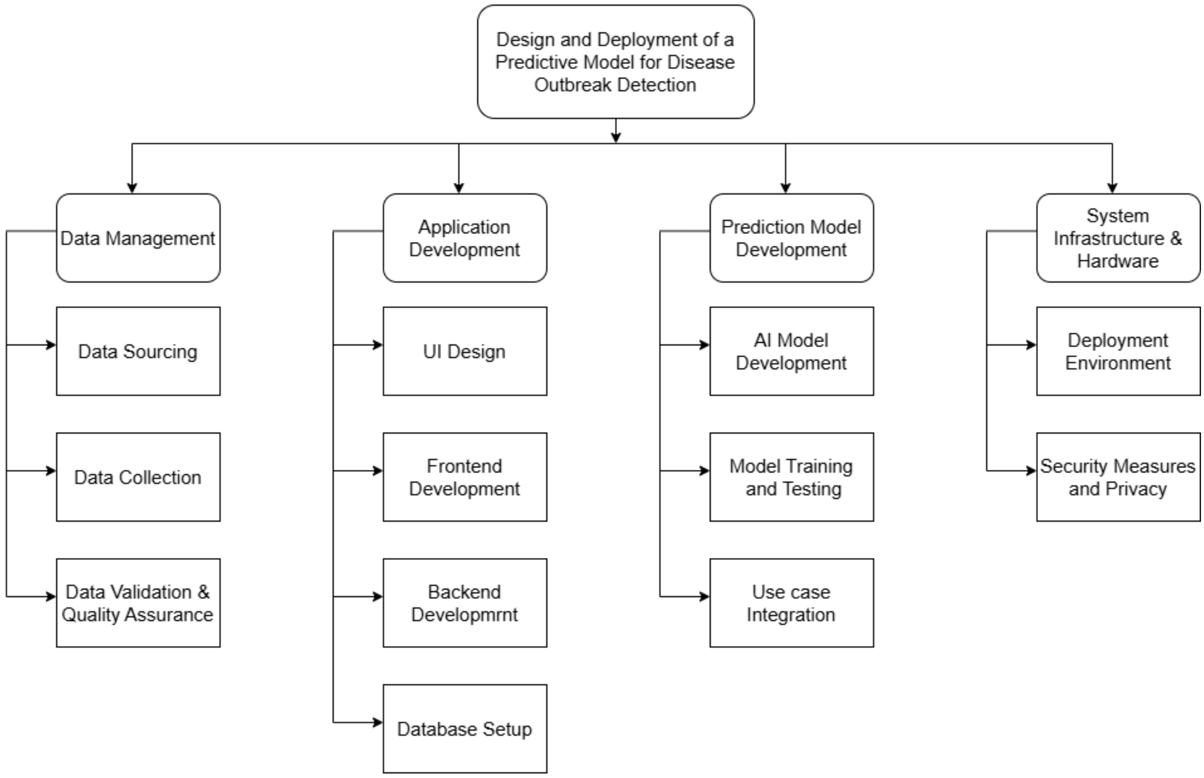


Figure 1: PBS – Product Breakdown Structure

The Data Management component means that the project is based on detailed and accurate data. It includes deciding on dependable sources of disease data, reaching out for data access, and establishing integration of external APIs for collection. Special approaches are used for performing data extraction and for the identification of up-to-date data sources. After data is gathered, validation procedures and quality control procedures are in place to rectify for missing or altogether lost data, while preserving the accuracy of the data collected. This component lays down the right framework for solid predictions and assists the precise activities of the subsequent analytical steps.

The Application Development component of the model brings abstract procedures to the back end of the service and presents them in an understandable form for users. The user interface is also developed to allow for easy interaction and this includes a landing page, registration and disease visualizations charts. Frontend development deals with styling of the site, browser compatibility and minimize the site load on the client side. Relating to the backend side, there are API calls that help data handling and dealing with authentication to protect users. The structure of the database is well thought out with an optimal structure of the tables, fast running queries, and safe redundant and backup systems. Altogether, all the deliverables above join to form a logically coherent and easily navigable framework to which users can obtain predictions from the model.

The most important and central component in the project is the Prediction Model Development component, based on which the main goal of the project is focused – to predict the occurrences of diseases in a country. This phase involves identification of appropriate algorithms and a process of variable selection for best use in predictions, and creating application programming interfaces for the model's integration. In this case actuals and past data are used because the model is applied on live data after the model is trained on historical data. The other level of integration involves establishing of outbreak limits, creating or modeling of cases and response alerting of different people. This component ensure that the model provide right and sound prediction that can enhance decision making.

And lastly, the System Infrastructure & Hardware component contains information on how the system is being secured, how the system is being prepared for future expansion. This means having specified host structures, developing schematic models, and testing the elasticity through cloud framework. This is to prevent other people or the organization from accessing the health data, this includes, the encryption of data and limitations to the access of the data. When considering these aspects, this component ensures safe and most efficient operation of the task and scalability for future alterations.

The PBS highlights all the pivotal tasks needed to produce a successful project. The model also provides a blueprint necessary for planning and organizing the projects, as well as for the identification of the project manager and the specific roles of the members of the team in the whole process. The PBS also structures how complex activities are to be accomplished in such a manner that all critical success factors are achieved in the most efficient way possible, assuming away any possibility of failure. This not only determines the usage of resources and time but also helps in providing the structured solution of major issues along with being properly aligned to the project goals and works. In addition, the PBS has the significant communication function of helping to manage relationships between team members by outlining accountabilities. Co-alignment brings order in task performance by decreasing confusion, improving communication, and guaranteeing organizational congruity. It also provides a basis for performance measurement and control, and enables decision makers to evaluate progress. Finally, the PBS is valuable to ensure the delivery of a project that proves value to stakeholders, helps achieve and maintain success in the long run, enables team to always come back accessing PBS and check whether final results really satisfied plan and mentioned task.

3.2 WORK BREAKDOWN STRUCTURE

The Work Breakdown Structure (WBS) can be defined as a hierarchical tree which divides the project into correspondent parts to ensure control during construction phases. Whereas the PBS primarily examines deliverables, the WBS describes the activities to be completed for deliverables. It also leads to purposeful and systematic work – it is impossible to forget about something since all relevant actions are assigned and tracked. In this respect, while the PBS decomposes the project aims into targets, the WBS subdivides the targets into manageable and measurable activities in relation to the objectives of the Design and Deployment of a Predictive Model for Disease Outbreak Detection.

Following the WBS chart (Figure 2: WBS - Work Breakdown Structure), the project is divided into four primary areas: Data Management, System Development for Application, Building of Predictive Model, System Hardware and Infrastructure. Each category is defined more specifically in terms of the particular tasks encompassed by the category, to identify the individual steps necessary for the completed project. Then, these are decomposed into activities which are main interest in the WBS chart. It relaxes comprehension of project necessities and creates favorable working relationships between the various stakeholders. The subsequent sections will explain each category of WBS and the activities related to each one.

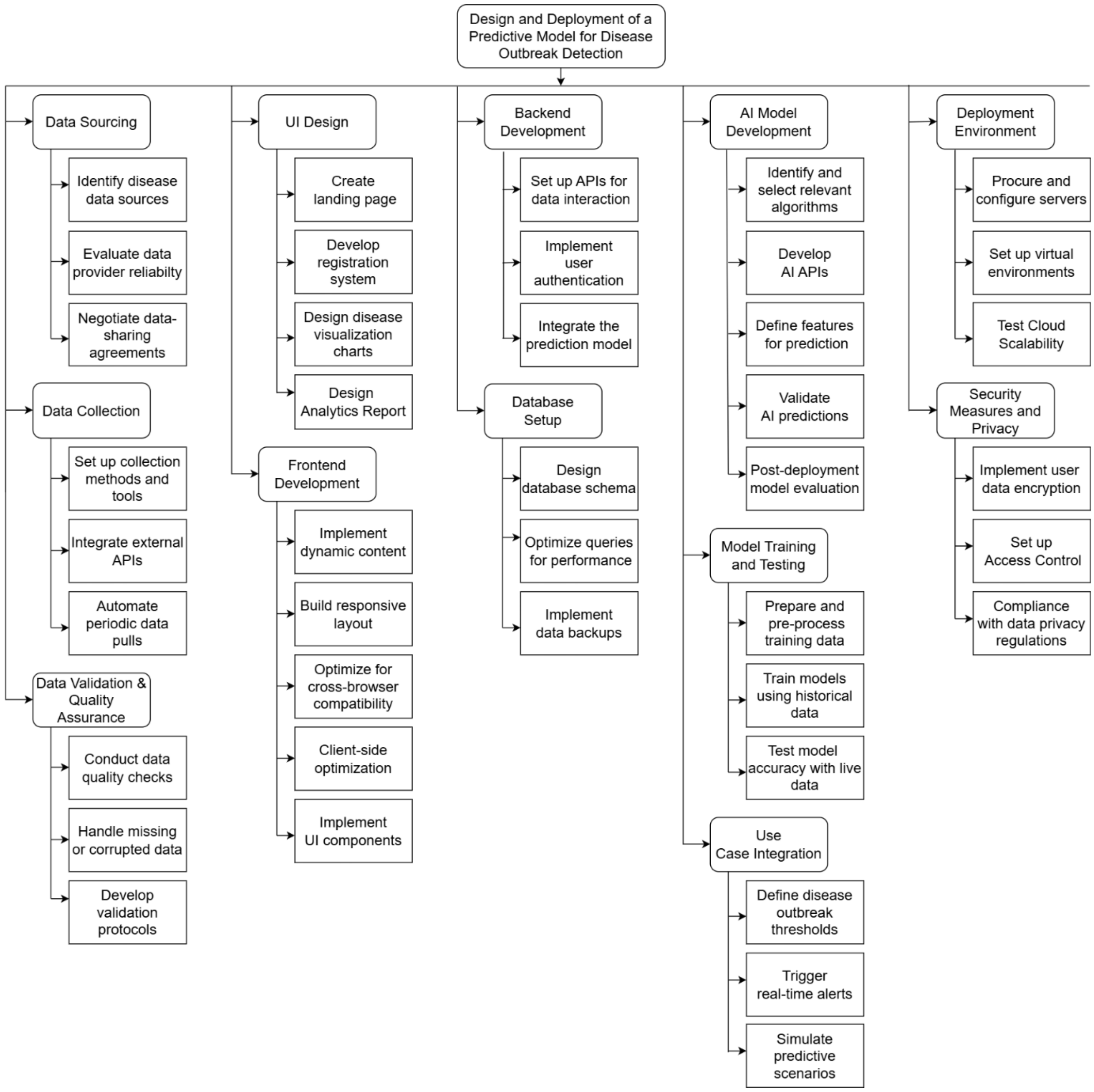


Figure 2: WBS - Work Breakdown Structure

The WBS of Data Management refers to the basic data management activities required in order to acquire, gather, and also to validate data. The first task is sourcing that has several activities such as: the identification of sources of disease related data that include disease data appraisal, the process of assessing the credibility of the data and the process of acquiring disease data in the right ways. Data collection is the next process after planning and execution of tools and methods required to collect data well. here, tasks are as follows: the integration of external APIs to assist in the data collection process, the enforcement of a structured data collection calendar, and periodic data pulls for afterwards rechecking sourcing and data validation. Verifying and ensuring the quality of collected data is meaningful in enhancing credibility of data in moments after data collection. Some of them will include: quality control on the gathered data which involves being in charge of data that is either missing or contains errors, and coming up with the necessary action to take so that the gathered data are of high quality, being able to know what to do with missing or corrupted data – identify, call for action and afterwards delete such data, and make validation protocols so corrupted and missing data can be cached.

WBS under Application Development are largest group because implementing this kind of PBS requires the largest number of activities.

The specific purpose of the Application Development WBS is to focus on the design of a disease prediction model software. Examples of the tasks that should be performed under the UI design component include: creating of the first screen that a user comes across, design of registration process for the application's users with implementing users' information for database knowledge and privacy settings; creation of the disease chart and analytical report among others. Needless to say, once the UI design phase of the undertaking is completed the actual frontal development is underway. Frontend development, by itself, has the greatest number of activities. Such tasks include management of the process to obtain real-time content for dynamic content making adjustments to layout according to the devices needed, improvements to the frontend for browsers meaning build responsive layout for any device, and the enhancement of the client-side for the purpose of providing clients with the best experience possible.

Moreover, the backend development activity is important in managing the users interfacing the application from the served side. This include setting up APIs for the passing of data, setting up user authentication, once again for database, privacy, and analytics reports, and implementing the prediction model for live predictions. Finally, the administration of the application data requires database setup to be performed. This task includes creation of normalized and efficient data structures plan, query optimization and of course, readiness for the increased data, and storing backups, on both, real and virtual servers, as there are lots of information and data.

The WBS for Prediction Model Development has focused more specifically on the AI and machine learning of the project. The AI model development activities include: deciding on which algorithms to utilize in disease outbreak prediction, deciding on the application programming interfaces that will be utilized in the model AI, and determining the characteristics that will help us identify the right disease outbreak prediction. With regards to the second step, model training and testing entails feeding the data and worked through the initial model to train the model and then tested for its ability to alert the right professionals on cases of diseases. It is important to mention that historical data will be compared with live data, and big change in variance might suggest that outbreak in from of disease will come. Last of all, in the use case integration, the grooming model is incorporated in with the application. This entails identifying the warning level for a disease outbreak, when the model suggests that there is an outbreak, the system produces alert notifications, and the system enhances accuracy by checking different predictive outputs against real events.

The System Infrastructure & Hardware WBS deals with the physical interaction of the system environment. It also involves the acquisition and configuring of the necessary apparatus like servers and creation of virtual development and tests environment, and determination of the current stage of the application to assess its potential for expansion in future if need arises. Creation will be both, computer servers, but primary focus will be on cloud servers and scalability, as majority of big projects/companies move towards this solution with more reliability and security implementation. Regarding security and privacy, it must be sure that users' private data will be under privacy regulations, and that some unnecessary implementations from users, like giving false information, will not happen by setting up access control. For making regular and secure sharing of data, user data encryption will be enabled, preventing hackers get information.

Therefore, the WBS is a fundamental roadmap of the complexity of the project to be accomplished in order to avoid additional complexities during the work. It helps to connect unambiguous project goals and tasks, and makes sure that all the components get the attention they deserve. WBS ensures that project contents are properly defined and hence in organizational the assignment of tasks within the project, so as to make sure that all phases in the project are accomplished in an orderly manner. In its way, it makes project elements more comprehensible, which prompts high-grade work coordination, increases the chances of outcomes achievement, and supports team cooperation. In addition, the adoption of the WBS enhances the Design and Deployment of a Predictive Model for Disease Outbreak Detection work's efficiency and effectiveness. It helps in planning, organizing and controlling of the resources by subdividing the goals into realistic activities. Consequently, from the WBS viewpoint, project accountability is achieved with measurable progress throughout the implemented project phases. In the long run, it contributes to project execution efficiency, increases the ratio of productivity, and strengthens the project design and implementation.

Also, the WBS guarantees the systematic, thus more methodical approach to the assignment of tasks, which results in the clearer definition of roles and tasks, and, therefore, the effective realization of the project. It is possible to divide the project into certain segments that help each participant understand the priorities of his or her work and increase the speed of completion. It reduces the potential of having some tasks repeated or other tasks being omitted completely because the project is so huge, by the fact that all the aspects of the project are accorded the attention they deserve. Using the WBS at the progress of the project one can easily identify the potential bottlenecks or lack of resources and rearrange them as necessary. It also helps all the stakeholders to understand the current state of the project and their responsibilities towards it with the help of which communication and collaboration is easy among the team members.

Moreover, the WBS also serves a purpose in resource estimating, scheduling, and cost monitoring activities. This makes the deployment of resources, setting of effective and efficient time horizons, and cost estimation of a project much easier when it is subdivided into work packages. This means that the project manager will be in a better position to track how the project is performing, and more importantly, the ability to notice that the project is off the track and make a well-informed decision on matters of concern. Also, with the help of WBS, the general efficiency of the project can be provided as each phase is to be finished within a specified time and cost limit. Lastly, the WBS is not only a planning and framework tool of the project, but also a key instrument for successful project delivery increasing its probability level to meet the project goals and objectives and to create values for the stakeholders.

4 SCHEDULE/TIME MANAGEMENT

Design and Deployment of a Predictive Model for Disease Outbreak Detection schedule management approach guarantees processes are ordered systematically and flexibly. The first three weeks of the project will take way for development of the baseline schedule, which consists of a list of significant activities such as data acquisition, model construction and system implementation. Current progress of the action plan will be checked on a weekly basis to detect inconsistencies and then corrected immediately to maintain the accuracy of the time table for everyone to follow. Vedad Kruho will act in the capacity of Project Manager to oversee these updates, with these updates being done within one business day of new development. Any subsequent slippage exceeding 20% of a major milestone will trigger an appropriate action to reevaluate the resource commitment and risks correspondingly. It also ensures that the project deliverable is on flush with the planned goals of the project. Additionally, there will be regular meetings to address if potential problems to be solved as soon as possible, and communication remains on a top level, both within project members and stakeholders. This approach is designed to keep project dynamic, analyze original plan and update if necessary, and be sure final project outcomes align with first goals and time frame.

4.1 MILESTONES

Milestones are key accomplishments to a project and give measures when enormous phases, tasks and deliverables are accomplished. They do give clear account of where progress is with a given project and whether it is on track or not in achieving the planned goal and or meeting the set time line. Since they are control points, they make it possible for project teams to check whether or not key activities have been performed according to schedule, thus resulting to proper decision making of the available resources. They also are the ways of informing stakeholders while providing them with an understanding of the project relative to the details of work broken down into various tasks. Aside from tracking, the use of the milestones is the most important because it will help in risk assessment. Meeting also has its advantages of forcing the team to be accountable since it emphasizes on the achievement of set milestones on time. Since they involve dividing the overall work of a large and complex project into easily manageable units, milestones enable large projects to be well-ordered and realized. Following table (Table 1: Milestones) provides clear three set of milestones that always should be crucial part for project management and team members through whole project progress.

Table 1: Milestones

Milestones	Estimated Completion Timeframe
Data Preparation and Validation Data sourcing, validation protocols and quality checks processes are completed, crucial for creating accurate analysis and prediction.	Four weeks after project initiation and approval.
Application Development and Model Integration Making application and setting up model integration with data features and user interaction.	Eight weeks after completion of the Data Preparation and Validation phase.
System Testing and Optimization Testing and upgrading model, to obtain high reliability, accuracy, scalability and user security.	Thirteen weeks after completion of Application Development and Model Integration phase.

Milestone 1 – Data Preparation and Validation takes us back to a problem previously presented where data and information are defining a framework as far as the data gathering and verification process of constructing the model is concerned. This means looking for and verifying disease information source, incorporating sources that are beyond the application, and using intelligent forms and data gathering processes. Some routine operations also fall under this category; how for instance to handle missing or corrupted data so as to preserve the quality of data assets. These tasks, drawn from PBS 1: Data Management, as was noted previously, provide the fundamental structure on which data needs to be input to the model to predictive analysis.

Milestone 2 – Application Development and Model Integration goal is particularly unique to the development of software interface that the end-users of the product will interact with and comes with the added bonus of developing a method by which this prediction model can be integrated into the interface. It means application interfaces have been created and designing tools are available, real time graphics implementation and backend for data interaction. In the same process where completion of training and testing of models and interconnection between these models gives rise to disease outbreak predictions. Tasks such as building APIs, creating visualization tools, and training the predictive model align with PBS 2: Application Development and PBS 3: Prediction Model Development, that guarantee performance of application be at the high level.

Milestone 3 – System Testing and Optimization ensures that the predictive model and the application are fast and run without errors. It involves the process of submitting the model on real life data, trying the application for the scalability and then adjusting the system's different aspects to match the user requirement. Certain of the findings gathered during the test phase feed into the change of the model and the overall GUI. Tasks under PBS 4: System Infrastructure & Hardware are employed in the need to protect the deployment environment, as well as meeting the provision of compliance with data privacy compliance standards. The final outcome of this milestone is the provision high load optimized provisioned solution.

4.2 PROJECT SCHEDULE AND NETWORK DIAGRAMS

The Project Schedule is a key element of project management because it provides a guide of all the actual project activities. It makes sure that things are done step by step, resources consumed are properly methodically and overall target or goal of the project is to be met within the desired time frame. When the dependencies between the activities are clearly described, the schedule helps identify potential bottlenecks, the optimum ways of avoiding these and the best way to keep the momentum going all through the stages of the project. For this purpose, we will examine Project Schedule through two tables where examination of predecessors, estimated/duration time and variance will inform conclusions that will enable the understanding of the concept. With these variables conclusions about each of WBS result will be analyzed, and answers for unit of accurate and time duration will be obtained, so team members can make final conclusion if everything was satisfied.

Table, (Table 2: Activity Table with Activity ID, Activity Name and Predecessor) represents the Activity Table, where we assign all activities from the Work Breakdown Structure (WBS) to specific activity IDs for clarity and easier project tracking. The activity IDs are structured in a logical and functional way to ensure the table is straightforward to read and easy to understand. There is also Predecessor column, indicating which activity must be completed before new activity starts. This column is from high importance, especially in making network diagram, but also to ensure logical flow and proper functionality. A lot of information can be concluded for each activity after checking the corresponding predecessor column.

Table 2: Activity Table with Activity ID, Activity Name and Predecessor

Activity ID	Activity Name	Predecessor
1.1.1	Identify disease data sources	/
1.1.2	Evaluate data provider reliability	1.1.1
1.1.3	Negotiate data-sharing agreements	1.1.1
1.2.1	Set up collection methods and tools	1.1.2, 1.1.3
1.2.2	Integrate external APIs	1.2.1
1.2.3	Automate periodic data pulls	1.2.1
1.3.1	Conduct data quality checks	1.2.2, 1.2.3
1.3.2	Handle missing or corrupted data	1.3.1
1.3.3	Develop validation protocols	1.3.1
2.1.1	Create landing page	1.2.1
2.1.2	Develop registration system	2.1.1
2.1.3	Design disease visualization charts	2.1.1
2.1.4	Design Analytics Report	2.1.3
2.2.1	Implement dynamic content	1.3.2, 2.3.2, 2.2.5
2.2.2	Build responsive layout	2.2.3
2.2.3	Optimize for cross-browser compatibility	2.2.1
2.2.4	Client-side optimization	2.2.3
2.2.5	Implement UI components	2.1.2, 2.1.4
2.3.1	Set up APIs for data interaction	1.2.2
2.3.2	Implement user authentication	1.3.3
2.3.3	Integrate the prediction model	2.2.4, 2.3.1
2.4.1	Design database schema	2.3.3
2.4.2	Optimize queries for performance	2.4.1
2.4.3	Implement data backups	2.4.2
3.1.1	Identify and select relevant algorithms	2.3.3
3.1.2	Develop AI APIs	3.1.1
3.1.3	Define features for prediction	3.1.1
3.1.4	Validate AI predictions	3.1.3
3.1.5	Post-deployment model evaluation	3.2.2, 3.2.3
3.2.1	Prepare and pre-process training data	3.1.2, 3.1.4
3.2.2	Train models using historical data	3.2.1
3.2.3	Test model accuracy with live data	3.2.1
3.3.1	Define disease outbreak thresholds	1.2.1
3.3.2	Trigger real-time alerts	3.3.3
3.3.3	Simulate predictive scenarios	2.2.2, 3.3.1
4.1.1	Procure and configure servers	3.3.3
4.1.2	Set up virtual environments	4.1.1
4.1.3	Test cloud scalability	4.1.2
4.2.1	Implement user data encryption	2.4.3
4.2.2	Set up Access Control	4.2.1
4.2.3	Compliance with data privacy regulations	4.2.2

To read table, analyze of Activity ID should be performed, which is used in organizing and classifying all activities in the project. The first digit in the Activity ID represents the PBS, which provides an instant point of reference as to the fundamental part of the project. The second number designates the position of the sub-PBS in relation to the corresponding PBS which attributes the subcategories to the proper place in the project structure. Last of all, the third number represents the actual Work Breakdown Structure (WBS) activity number in the specific sub-PBS that insists on which particular task is to be performed. For example, consider activity 3.1.4. The first number, 3, represents PBS – Predictive Model Development. The second number, 1, represents AI Model Development within PBS. The third number, 4, represents the index of the activity inside AI Model Development, which is to validate AI predictions. For example, activity 1.3.1 - Conduct data quality checks, has predecessors 1.2.2 – Integrate external APIs and 1.2.3 – Automate periodic data pulls, and cannot start before both, 1.2.2 and 1.2.3 are finished.

Next table (Table 3: Expanded Activity Table with Estimated Time (TE) and Variance (σ2)) displays the Estimated Time (TE), also known as Activity Duration which is calculated using β-distribution. TE represents duration of each activity, and in this project is measured in days as unit of time. It provides clear and realistic estimation based on different components. This method is important for further planning and also as it accurate manages any uncertainty in project. Logically reading, larger Estimated Time, emphasizes that unit of time will be larger. In addition to Estimated Time, table (Table 3: Expanded Activity Table with Estimated Time (TE) and Variance (σ2)) also provides result for variance (σ^2) which measures how our predicted outcome differs from actual one, by measuring uncertainty. It is useful to understand what potential risk might be for each activity. Variance and uncertainty are directly proportional, meaning with higher variance, uncertainty will be greater and expected result will ot be close to actual one, while lower offers more confidence in the time duration estimation, and closer value to expected one.

To calculate TE and σ, following formulas are used respectively:

$$TE = \frac{a + 4m + b}{6}$$

$$\delta^2 = \left(\frac{b - a}{6}\right)^2$$

where:

TE - Estimated time or Activity Duration, measured in days for this project.

a - Optimistic estimate, assuming no obstacles and ideal conditions.

b - Pessimistic estimate, considering all potential challenges and delays.

m - Most-likely estimate, reflecting the most probable scenario with some manageable challenges.

δ^2 – Variance, represents uncertainty and difference between measured and calculated value.

Table 3: Expanded Activity Table with Estimated Time (TE) and Variance (σ^2)

Activity	Predecessor	a	m	b	TE	σ^2
1.1.1	/	2	4	6	4.00	0.44
1.1.2	1.1.1	3	5	8	5.17	0.69
1.1.3	1.1.1	4	6	8	6.00	0.44

Activity	Predecessor	a	m	b	TE	σ^2
1.2.1	1.1.2, 1.1.3	5	8	14	8.50	2.25
1.2.2	1.2.1	3	6	9	6.00	1.00
1.2.3	1.2.1	2	5	9	5.17	1.36
1.3.1	1.2.2, 1.2.3	5	9	13	9.00	1.78
1.3.2	1.3.1	3	5	7	5.00	0.44
1.3.3	1.3.1	4	6	8	6.00	0.44
2.1.1	1.2.1	6	9	13	9.17	1.36
2.1.2	2.1.1	4	7	10	7.00	1.00
2.1.3	2.1.1	3	5	9	5.33	1.00
2.1.4	2.1.3	5	8	11	8.00	1.00
2.2.1	1.3.2, 2.3.2, 2.2.5	9	14	19	14.00	2.78
2.2.2	2.2.3	3	5	8	5.17	0.69
2.2.3	2.2.1	6	10	13	9.83	1.36
2.2.4	2.2.3	5	9	12	8.83	1.36
2.2.5	2.1.2, 2.1.4	8	11	15	11.17	1.36
2.3.1	1.2.2	3	5	7	5.00	0.44
2.3.2	1.3.3	2	4	6	4.00	0.44
2.3.3	2.2.4, 2.3.1	7	11	15	11.00	1.78
2.4.1	2.3.3	4	6	11	6.50	1.36
2.4.2	2.4.1	3	5	10	5.50	1.36
2.4.3	2.4.2	5	8	12	8.17	1.36
3.1.1	2.3.3	6	9	12	9.00	1.00
3.1.2	3.1.1	4	7	10	7.00	1.00
3.1.3	3.1.1	3	5	7	5.00	0.44
3.1.4	3.1.3	5	8	11	8.00	1.00
3.1.5	3.2.2, 3.2.3	7	10	16	10.50	2.25
3.2.1	3.1.2, 3.1.4	6	9	15	9.50	2.25
3.2.2	3.2.1	4	6	8	6.00	0.44
3.2.3	3.2.1	5	7	9	7.00	0.44
3.3.1	1.2.1	3	6	9	6.00	1.00
3.3.2	3.3.3	2	4	6	4.00	0.44
3.3.3	2.2.2, 3.3.1	6	10	14	10.00	1.78
4.1.1	3.3.3	4	7	10	7.00	1.00
4.1.2	4.1.1	3	5	7	5.00	0.44
4.1.3	4.1.2	5	8	11	8.00	1.00
4.2.1	2.4.3	6	9	13	9.17	1.36
4.2.2	4.2.1	4	6	8	6.00	0.44
4.2.3	4.2.2	5	8	12	8.17	1.36

This table offers very important facts about the project schedule since it estimates the time required to complete the activity using what is known as the Beta Distribution and formula for Estimated duration. These estimates, in terms of days, go into computing the activity duration (TE), and the variance (δ^2) that reflects uncertainty. The values for optimistic (a), pessimistic (b), and most likely (m) time estimates depend on the level of work tasks' dependencies and complexity. Activities which have comparatively less numbers of predecessors are likely to have low m and b values, for instance m and b for activity 1.1.1 (Identify disease data sources) as they are straightforward and there is no time delay. However, if the activity has multiple predecessors or if a certain task is tied to others, as is the case with 1.3.1 (Conduct data quality checks), m and b are somewhat higher because the time requirement adds up. Predecessors are also defined in the table regarding the set of activities where predecessors stand to define the intended sequence of subsequent activities. For example, dependencies in 1.1.2 (Evaluate data provider reliability) assume that evaluation can only be done after identifying data sources in 1.1.1. In the same way, 1.2.1 (Set up collection methods and tools) requires 1.1.2 and 1.1.3 to be completed which illustrate that all activities are interrelated. Such dependencies assert that one task delays another one; a particular task can be dependent on the one that has not been completed. Although the table gives this relation the network diagram of the same gives more insight of how these relations are in distribution to the project timeline. Moreover, variance is also explained as measure of uncertainty level associated with each task. Lesser variation implies more reliability in the time estimates and could be seen from activities usually characterized by lesser dependencies as can be seen below. For example, 1.1.1 has small variance, as it is starting point and free of other activities. On the other hand, tasks like 3.1.5 (Post-deployment model evaluation) tend to have higher variances because the tasks themselves are complex as well as because they interface with other activities, 3.2.2 (Train models using historical data) and 3.2.3 (Test model accuracy with live data). Large variances indicate the location where attention needs to be paid, so that they can avoid problems and stick to the schedule. Overall, table shows pattern where early activities are relatively not that much time consuming, and where prediction is similar as actual results, but as project goes onwards, Time Duration and Variance will increase. With the progress of the work, the Time Duration and Variance grows due to higher dependencies between tasks. This progression is for emphasizing the process by which even though risk and uncertainties are high in latter phases of development, it is essential that planning risks are well done when forming seed money to avoid disappointment in latter phases. That is why it is from high importance to estimate both, Duration Time and Variance in the right way, as, especially in late phases of project, it will be very important where we can expect certain uncertainties or too much time phase for activity to be completed. Such observations will pave way for the evaluation of the network diagram that presents a more real view of dependencies and hence the impact on the projects schedule.

Another important part is the network diagram which is an actualization of a project's tasks and the relationships between them. A key means of showing the relations between actions in a sequence of tasks and the logical sequence and hierarchy of those tasks in project management. Apart from collapsing sequence dependencies, the network diagram assists in evaluation of critical paths, recognition of bottleneck points and the enhancement of the due to time line. It is most helpful for keeping tabs on who is doing what and making certain that resources are being properly deployed all along the development process.

In following network diagram (Figure 3: Network Diagram) each node signifies one activity from WBS. Every node consists of the details about the activity, which includes an identification number, description, and probable time to complete. Apart from nodes, there are interconnections done with arrows that show which activity will be predecessor to which activity The links between nodes depict the relations so that only a set of activities is completed in a certain sequence. However, each node must be provided with at least one input and one output in order to provide a through put of tasks other than start and end node. Thus, the network diagram gives a broad picture of how the project is done, and hence in planning, monitoring and executing a project.

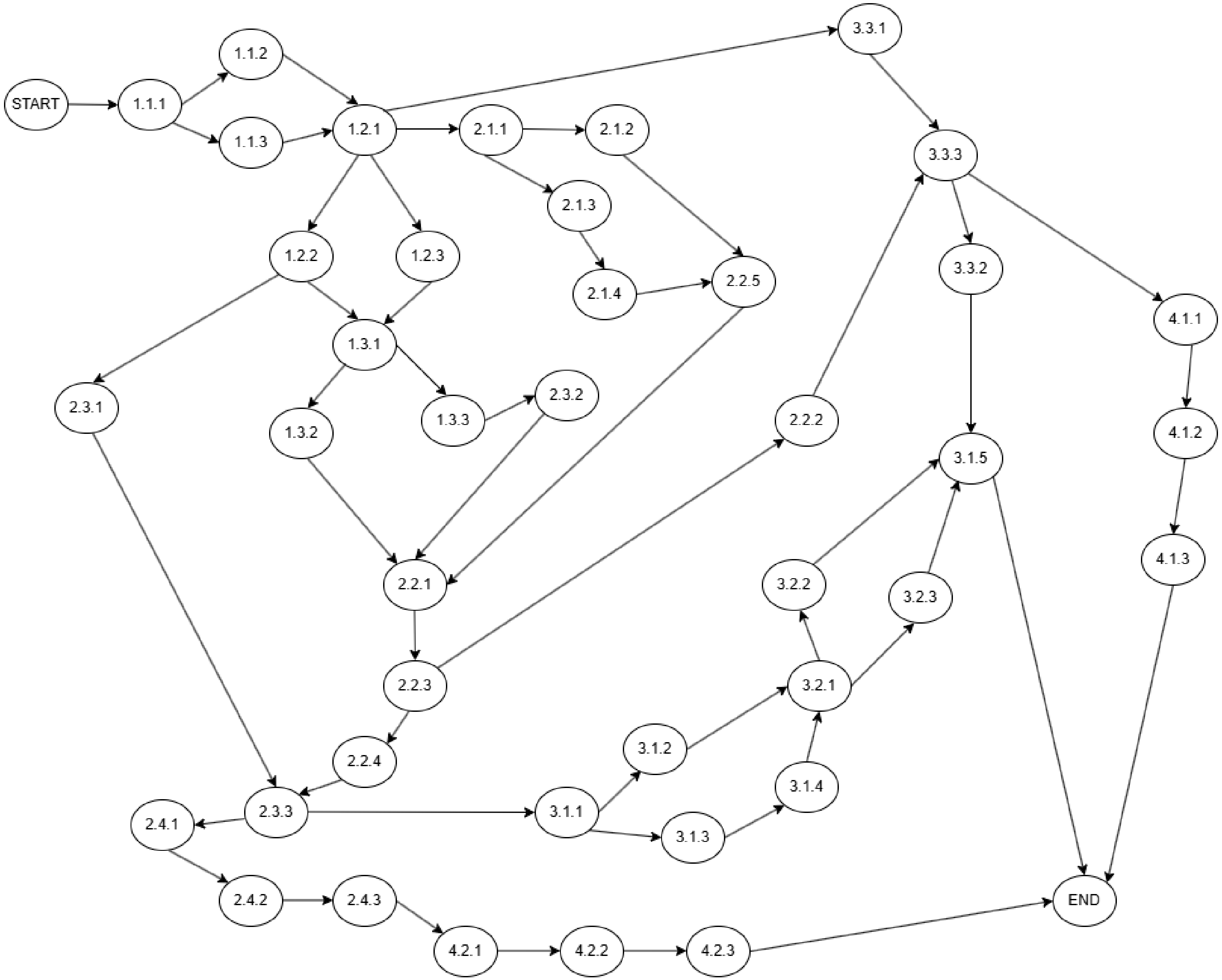


Figure 3: Network Diagram

The start node of network diagram connects to WBS activity 1.1.1 (Identify disease data source), making the beginning of project. Three activities that connect to end node are: 3.1.5 (Post-deployment model evaluation), 4.1.3 (Test cloud scalability) and 4.2.3 (Compliance with data privacy regulations). Such activities indicate the completion of the large pieces of the whole picture – evaluation, scalability, and security compliance, showing that these are critical for project outcome. Certain nodes in network diagram acts as junction point and enhances their importance position in diagram. For example, 1.2.1 (Set up collection methods and tools) is key activity as it acts as predecessor for activities: 1.2.2 (Integrate external APIs), 1.2.3 (Automate periodic data pulls), 2.1.1 (Create landing page), and 3.3.1 (Define disease outbreak thresholds). Similar to that, one activity can depend on more others, like 2.2.1 (Implement dynamic content) which cannot begin before it's three dependencies: .3.2 (Handle missing or corrupted data), 2.3.2 (Implement user authentication), and 2.2.5 (Implement UI components) are finished. These relationships explain how activity are interconnected giving importance of right understand of dependencies. Even though some activities might not have the same PBS, they can interconnect with arrows. For example, 3.3.1 (Define disease outbreak thresholds) can only start after 1.2.1 (Set up collection methods and tools) is finished, as we need methods and tools to define thresholds. Similarly, 4.2.1 (Implement user data encryption) depends on the completion of 2.4.3 (Implement data backups), illustrating the connection between database security and encryption protocols. Moreover, activities can be in parallel phase of doing. It is important to have such activities as it accelerates project execution. For example, tasks like 1.3.1 (Conduct data quality checks) and 2.1.1 (Create landing page) can progress simultaneously, reducing idle time and ensuring progress is remained in standardised form. In general, there is nothing more useful than helping to create a clear and detailed diagram of the network project, as well as to identify dependencies and critical paths, as well as possible delays. This system provides good resource management and timely decisions on project implementation from inception, through to end.

4.2.1 Dependencies

Dependencies within a project are very important when it comes to defining how activities are linked or arranged. In this project, dependence can be categorized as internal and external.

Internal dependencies can also be described as relevant associations within the chain of the project activities. These dependencies are organized in a sequence that will make sense, in task flow, to anyone producing the documentation. For instance:

- Predecessors and Successors: Subtasks like the 1.1.1 (Identify disease data sources), precede tasks like 1.1.2 (Evaluate data provider reliability), and task 1.1.3 (Negotiate data-sharing agreements). In the same way, 1.2.1 (Set up collection methods and tools) has impact on downstream activities such as 1.2.2 (Integrate external APIs) and 2.1.1 (Create landing page).
- Cross-PBS Dependencies: From the above analysis, there is interlinkage of activities from the different PBS components to ensure project integration. For instance, 4.1.1 (Procure and configure servers) is related to 3.3.3 (Simulate predictive scenarios), showing integration across different PBS.
- Critical Path Dependencies: Some dependencies make it compulsory for the project to be completed only through certain means; certain tasks must be completed within a given time frame for the project to complete the most important tasks. For example, the end activities of both sub-processes 3.1.5 (Post-deployment model evaluation), 4.1.3 (Test cloud scalability), and 4.2.3 (Compliance with data privacy regulations) are linked to one another to create a coherent and coordinated project closure.

External dependencies refer to matters within a project that depend on other entities that are beyond the control of the project team. For instance:

- Data Availability: It is dependent on the number and type of data from external sources which is presented in the first and third activities in the work breakdown structure, 1.1.1 (Identify disease data sources) and 1.1.3 (Negotiate data sharing agreements).
- Regulatory Compliance: Some activities are in line with external conditions like 4.2.3 (Compliance with data privacy regulations) based on laws that may change with time.
- Stakeholder Approval: Some of the activities such as 2.2.3 (Optimize for cross-browser compatibility) may require feedback and approval of external stakeholders before progressing to the next activities.

Controlling these dependencies is crucial for avoiding such risks as time slippage or more precisely resource contending. While internal dependencies involve proper sequencing and coordination of work elements within a project, external dependencies called for good planning and adequate management of its chain of activities. Both of these dependencies highlight the interdependency of all the tasks in the project therefore call for integration in order to enhance efficiency in project delivery.

4.3 CRITICAL PATH METHOD

Furthermore, the Critical Path Method (CPM) is used to identify the longest sequence of dependent tasks that must be completed on time to ensure the overall project stays on schedule. This is a crucial aspect of project management, as any delay in critical path activities will directly affect the project's completion timeline. A better understanding of CPM, along with the Critical Path Network Diagram, will be provided after the configuration and implementation of the new node's variables. For better understanding, (Figure 4: Node Model Explanation) gives model which will be followed.

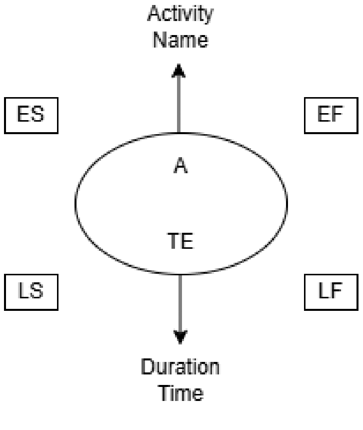


Figure 4: Node Model Explanation

These new variables, measured in days, are:

- ES (Earliest Start) – The earliest time an activity can begin without delaying the project.
- EF (Earliest Finish) – The earliest time an activity can be completed.
- LS (Latest Start) – The latest time activity can begin without delaying the project’s completion.
- LF (Latest Finish) – The latest time activity can be completed without delaying the project’s overall deadline.

There exists pattern that must be followed to calculate variables correctly. It is very important not to make mistake as it will affect values for slack time and critical paths calculation. Steps are given as following:

- All values of: ES, EF, LS, LF for start node are equal to zero.
- All values of: ES, EF, LS, LF for end node are equal to EF_{MAX}.
- ES for the current node is EF_{MAX} of its immediate predecessor nodes.
- EF for the current node is calculated using formula: $EF = ES + TE$.
- Both ES and EF are calculated using forward traversal.
- LF for the current node is LS_{MIN} of its immediate successor nodes.
- LS for the current node is calculated using formula: $LS = LF - TE$.
- Both LS and LF are calculated using backward traversal.

These variables calculations are from quite importance as they can determine the value of Slack Time (SL). It represents unused amount of time, where flexibility of project is implemented as some of activities may be delayed.

Slack time is calculated using one of these formulas:

$$SL = LS - ES$$

$$SL = LF - EF$$

Slack Activities that have values equal to zero represent critical path activities. Following table (Table 4: Critical Path Activity Table) introduces and gives values of: earliest start, earliest finish, latest start, and latest finish, from which slack time can be calculated and critical path recognized.

Table 4: Critical Path Activity Table

Activity ID	Predecessor	TE	ES	EF	LS	LF	SL	CP	σ2
1.1.1	/	4	0	4	0	4	0	**yes**	0.44
1.1.2	1.1.1	5	4	9	5	10	1	no	0.69
1.1.3	1.1.1	6	4	10	4	10	0	**yes**	0.44
1.2.1	1.1.2, 1.1.3	8	10	18	10	18	0	**yes**	2.25
1.2.2	1.2.1	6	18	24	26	32	8	no	1.00
1.2.3	1.2.1	5	18	23	27	32	9	no	1.36
1.3.1	1.2.2, 1.2.3	9	24	33	32	41	8	no	1.78
1.3.2	1.3.1	5	33	38	46	51	13	no	0.44
1.3.3	1.3.1	6	33	39	41	47	8	no	0.44
2.1.1	1.2.1	9	18	27	18	27	0	**yes**	1.36
2.1.2	2.1.1	7	27	34	33	40	6	no	1.00
2.1.3	2.1.1	5	27	32	27	32	0	**yes**	1.00
2.1.4	2.1.3	8	32	40	32	40	0	**yes**	1.00
2.2.1	1.3.2, 2.3.2, 2.2.5	14	51	65	51	65	0	**yes**	2.78
2.2.2	2.2.3	5	75	80	108	113	33	no	0.69
2.2.3	2.2.1	9	65	75	65	75	0	**yes**	1.36
2.2.4	2.2.3	8	75	84	75	84	0	**yes**	1.36
2.2.5	2.1.2, 2.1.4	11	84	95	84	95	0	**yes**	1.36
2.3.1	1.2.2	5	24	29	79	84	55	no	0.44

Activity ID	Predecessor	TE	ES	EF	LS	LF	SL	CP	σ2
2.3.2	1.3.3	4	39	43	47	51	8	no	0.44
2.3.3	2.2.4, 2.3.1	11	84	95	84	95	0	**yes**	1.78
2.4.1	2.3.3	6	95	101	101	107	6	no	1.36
2.4.2	2.4.1	5	101	106	107	112	6	no	1.36
2.4.3	2.4.2	8	106	114	112	120	6	no	1.36
3.1.1	2.3.3	9	95	104	95	104	0	**yes**	1.00
3.1.2	3.1.1	7	104	111	110	117	6	no	1.00
3.1.3	3.1.1	5	104	109	104	109	0	**yes**	0.44
3.1.4	3.1.3	8	109	117	109	117	0	**yes**	1.00
3.1.5	3.2.2, 3.2.3	10	133	143	133	143	0	**yes**	2.25
3.2.1	3.1.2, 3.1.4	9	117	126	117	126	0	**yes**	2.25
3.2.2	3.2.1	6	126	132	127	133	1	no	0.44
3.2.3	3.2.1	7	126	133	126	133	0	**yes**	0.44
3.3.1	1.2.1	6	18	24	107	113	89	no	1.00
3.3.2	3.3.3	4	90	94	129	133	39	no	0.44
3.3.3	2.2.2, 3.3.1	10	80	90	113	123	33	no	1.78
4.1.1	3.3.3	7	90	97	123	130	33	no	1.00
4.1.2	4.1.1	5	97	103	130	135	33	no	0.44
4.1.3	4.1.2	8	97	102	130	135	33	no	1.00
4.2.1	2.4.3	9	114	123	120	129	6	no	1.36
4.2.2	4.2.1	6	123	129	129	135	6	no	0.44
4.2.3	4.2.2	8	129	137	135	143	6	no	1.36

From the table we can see that there are 17 activities with a slack time of 0, meaning there are 17 critical path activities. Slack time for each activity is in reasonable range, except for activity 3.3.1 (Define disease outbreak thresholds) that has 89 days of slack time. It is logic to get this value as only predecessor for this activity is 1.2.1 (Set up collection methods and tools), which connects many other activities and is as well critical path activities. In simpler words, it will take time to get to 3.3.1, so it has larger slack time than other activities.

Simultaneously with implementing the critical path table, the critical path network diagram is developed to visually represent the sequence of activities within the project. This diagram takes a central place in describing the work of the project, its dependencies, and connections between different tasks. This makes it possible for the user of the network diagram to read off the critical path which are the tasks that have a direct bearing on the projects' total duration if delayed. In addition, the critical path network diagram offers information regarding risk of congestion as well as avenues through which the congestion impact a large portion of the project. It assists in the performance of forecast actions, which enables one to make changes to avoid risks while keeping up the pace of the project. This diagram becomes very useful in tracking progress and guarantees a systematized way of tackling different goals within the given time and resources for the project.

The following critical path network diagram (Figure 5: Critical Path Network Diagram) breakdown of the nature and features of the critical path network diagram, its components, the way various important parameters such as ES, EF, LS, LF are identified, SL, is explained in the subsequent sections. This explanation will also show how diagram combines with the CPM to create the most effective scheduling and management tool.

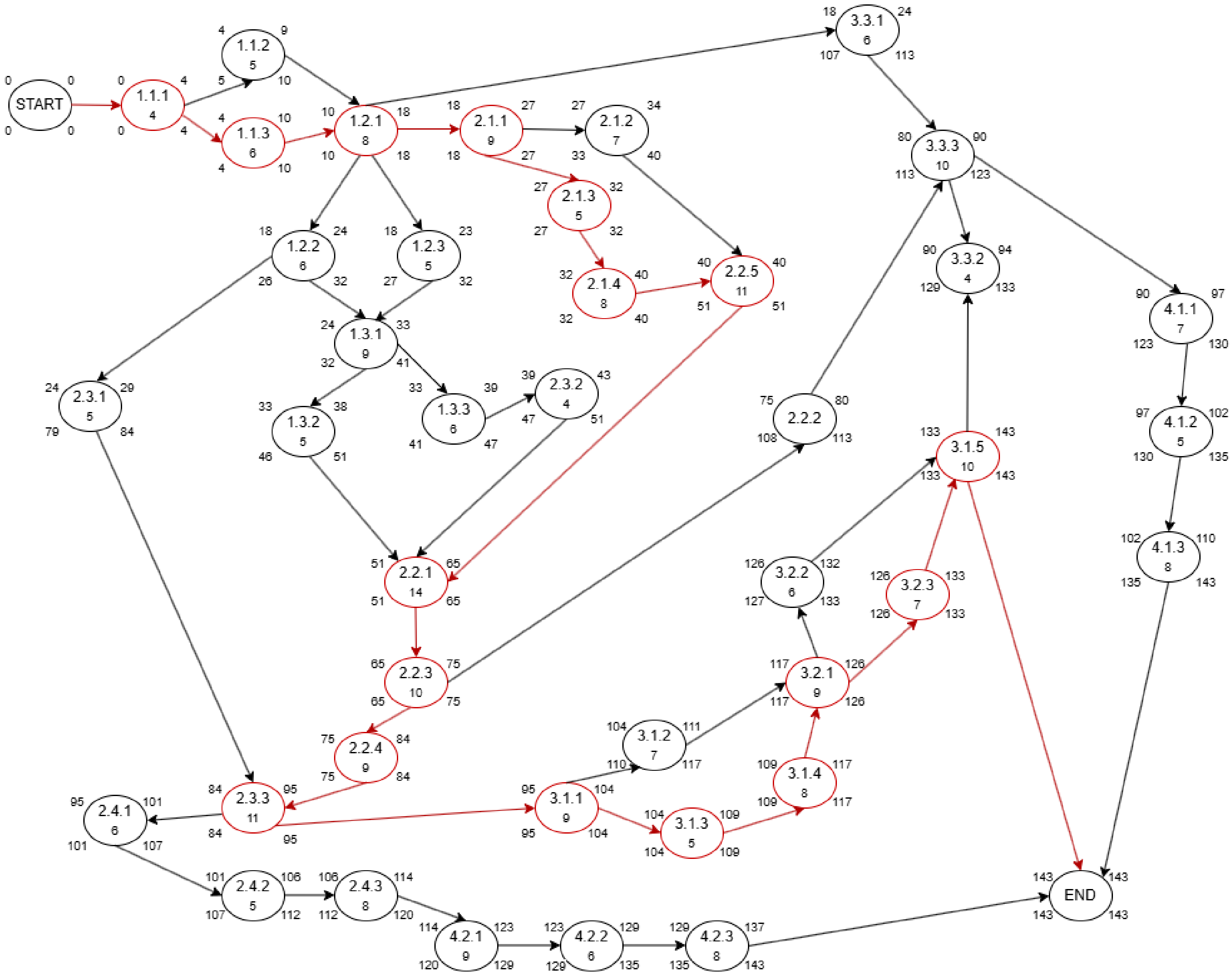


Figure 5: Critical Path Network Diagram

Critical path activity nodes have red outer border and are connected with red arrows. From a diagram it is clearly visible that there is critical path from the start to the end. Activities with slack time of 1 have been close to be part of critical path (3.2.2). In that case we would have parallel critical paths activities. Moreover, the application of the network diagram presents an understanding of dependent and independent activities with an indication as to the amount of latitude with scheduling the program. For example, the extra time available in non-critical activities creates a work margin which can be helpful while handling the risk factors and time losses noticeably on the schedule. Due to realization of the critical sequential dependencies the procedure makes it possible to proactively allocate resources and even prospectively alter priorities to accord with compression schedule. Thirdly, variances from the expected timelines are easily identified, thus early corrective action can be implemented. The visualization is reinforcing more the notion of keeping the free float along the critical path where, at the same time, using the slack time in the adjacent activities in order to increase the overall efficiency and balance the workloads.

4.4 UNCERTAINTY OF PROJECT COMPLETION

There will always be some uncertainty in project completion. Projects can be completed earlier, rarely to happen, so likelihood for project to be extended and completed with more unit of time is usually calculated. For this project, determination of likelihood that project will be completed within 7 days more will be calculated.

Following table (Table 5: Critical Path Table for Uncertainty Calculation) is extraction from the previous table with activities: of slack time 0, critical path and calculated variance are given.

Table 5: Critical Path Table for Uncertainty Calculation

Activity ID	SL	CP	σ^2
1.1.1	0	yes	0.44
1.1.3	0	yes	0.44
1.2.1	0	yes	2.25
2.1.1	0	yes	1.36
2.1.3	0	yes	1.00
2.1.4	0	yes	1.00
2.2.1	0	yes	2.78
2.2.3	0	yes	1.36
2.2.4	0	yes	1.36
2.2.5	0	yes	1.36
2.3.3	0	yes	1.78
3.1.1	0	yes	1.00
3.1.3	0	yes	0.44
3.1.4	0	yes	1.00
3.1.5	0	yes	2.25
3.2.1	0	yes	2.25
3.2.3	0	yes	0.44

Table lists critical path activities with corresponding variance. This is because we need sum of these variances for later calculation of project be delayed.

$$\sigma_p^2 = \sum_{i=1}^{n} \sigma_{CPi}^2$$

$\sigma_p^2 = \sigma_{1.1.1}^2 + \sigma_{1.1.3}^2 + \sigma_{1.2.1}^2 + \sigma_{2.1.1}^2 + \sigma_{2.1.3}^2 + \sigma_{2.1.4}^2 + \sigma_{2.2.1}^2 + \sigma_{2.2.3}^2 + \sigma_{2.2.4}^2 + \sigma_{2.2.5}^2 + \sigma_{2.3.3}^2 + \sigma_{3.1.1}^2 + \sigma_{3.1.3}^2 + \sigma_{3.1.4}^2 + \sigma_{3.1.5}^2 + \sigma_{3.2.1}^2 + \sigma_{3.2.3}^2$

$\sigma_p^2 = 0.44 + 0.44 + 2.25 + 1.36 + 1.00 + 1.00 + 2.78 + 1.36 + 1.36 + 1.36 + 1.78 + 1.00 + 0.44 + 1.00 + 2.25 + 2.25 + 0.44 = 22.51$

After finding variance, take square root to find standard deviation.

$$\sigma_p = \sqrt{\sigma_p^2} = \sqrt{22.51} = 4.74447 \text{ days}$$

Where:

σ_p - standard deviation

To find probability that project will be delayed for 7 days:

$$z = \frac{D - d}{\sigma_p} = \frac{150 - 143}{4.74447} = \frac{7}{4.74447} = 1.47$$

Where:

z – Score from the standard normal distribution.

D – Calculated duration in days from a critical path network diagram + 7 days for delay.

d – Calculated duration in days from a critical path network diagram.

Reading from the z-index table:

$$\Phi(1.47) = 0.93$$

Suggesting area to the left of z = 1.47 is 0.93. This means that there is 93% of chance that project will be delayed for 7 days. Quite high probability for project to be postponed is quite logic in this case as both, variance and standard deviation, are large. This is because, number of critical path activities, from which we sum up variance is big. Also, usually, larger number of activities will make longer critical path, which happen in this project, and knowing that there are 41 activities that by theoretical calculation should be done in just 143 days, it is reasonable to expect high probability for project to be postponed for additional 7 days.

4.5 GANTT CHART

A Gantt chart is one of the most popular project management systems that help visualize project timelines. It depicts the start and end points of single activity and tasks in a chronological way. This chart is usually shown as a horizontal bar that enables project managers and teams to visualize the entire timeline of a project, in addition to the dependency of tasks, their duration and progress. The level of significance of a Gantt chart is in the fact that this technique helps to schedule a large project and control the time. It creates understanding and co-ordination between the stakeholders as organizational chart offers an openness of the project in terms of time and work arrangement. Also, it assists in detecting situations when the tasks could be delayed, combined, or when the time for performing certain tasks could be apparently larger than beneficial. It shows the dependency of one task to the other and important milestones in the project. This makes the Gantt chart a strong aid in ensuring that a project is on time and has not been made larger by additional new sub-tasks when the project is behind schedule, and the existing sub-tasks on the critical path must unfold in their entirety.

Following figure (Figure 6: Gantt Chart Part I) and figure (Figure 7: Gantt Chart Part II) provides two screenshots from the ProjectLibre software. It is one Gantt chart with two screenshots as single picture cannot fit the page. It has activity table with listed: ID for each activity and milestones, name for activities and milestones, listed predecessor/s for each activity, time duration and automatically calculated slack time.

		Name	Predecessors	Duration	Total Slack
1		Identify disease data sources		4 days	0 days
2		Evaluate data provider reliability	1	5 days	1 day
3		Data Preparation and Validation	2	0 days	134 days
4		Negotiate data-sharing agreements	1	6 days	0 days
5		Set up collection methods and tools	2;4	8 days	0 days
6		Integrate external APIs	5	6 days	8 days
7		Automate periodic data pulls	5	5 days	9 days
8		Conduct data quality checks	6;7	9 days	8 days
9		Handle missing or corrupted data	8	5 days	13 days
10		Develop validation protocols	8	6 days	8 days
11		Application Development and Model Integra	10	0 days	104 days
12		Create landing page	5	9 days	0 days
13		Develop registration system	12	7 days	6 days
14		Design disease visualization charts	12	5 days	0 days
15		Design Analytics Report	14	8 days	0 days
16		Implement dynamic content	9;20;22	14 days	0 days
17		Build responsive layout	18	5 days	33 days
18		Optimize for cross-browser compatibility	16	10 days	0 days
19		Client-side optimization	18	9 days	0 days
20		Implement UI components	13;15	11 days	0 days
21		Set up APIs for data interaction	6	5 days	55 days
22		Implement user authentication	10	4 days	8 days
23		Integrate the prediction model	19;21	11 days	0 days
24		Design database schema	23	6 days	6 days
25		Optimize queries for performance	24	5 days	6 days
26		Implement data backups	25	8 days	6 days
27		Identify and select relevant algorithms	23	9 days	0 days
28		Develop AI APIs	27	7 days	6 days
29		Define features for prediction	27	5 days	0 days
30		Validate AI predictions	29	8 days	0 days
31		Post-deployment model evaluation	34;35;37	10 days	0 days
32		System Testing and Optimization	27	0 days	39 days
33		Prepare and pre-process training data	28;30	9 days	0 days
34		Train models using historical data	33	6 days	1 day
35		Test model accuracy with live data	33	7 days	0 days
36		Define disease outbreak thresholds	5	6 days	89 days
37		Trigger real-time alerts	38	4 days	39 days
38		Simulate predictive scenarios	17;36	10 days	33 days
39		Procure and configure servers	38	7 days	33 days
40		Set up virtual environments	39	5 days	33 days
41		Test cloud scalability	40	8 days	33 days
42		Implement user data encryption	26	9 days	6 days
43		Set up Access Control	42	6 days	6 days

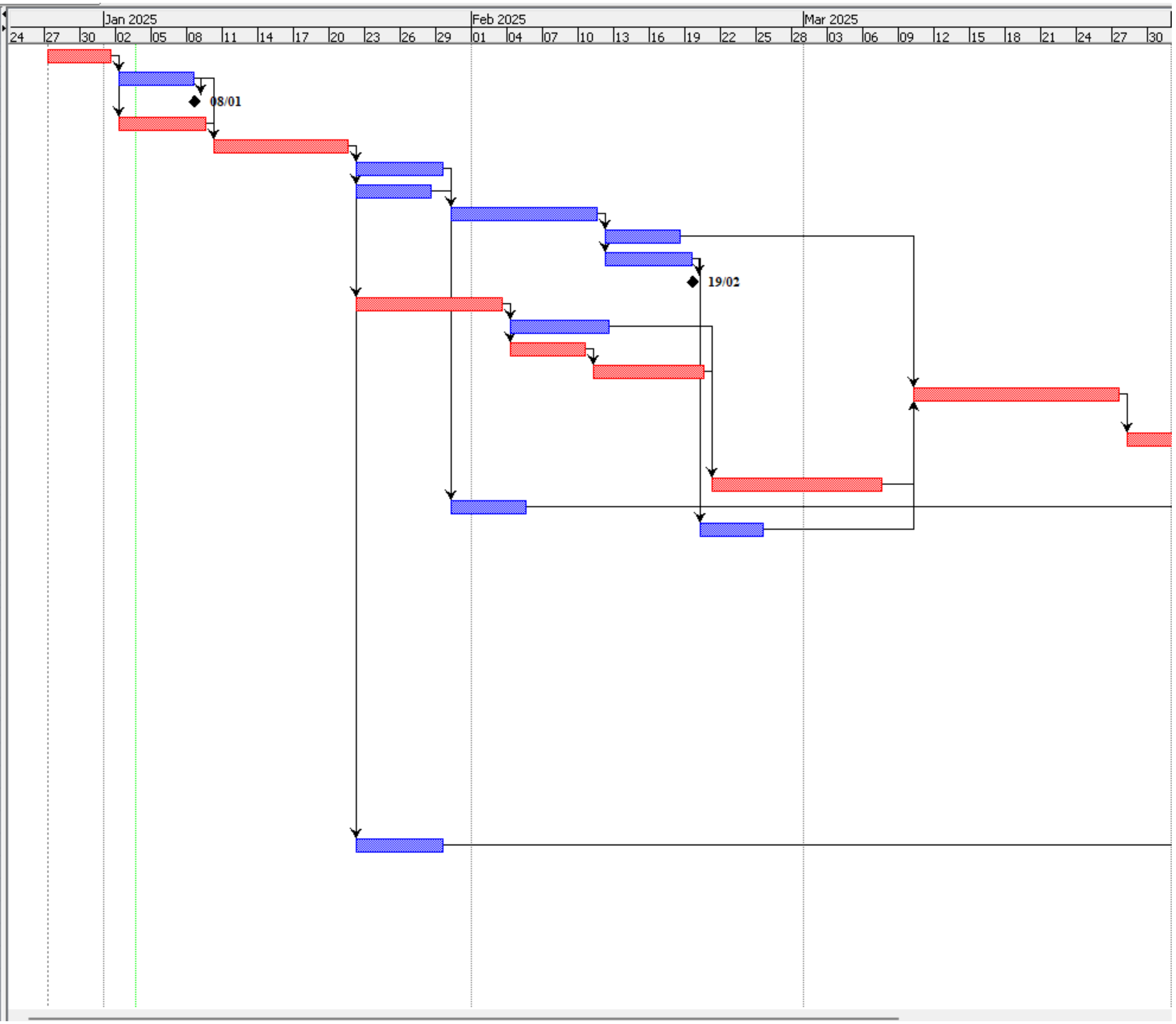


Figure 6: Gantt Chart Part I

		Name	Predecessors	Duration	Total Slack
1		Identify disease data sources		4 days	0 days
2		Evaluate data provider reliability	1	5 days	1 day
3		Data Preparation and Validation	2	0 days	134 days
4		Negotiate data-sharing agreements	1	6 days	0 days
5		Set up collection methods and tools	2;4	8 days	0 days
6		Integrate external APIs	5	6 days	8 days
7		Automate periodic data pulls	5	5 days	9 days
8		Conduct data quality checks	6;7	9 days	8 days
9		Handle missing or corrupted data	8	5 days	13 days
10		Develop validation protocols	8	6 days	8 days
11		Application Development and Model Integra	10	0 days	104 days
12		Create landing page	5	9 days	0 days
13		Develop registration system	12	7 days	6 days
14		Design disease visualization charts	12	5 days	0 days
15		Design Analytics Report	14	8 days	0 days
16		Implement dynamic content	9;20;22	14 days	0 days
17		Build responsive layout	18	5 days	33 days
18		Optimize for cross-browser compatibility	16	10 days	0 days
19		Client-side optimization	18	9 days	0 days
20		Implement UI components	13;15	11 days	0 days
21		Set up APIs for data interaction	6	5 days	55 days
22		Implement user authentication	10	4 days	8 days
23		Integrate the prediction model	19;21	11 days	0 days
24		Design database schema	23	6 days	6 days
25		Optimize queries for performance	24	5 days	6 days
26		Implement data backups	25	8 days	6 days
27		Identify and select relevant algorithms	23	9 days	0 days
28		Develop AI APIs	27	7 days	6 days
29		Define features for prediction	27	5 days	0 days
30		Validate AI predictions	29	8 days	0 days
31		Post-deployment model evaluation	34;35;37	10 days	0 days
32		System Testing and Optimization	27	0 days	39 days
33		Prepare and pre-process training data	28;30	9 days	0 days
34		Train models using historical data	33	6 days	1 day
35		Test model accuracy with live data	33	7 days	0 days
36		Define disease outbreak thresholds	5	6 days	89 days
37		Trigger real-time alerts	38	4 days	39 days
38		Simulate predictive scenarios	17;36	10 days	33 days
39		Procure and configure servers	38	7 days	33 days
40		Set up virtual environments	39	5 days	33 days
41		Test cloud scalability	40	8 days	33 days
42		Implement user data encryption	26	9 days	6 days
43		Set up Access Control	42	6 days	6 days

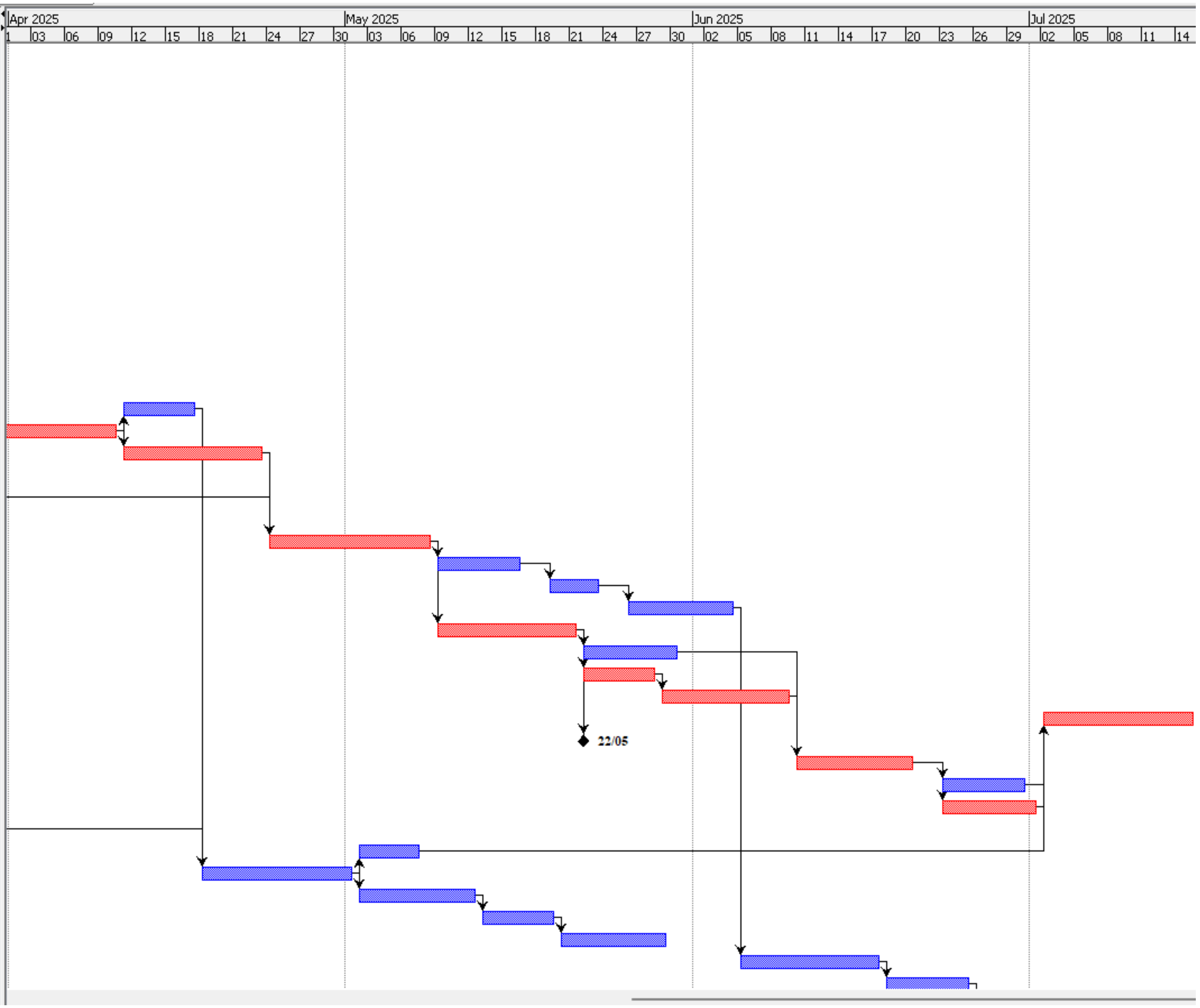


Figure 7: Gantt Chart Part II

Looking at the activity table and the input data given by the user of the software, the program determines the slack time for the corresponding activity. Flexible time or slack time means the time that an activity may be postponed in order that total elapsed time shall not be increased. To ensure that the value derived from the software corresponds to the results determined manually using pen and paper, the calculated slack times were compared. The results were as follows; when this was done with pen and paper, the resulting slack times were the same as calculated by the software, thereby further proving that the software did calculate the slack times perfectly correct.

Due to the fact that it is convenient in the management and visualization of certain project's process, the activity table has three milestones. These include milestones from the project plan formulation which work as benchmark for the accomplishment of the project. Unlike standard activity, these milestones have a duration of zero because they are events that are discrete rather than long term ongoing processes. On the Gantt Chart, these milestones are visually represented as diamond shapes, each labeled with the expected start date of the milestone.

Remarkably, the activities on the Gantt Chart are represented as rectangular blocks, which give clear information about the time span of an activity and its location within a project timeline. To improve the control the activities marked by the red color concerns the critical path. These are the critical path activities since wherever they are located the time over and above what is scheduled affects the total time required to complete the project. Non-essential activities are shown in blue, as they imply flexible or slack resources are used in the activity. In fact, this project's Gantt Chart includes all the activities in 41 rectangular shapes. Of these 17 boxes are red signifying that these activities are on the critical path. This corresponds with the results derived from the manually drawn network diagram where the critical path is identified thus enhancing the reliability of the manual and software generated techniques of analysis.

Furthermore, the Gantt Chart uses black lines separating the rectangular boxes with grey filling connecting them where they depict the predecessor relationship of the related activities. They also provide the interaction links which tell which activity can take place next or which activity must be carried out before another one starts. Above the Gantt Chart, there is a calendar bar giving accurate information of the points of time in which each activity is expected to start and end. This helps be able to plan for the specific project timeline and also meet all the due dates.

In general, it was possible to notice that the use of the software was highly helpful in the elaboration of an appropriate and well- readable Gantt Chart. Processing calculations automatically and displaying project essential information minimized the time lost by employees and also removed the possibility of some key errors. The use of milestones, color coded activities and the calendar made the chart especially informative and quite easy to follow. Such an approach relieves everyone in the team of having to try and follow the whole lot and gives them more time to concentrate on the areas of the project that are important.

Thus, the Gantt Chart became an essential tool to assign and control the schedule for the activities needed to accomplish the project. They were able not only to make the scheduling and tracking of tasks easier but also to increase the interactivity and teamwork within the team due to the clear visualization of the project time line and relations between tasks. Therefore, the Gantt Chart emerges as a unique resource in the project management as it provides clear perspective and improves the overall effectiveness in relation to goal attainment of the project within its parameters.

5 COST/BUDGET MANAGEMENT

Cost/Budget Management is the process of planning, estimating, allocating, and controlling the costs within a project to ensure it is completed within the approved budget. This involves continuous monitoring and management of expenditures throughout the project lifecycle to prevent cost overruns and ensure financial efficiency. The main goal of cost/budget management is to set proper monetary parameters for a particular project as well as to include all of the needed resources' prices. It also helps project managers to plan ahead of the costs that are expected to be incurred, monitor the projects' financial position and make decision that put the project back on track on the set financial objectives. One of the major key success factors of any project is proper control of costs/budget. It avoids unpredicted cash gaps, demonstrates assurance to stakeholders, and puts into question its feasibility and profitability. Both cost control and cost reduction help prevent wastage of organizational resources, guide resources usage, and ensure the organization's clear financial responsibility. Without it, work may be affected, deadlines missed, costs go sky high, and the project may fail. Cost/Budget Management can be further explored through key components such as resource planning, budget planning, and project crashing. Each of these aspects contributes to a comprehensive understanding of how to optimize costs while achieving project objectives.

5.1 RESOURCE PLAN

Resource Plan is a strategic map that details the resources needed to achieve a goal in a given project. Such resource can comprise of human resources known as the workers and non-human resource known as the materials. It outlines what is required for the project, when this is required and how it will be acquired to enhance the completion of the project in the right time. Resource management plan is an important aspect of project management because it means having all the required resources available when they are needed in order to avoid unnecessary hold up. Resource management helps improve efficiency in executing project activities, minimizes costs by preventing overbooking of resources or underutilization. It also permits easy sharing of information and planning among the members enhancing efficiency. The resource plan is generally divided into two components: work and material.

Work section deals with the human resource needed for the project. It clearly defines who does what and when, that is, it matches skills with responsibilities and work load with calendars. Management of workers avoids overloading or making sub-groups of team members and ensure to make balanced and successful environment.

Material part deals with the assets that can be both, physical (touched) components and software (programs) components. In the implementation of the project, they include: machines, implements, equipment, products, or programs. In order to avoid material shortages or material overruns, which causes additional costs or project delays, much attention must be given to planning for material needs.

The following table (Table 6: Resource Plan Table) establishes overview of all work and material components that have been used in a project. Once again, it is done in software ProjectLibre. It serves as capital element for resource processing, offering detailed and well-structured representation. By categorizing both, work and material components, table gives transparency and making easier tracking for plan. It is very important, as a primary step to calculate and enter clear and right values and data in a table. If calculation is wrong, it can lead to wrong results in each, resource plan, cost plan, and project crashing. But a well-prepared resource table not only helps to manage the resources effectively but also reduces the possibilities of such omissions and inefficiency.

Table 6: Resource Plan Table

Code	Name	Type	Initials	Max. Units	Standard Rate
1	Project Manager	Work	PM	100%	£100.00/day
2	Data Analytics Engineer	Work	DAE	150%	£60.00/day
3	QA Engineer	Work	QAE	300%	£65.00/day
4	Backend Engineer 1	Work	BE1	250%	£90.00/day
5	Backend Engineer 2	Work	BE2	300%	£90.00/day
6	Frontend Engineer 1	Work	FE1	200%	£90.00/day
7	Frontend Engineer 2	Work	FE2	150%	£90.00/day
8	Frontend Engineer 3	Work	FE3	250%	£90.00/day
9	Management Consultant	Work	MC	100%	£80.00/day
10	Cybersecurity Engineer	Work	CE	400%	£90.00/day
11	Administrator	Work	A	100%	£60.00/day
12	Database Engineer	Work	DE	250%	£75.00/day
13	Biogenetics Engineer	Work	BE	200%	£80.00/day
14	Network Installer	Work	NI	400%	£70.00/day
15	Lawyer	Work	L	100%	£80.00/day
16	UI Engineer	Work	T	300%	£70.00/day
17	AI Engineer 1	Work	AIE1	300%	£90.00/day
18	AI Engineer 2	Work	AIE2	300%	£90.00/day
19	Sensor	Material	S		£200.00
20	Cable	Material	C		£10.00
21	AI Chatbot	Material	AI		£500.00
22	Computer Setup	Material	CS		£3000.00
23	Router	Material	R		£50.00
24	MS Office	Material	MS		£100.00
25	Transport	Material	T		£150.00
26	Design Tool	Material	DT		£200.00
27	Servers	Material	SR		£1000.00
28	Frontend Tool	Material	F		£300.00
29	Backend Tool	Material	B		£300.00

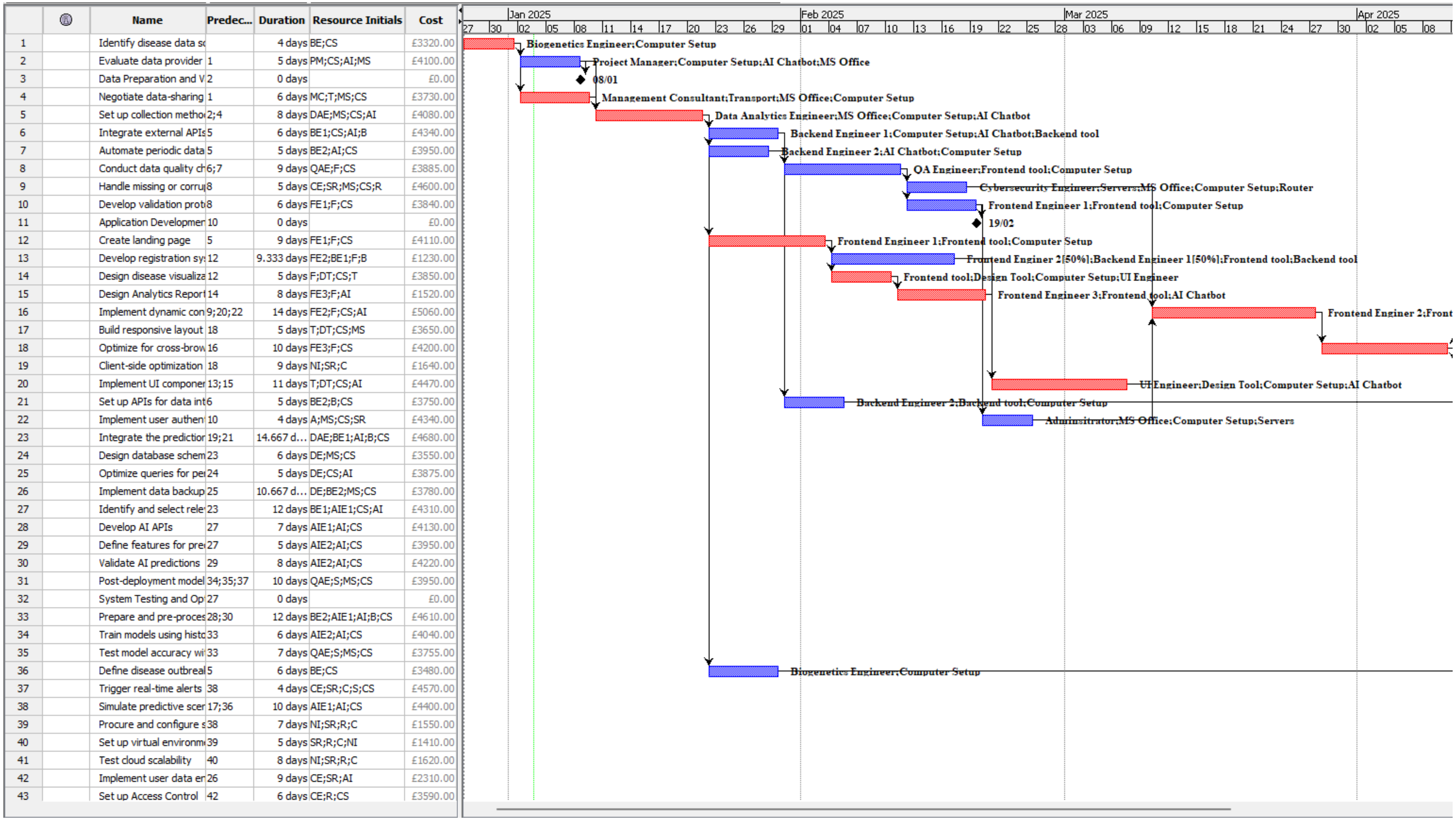
This table is perfectly built from scratch using the ProjectLibre software, and it reflects one of the most critical elements or the Resource Plan from the project management field. It provides a detailed breakdown of the two primary types of resources that will be utilized throughout the project: work and materials. The work resources represent human assets that consist of professionals whose skills will help in the achievement of the project, while material refers to the objects that the human assets will utilize in their work. Altogether all these resources can be said to be fundamental components of the working architecture of the project. The table lists the knowledge and expertise of 18 experts who will be involved in the project on different levels. They are each given tasks according to the type of knowledge and expertise that the expert possesses making the work more accurate and effective. Besides this, the table also specifies details of 11 material requirements which will be issued to the experts as when needed for their tasks. Here it should be mentioned that not all the materials will be distributed to each of the experts, as their applicability will vary depending on the tasks. For example, it is unadvisable for a Management Consultant to demand a Sensor since it is an instrument that they do not need. It helps in avoiding some uncontrolled expenses because the flow of materials will go through a reasonable and systematic arrangement. To enable easy organization of planning schedules and easy project running in the future, each of the experts in the table is given initials as a code or ID. This approach also improves clarity, and makes work easier particularly in large projects requiring the engagement of a number of employees and various distributions of work and resources. The Max. Units column in the table plays a pivotal role by specifying the extent of an expert's engagement in project activities. This value reflects how many activities each expert will participate in and their level of involvement. For example, value of 100% means that the expert is fully devoted to a particular activity, he or she spends full-time and does not share with other activities. On the other hand, value of 150% means that the expert will be able to handle several tasks at the same time, including a core task to which he or she devotes one's entire working hours, and an additional task that is divided with another expert. In this case, the additional workload is shared in equal measure, that is 50/50; nobody will be overloaded. Besides providing the details of distribution of resources, the table defines the Standard Rate of each expert. This rate defines how much it would cost to hire an expert to work on the project for one day and provides a basis for setting the actual cost for project. For instance, if an expert is assigned to a task for five days, their cost will be derived by multiplying their daily rate by the number of days worked. Regarding material components, there cost is one time, meaning after it's utilization, all costs as installation, procurement or usage are covered until activity is finished. For example, Frontend Tool for development activities costs overall £300.00.

To sum up, this table is a framework in the context of which all the resources used in the course of the project are presented and is easy to read, detailed, and structured in terms of logic. Besides, it also supplements the management of resources while also promoting a corresponding correspondence between the resources and the goals of the project. Hence, by arranging the work in a structural way and managing the materials effectively, by defining the proper occupations and being clear on the costs the table is a crucial part of the project and its positively affects the outcome.

5.2 BUDGET PLAN

Budget Plan is a financial roadmap which gives an estimate of the amount of money that an organization needs to complete a project. This one app for all of the company's costs, whether they are personnel costs, materials, equipment, and other cost of sales elements. The significance of the budget plan mainly the reason for financial control, whereby the project manager is in a position to control funds and make sure they are not wastefully spent. It also assists in managing risks since controllability plans for any additional expenses which may arise. Furthermore, it is a working document in the context of budgeting as it provides guidelines to compare actual accomplishments to the plan, to establish variances and corrections for them. In course of this project, we will also be using tools such as the Gantt chart adjusted for the present and resource consumption report that will outline the budget plan and the general expenses correspondingly. This makes the approach more transparent and accurate in helping to achieve the best outcomes in the implementation of projects whilst considering the financial aspect.

Following figure (Figure 8: Gantt Chart for Budget Plan Part I) and figure (Figure 9: Gantt Chart for Budget Plan Part II) represent two screenshots of the same Gantt Chart. This Gantt Chart represents updated version of previous Gantt Chart as all of resources and materials that have been considered and briefly are added to each corresponding activity where needed. Also, additional column is Cost that will calculate predictive cost for each activity in a table.



	Name	Predec...	Duration	Resource Initials	Cost
1	Identify disease data sc		4 days	BE;CS	£3320.00
2	Evaluate data provider	1	5 days	PM;CS;AI;MS	£4100.00
3	Data Preparation and V	2	0 days		£0.00
4	Negotiate data-sharing	1	6 days	MC;T;MS;CS	£3730.00
5	Set up collection metho	2;4	8 days	DAE;MS;CS;AI	£4080.00
6	Integrate external APIs	5	6 days	BE1;CS;AI;B	£4340.00
7	Automate periodic data	5	5 days	BE2;AI;CS	£3950.00
8	Conduct data quality ch	6;7	9 days	QAE;F;CS	£3885.00
9	Handle missing or corru	8	5 days	CE;SR;MS;CS;R	£4600.00
10	Develop validation prot	8	6 days	FE1;F;CS	£3840.00
11	Application Developmer	10	0 days		£0.00
12	Create landing page	5	9 days	FE1;F;CS	£4110.00
13	Develop registration sy	12	9.333 days	FE2;BE1;F;B	£1230.00
14	Design disease visualiza	12	5 days	F;DT;CS;T	£3850.00
15	Design Analytics Report	14	8 days	FE3;F;AI	£1520.00
16	Implement dynamic con	9;20;22	14 days	FE2;F;CS;AI	£5060.00
17	Build responsive layout	18	5 days	T;DT;CS;MS	£3650.00
18	Optimize for cross-brow	16	10 days	FE3;F;CS	£4200.00
19	Client-side optimization	18	9 days	NI;SR;C	£1640.00
20	Implement UI componer	13;15	11 days	T;DT;CS;AI	£4470.00
21	Set up APIs for data int	6	5 days	BE2;B;CS	£3750.00
22	Implement user authen	10	4 days	A;MS;CS;SR	£4340.00
23	Integrate the predictior	19;21	14.667 d...	DAE;BE1;AI;B;CS	£4680.00
24	Design database schem	23	6 days	DE;MS;CS	£3550.00
25	Optimize queries for pe	24	5 days	DE;CS;AI	£3875.00
26	Implement data backup	25	10.667 d...	DE;BE2;MS;CS	£3780.00
27	Identify and select rele	23	12 days	BE1;AIE1;CS;AI	£4310.00
28	Develop AI APIs	27	7 days	AIE1;AI;CS	£4130.00
29	Define features for pre	27	5 days	AIE2;AI;CS	£3950.00
30	Validate AI predictions	29	8 days	AIE2;AI;CS	£4220.00
31	Post-deployment model	34;35;37	10 days	QAE;S;MS;CS	£3950.00
32	System Testing and Op	27	0 days		£0.00
33	Prepare and pre-proces	28;30	12 days	BE2;AIE1;AI;B;CS	£4610.00
34	Train models using histo	33	6 days	AIE2;AI;CS	£4040.00
35	Test model accuracy wi	33	7 days	QAE;S;MS;CS	£3755.00
36	Define disease outbreal	5	6 days	BE;CS	£3480.00
37	Trigger real-time alerts	38	4 days	CE;SR;C;S;CS	£4570.00
38	Simulate predictive scer	17;36	10 days	AIE1;AI;CS	£4400.00
39	Procure and configure s	38	7 days	NI;SR;R;C	£1550.00
40	Set up virtual environm	39	5 days	SR;R;C;NI	£1410.00
41	Test cloud scalability	40	8 days	NI;SR;R;C	£1620.00
42	Implement user data er	26	9 days	CE;SR;AI	£2310.00
43	Set up Access Control	42	6 days	CE;R;CS	£3590.00

Figure 8: Gantt Chart for Budget Plan Part I

		Name	Predec...	Duration	Resource Initials	Cost
1		Identify disease data sc		4 days	BE;CS	£3320.00
2		Evaluate data provider	1	5 days	PM;CS;AI;MS	£4100.00
3		Data Preparation and V	2	0 days		£0.00
4		Negotiate data-sharing	1	6 days	MC;T;MS;CS	£3730.00
5		Set up collection metho	2;4	8 days	DAE;MS;CS;AI	£4080.00
6		Integrate external APIs	5	6 days	BE1;CS;AI;B	£4340.00
7		Automate periodic data	5	5 days	BE2;AI;CS	£3950.00
8		Conduct data quality ch	6;7	9 days	QAE;F;CS	£3885.00
9		Handle missing or corru	8	5 days	CE;SR;MS;CS;R	£4600.00
10		Develop validation prot	8	6 days	FE1;F;CS	£3840.00
11		Application Developmen	10	0 days		£0.00
12		Create landing page	5	9 days	FE1;F;CS	£4110.00
13		Develop registration sy	12	9.333 days	FE2;BE1;F;B	£1230.00
14		Design disease visualiza	12	5 days	F;DT;CS;T	£3850.00
15		Design Analytics Report	14	8 days	FE3;F;AI	£1520.00
16		Implement dynamic con	9;20;22	14 days	FE2;F;CS;AI	£5060.00
17		Build responsive layout	18	5 days	T;DT;CS;MS	£3650.00
18		Optimize for cross-brow	16	10 days	FE3;F;CS	£4200.00
19		Client-side optimization	18	9 days	NI;SR;C	£1640.00
20		Implement UI componer	13;15	11 days	T;DT;CS;AI	£4470.00
21		Set up APIs for data int	6	5 days	BE2;B;CS	£3750.00
22		Implement user authen	10	4 days	A;MS;CS;SR	£4340.00
23		Integrate the predictior	19;21	14.667 d...	DAE;BE1;AI;B;CS	£4680.00
24		Design database schem	23	6 days	DE;MS;CS	£3550.00
25		Optimize queries for pe	24	5 days	DE;CS;AI	£3875.00
26		Implement data backup	25	10.667 d...	DE;BE2;MS;CS	£3780.00
27		Identify and select rele	23	12 days	BE1;AIE1;CS;AI	£4310.00
28		Develop AI APIs	27	7 days	AIE1;AI;CS	£4130.00
29		Define features for pre	27	5 days	AIE2;AI;CS	£3950.00
30		Validate AI predictions	29	8 days	AIE2;AI;CS	£4220.00
31		Post-deployment model	34;35;37	10 days	QAE;S;MS;CS	£3950.00
32		System Testing and Op	27	0 days		£0.00
33		Prepare and pre-proces	28;30	12 days	BE2;AIE1;AI;B;CS	£4610.00
34		Train models using histc	33	6 days	AIE2;AI;CS	£4040.00
35		Test model accuracy wi	33	7 days	QAE;S;MS;CS	£3755.00
36		Define disease outbreal	5	6 days	BE;CS	£3480.00
37		Trigger real-time alerts	38	4 days	CE;SR;C;S;CS	£4570.00
38		Simulate predictive scer	17;36	10 days	AIE1;AI;CS	£4400.00
39		Procure and configure s	38	7 days	NI;SR;R;C	£1550.00
40		Set up virtual environm	39	5 days	SR;R;C;NI	£1410.00
41		Test cloud scalability	40	8 days	NI;SR;R;C	£1620.00
42		Implement user data en	26	9 days	CE;SR;AI	£2310.00
43		Set up Access Control	42	6 days	CE;R;CS	£3590.00

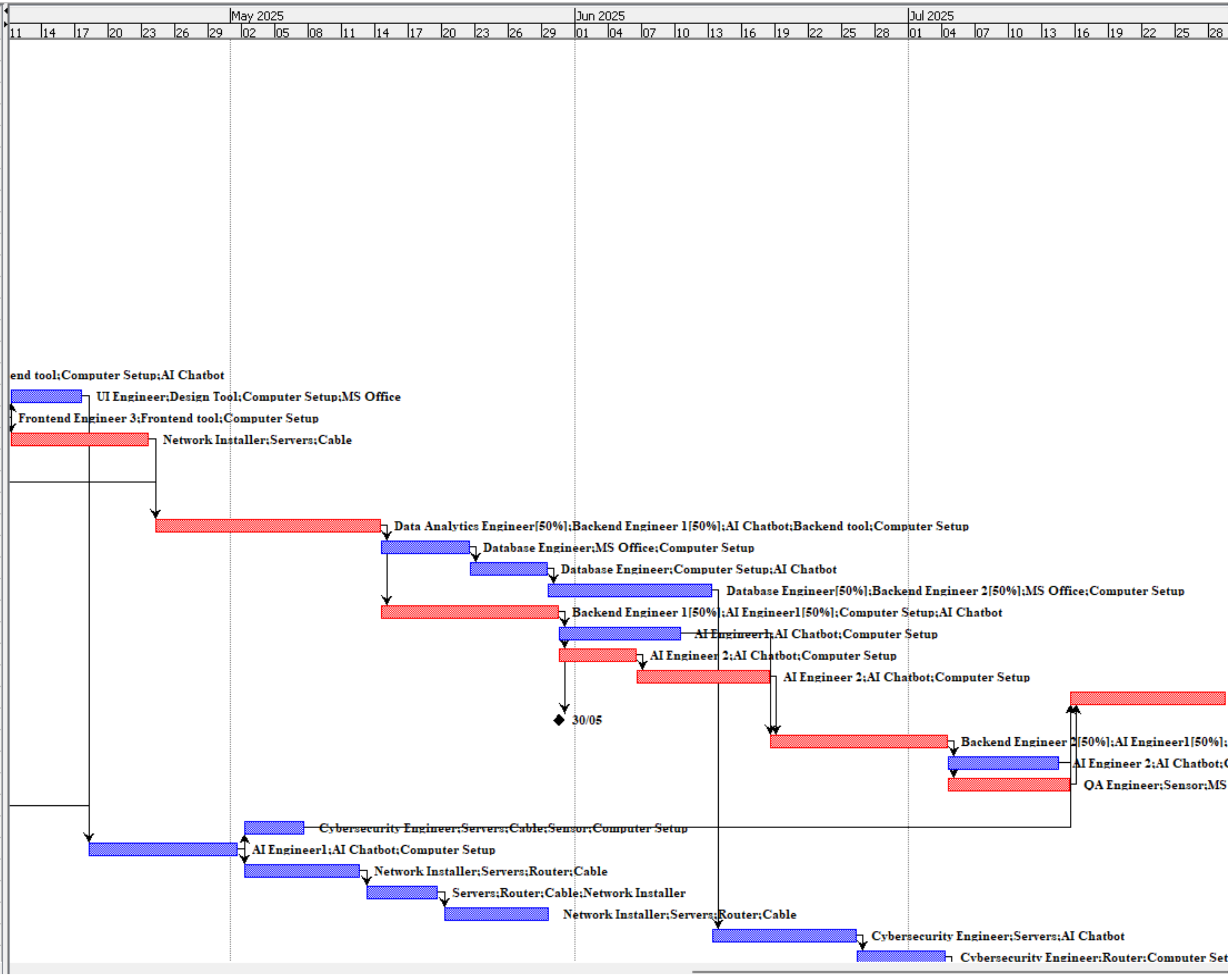


Figure 9: Gantt Chart for Budget Plan Part II

This updated Gantt chart is a modification of previous chart that contains new columns to enable a better view of the project. These new columns include Resource Initials through which all the resources used in the project are identified. For better organization and ease of understanding the data, every reserve receives special initials in form of capital letters. The approach adopted here avoids confusion and makes the chart easier to comprehend in large projects that involve many resources. Moreover, for some activities after adding all resources to each activity, software changes time duration. This is done in the activities where we have more workers, like two, and where they do job on the activity as half-time job. The Cost column is another important addition to the chart and stands in the center of the Budget Plan. This column defines the estimated cost that should be incurred to each activity and is an essential ingredient in the financial aspect of a project. All the costs in this column are computed by the software, which makes them accurate as well as precise. The formulation process requires the user to allocate each necessary resource, work and material, to each activity. After all the resources are connected to the activity, the software uses the resource plan defined earlier, as well as the cost of every resource to make the overall sum for every activity. This automation reduces human interference and offers an approximate figure of the costs incurred within the project. With these other extra columns added into the Gantt chart, it not only helps enhance resource management but also provides a good reference for budgeting. It presents a clear and comprehensive picture of where and how resources are used, and where costs are going, thereby enabling sound financial control or direction and good project management.

Moreover, from the Gantt Chart figure, we can extract and create a sub-table that lists all activities alongside their respective expected costs. This sub-table (Table 7: Activity Budget Cost Calculation) serves as a focused representation of financial data, isolating each activity's cost for easier analysis and reference. The importance of this sub-table lies in its ability to provide a clear and concise breakdown of individual activity costs, offering valuable insights into the financial structure of the project. By summing up the predicted costs for all activities, the sub-table enables the calculation of the project's total cost. This approach ensures transparency and allows for precise financial forecasting, which is essential for maintaining budgetary control and making informed decisions throughout the project lifecycle.

Table 7: Activity Budget Cost Calculation

Name	Cost
Identify disease data sources	£3320,0
Evaluate data provider reliability	£4100,0
Negotiate data-sharing agreements	£3730,0
Set up collection methods and tools	£4080,0
Integrate external APIs	£4340,0
Automate periodic data pulls	£3950,0
Conduct data quality checks	£3885,0
Handle missing or corrupted data	£4600,0
Develop validation protocols	£3840,0
Create landing page	£4110,0
Develop registration system	£1230,0
Design disease visualization charts	£3850,0
Design Analytics Report	£1520,0
Implement dynamic content	£5060,0
Build responsive layout	£3650,0

Name	Cost
Optimize for cross-browser compatibility	£4200,0
Client-side optimization	£1640,0
Implement UI components	£4470,0
Set up APIs for data interaction	£3750,0
Implement user authentication	£4340,0
Integrate the prediction model	£4680,0
Design database schema	£3550,0
Optimize queries for performance	£3875,0
Implement data backups	£3780,0
Identify and select relevant algorithms	£4310,0
Develop AI APIs	£4130,0
Define features for prediction	£3950,0
Validate AI predictions	£4220,0
Post-deployment model evaluation	£3950,0
Prepare and pre-process training data	£4610,0
Train models using historical data	£4040,0
Test model accuracy with live data	£3755,0
Define disease outbreak thresholds	£3480,0
Trigger real-time alerts	£4570,0
Simulate predictive scenarios	£4400,0
Procure and configure servers	£1550,0
Set up virtual environments	£1410,0
Test cloud scalability	£1620,0
Implement user data encryption	£2310,0
Set up Access Control	£3590,0
Compliance with data privacy regulations	£3740,0
Total cost	**£149185,0**

In the table, we have comprehensively listed all project activities alongside their respective budgeted costs, offering a detailed financial breakdown. Milestones have been intentionally excluded from this list, as they are not classified as activities and do not contribute to the project costs due to their zero-time duration. These milestones serve as reference points rather than cost-incurring tasks, ensuring that the focus remains on activities that directly impact the budget. After summing up the expected costs for each activity, the total project cost has been calculated to be £149,185.0. This figure represents the cumulative expenditure required to complete all planned activities within the project scope. By presenting this data in a structured manner, the table provides an accurate and transparent view of the financial requirements. It also serves as a critical tool for stakeholders to monitor costs, allocate resources effectively, and ensure that the project remains on track financially.

Another approach to calculate the total cost involves using a reverse logic method. Instead of focusing on the budget for individual activities, this method calculates the cost for each resource outlined in the resource plan and then sums them up to determine the total project cost. This approach provides a resource-centric view, emphasizing the financial allocation for each expert and material used throughout the project.

In the following screenshots (Table 8: Resource Budget Cost Calculation) from the software ProjectLibre, a detailed list of the budget for each resource and material is presented. This visual representation makes it easy to see the exact financial allocation for every resource involved in the project. By breaking down the costs in this manner, it becomes simpler to analyse and manage the expenses associated with both human expertise and materials, ensuring accurate financial planning and control.

Table 8: Resource Budget Cost Calculation

	Name	Work	Cost
1	Project Manager	40 hours	£500.00
	Evaluate data provider reliability	*40 hours*	*£500.00*
2	Data Analytics Engineer	93.333 hours	£700.00
	Integrate the prediction mode	*29.333 hours*	*£220.00*
	Set up collection methods and tools	*64 hours*	*£480.00*
3	QA Engineer	208 hours	£1690.00
	Test model accuracy with live data	*56 hours*	*£455.00*
	Post-deployment model evaluation	*80 hours*	*£650.00*
	Conduct data quality checks	*72 hours*	*£585.00*
4	Backend Engineer 1	168 hours	£1890.00
	Identify and select relevant algorithms	*24 hours*	*£270.00*
	Develop registration system	*37.333 hours*	*£420.00*
	Integrate the prediction mode	*58.667 hours*	*£660.00*
	Integrate external APIs	*48 hours*	*£540.00*
5	Backend Engineer 2	146.667 hours	£1650.00
	Automate periodic data pulls	*40 hours*	*£450.00*
	Prepare and pre-process training data	*24 hours*	*£270.00*
	Set up APIs for data interaction	*40 hours*	*£450.00*
	Implement data backups	*42.667 hours*	*£480.00*
6	Frontend Engineer 1	120 hours	£1350.00
	Develop validation protocols	*48 hours*	*£540.00*
	Create landing page	*72 hours*	*£810.00*
7	Frontend Enginer 2	130.667 hours	£1470.00
	Develop registration system	*18.667 hours*	*£210.00*
	Implement dynamic content	*112 hours*	*£1260.00*
8	Frontend Engineer 3	144 hours	£1620.00
	Design Analytics Report	*64 hours*	*£720.00*
	Optimize for cross-browser compatibility	*80 hours*	*£900.00*
9	Management Consultant	48 hours	£480.00
	Negotiate data-sharing agreements	*48 hours*	*£480.00*
10	Cybersecurity Engineer	192 hours	£2160.00
	Trigger real-time alerts	*32 hours*	*£360.00*
	Set up Access Contro	*48 hours*	*£540.00*
	Implement user data encryption	*72 hours*	*£810.00*
	Handle missing or corrupted data	*40 hours*	*£450.00*
11	Adminsitrator	32 hours	£240.00

	Name	Work	Cost
	Implement user authentication	*32 hours*	*£240.00*
12	Database Engineer	109.333 hours	£1025.00
	Design database schema	*48 hours*	*£450.00*
	Optimize queries for performance	*40 hours*	*£375.00*
	Implement data backups	*21.333 hours*	*£200.00*
13	Biogenetics Engineer	80 hours	£800.00
	Identify disease data sources	*32 hours*	*£320.00*
	Define disease outbreak thresholds	*48 hours*	*£480.00*
14	Network Installer	232 hours	£2030.00
	Set up virtual environments	*40 hours*	*£350.00*
	Test cloud scalability	*64 hours*	*£560.00*
	Client-side optimization	*72 hours*	*£630.00*
	Procure and configure servers	*56 hours*	*£490.00*
15	Lawyer	64 hours	£640.00
	Compliance with data privacy regulations	*64 hours*	*£640.00*
16	UI Engineer	168 hours	£1470.00
	Design disease visualization charts	*40 hours*	*£350.00*
	Build responsive layout	*40 hours*	*£350.00*
	Implement UI components	*88 hours*	*£770.00*
17	AI Engineer 1	232 hours	£2610.00
	Simulate predictive scenarios	*80 hours*	*£900.00*
	Prepare and pre-process training data	*48 hours*	*£540.00*
	Identify and select relevant algorithms	*48 hours*	*£540.00*
	Develop AI APIs	*56 hours*	*£630.00*
18	AI Engineer 2	152 hours	£1710.00
	Validate AI predictions	*64 hours*	*£720.00*
	Define features for prediction	*40 hours*	*£450.00*
	Train models using historical data	*48 hours*	*£540.00*
19	Sensor	0 hours	£600.00
	Test model accuracy with live data	*1*	*£200.00*
	Trigger real-time alerts	*1*	*£200.00*
	Post-deployment model evaluation	*1*	*£200.00*
20	Cable	0 hours	£50.00
	Test cloud scalability	*1*	*£10.00*
	Set up virtual environments	*1*	*£10.00*
	Client-side optimization	*1*	*£10.00*
	Procure and configure servers	*1*	*£10.00*
	Trigger real-time alerts	*1*	*£10.00*
21	AI Chatbot	0 hours	£8500.00
	Evaluate data provider reliability	*1*	*£500.00*
	Simulate predictive scenarios	*1*	*£500.00*
	Validate AI predictions	*1*	*£500.00*
	Design Analytics Report *Integrate the prediction model*	*1* *1*	*£500.00* *£500.00*
	Prepare and pre-process training data	*1*	*£500.00*

	Name	Work	Cost
	Define features for prediction	1	£500.00
	Optimize queries for performance	1	£500.00
	Automate periodic data pulls	1	£500.00
	Train models using historical data	1	£500.00
	Implement dynamic content	1	£500.00
	Integrate external APIs	1	£500.00
	Develop AI APIs	1	£500.00
	Identify and select relevant algorithms	1	£500.00
	Set up collection methods and tools	1	£500.00
	Implement UI components	1	£500.00
	Implement user data encryption	1	£500.00
22	Computer Setup	0 hours	£102000.00
	Set up Access Control	1	£3000.00
	Define disease outbreak thresholds	1	£3000.00
	Handle missing or corrupted data	1	£3000.00
	Create landing page	1	£3000.00
	Identify disease data sources	1	£3000.00
	Post-deployment model evaluation	1	£3000.00
	Identify and select relevant algorithms	1	£3000.00
	Integrate the prediction model	1	£3000.00
	Prepare and pre-process training data	1	£3000.00
	Evaluate data provider reliability	1	£3000.00
	Simulate predictive scenarios	1	£3000.00
	Integrate external APIs	1	£3000.00
	Compliance with data privacy regulations	1	£3000.00
	Implement UI components	1	£3000.00
	Train models using historical data	1	£3000.00
	Implement dynamic content	1	£3000.00
	Implement user authentication	1	£3000.00
	Conduct data quality checks	1	£3000.00
	Set up APIs for data interaction	1	£3000.00
	Design disease visualization charts	1	£3000.00
	Optimize queries for performance	1	£3000.00
	Develop validation protocols	1	£3000.00
	Design database schema	1	£3000.00
	Automate periodic data pulls	1	£3000.00
	Negotiate data-sharing agreements	1	£3000.00
	Set up collection methods and tools	1	£3000.00
	Build responsive layout	1	£3000.00
	Implement data backups	1	£3000.00
	Validate AI predictions	1	£3000.00
	Test model accuracy with live data	1	£3000.00
23	Router	0 hours	£250.00
	Set up virtual environments	1	£50.00
	Handle missing or corrupted data	1	£50.00

	Name	Work	Cost
	Set up Access Control	*1*	*£50.00*
	Procure and configure servers	*1*	*£50.00*
	Test cloud scalability	*1*	*£50.00*
24	MS Office	0 hours	£1100.00
	Evaluate data provider reliability	*1*	*£100.00*
	Post-deployment model evaluation	*1*	*£100.00*
	Build responsive layout	*1*	*£100.00*
	Handle missing or corrupted data	*1*	*£100.00*
	Implement user authentication	*1*	*£100.00*
	Set up collection methods and tools	*1*	*£100.00*
	Negotiate data-sharing agreements	*1*	*£100.00*
	Implement data backups	*1*	*£100.00*
	Compliance with data privacy regulations	*1*	*£100.00*
	Design database schema	*1*	*£100.00*
	Test model accuracy with live data	*1*	*£100.00*
25	Transport	0 hours	£150.00
	Negotiate data-sharing agreements	*1*	*£150.00*
26	Design Tool	0 hours	£600.00
	Implement UI components	*1*	*£200.00*
	Design disease visualization charts	*1*	*£200.00*
	Build responsive layout	*1*	*£200.00*
27	Servers	0 hours	£8000.00
	Implement user authentication	*1*	*£1000.00*
	Set up virtual environments	*1*	*£1000.00*
	Procure and configure servers	*1*	*£1000.00*
	Test cloud scalability	*1*	*£1000.00*
	Implement user data encryption	*1*	*£1000.00*
	Client-side optimization	*1*	*£1000.00*
	Handle missing or corrupted data	*1*	*£1000.00*
	Trigger real-time alerts	*1*	*£1000.00*
28	Frontend tool	0 hours	£2400.00
	Implement dynamic content	*1*	*£300.00*
	Create landing page	*1*	*£300.00*
	Design disease visualization charts	*1*	*£300.00*
	Develop validation protocols	*1*	*£300.00*
	Optimize for cross-browser compatibility	*1*	*£300.00*
	Conduct data quality checks	*1*	*£300.00*
	Design Analytics Report	*1*	*£300.00*
	Develop registration system	*1*	*£300.00*
29	Backend tool	0 hours	£1500.00
	Set up APIs for data interaction	*1*	*£300.00*
	Integrate the prediction model	*1*	*£300.00*
	Integrate external APIs *Develop registration system*	*1* *1*	*£300.00* *£300.00*
	Prepare and pre-process training data	*1*	*£300.00*

This table which is automatically build by a software gives detailed resource allocation for each activity. It calculates resource cost for each activity, and gives total cost of each resource. From the table it is clearly seen that most demanding resource is computer setup that can be find in many activities. Looking out the logic where topic is building and development model and app, it is reasonable that this material is the most used one. Each engineer needs this material to make job done and in the good manner. It might look to broad, but it is not, as many software that engineers need for this project are open and free source, that is why proper computer setup, with powerful laptops, proper equipment and connection is crucial for the project. Furthermore, price of this resource is the most expansive, as the market and price for these goods just goes up. Second most demanding resource is also material, and that is AI chatbot. Once again, in modern technology where AI helps workers in every field, there is big importance of proper AI chatbot. Looking in near future, there is chance that AI chatbot takes place of some workers role, that will affect overall project management setup a lot.

Looking at workers positions, frontend, backend and AI engineers have the most job to do. For this project, even, there is needed to have 3 frontend engineers to make project be completed at calculated time. For building application, making interface, store data, frontend and backend engineers are needed the most, but for predicting modelling, once again, AI is needed. This shows that AI for this project, in the future even more, will be in high demand.

Overall, this detailed table filled with all information required gives clean picture how resources will be allocated and how budget is going to be make. It shows, that even though, there might be some huge differences in price between materials, for example, computer setup requires more than £100000, while cables only £50, each resource is from high importance. If one material is missing, or if one worker is not starting activity on time, there is huge problem in project finishing, especially if it is critical path activity. That is why, detailed and good budget table, optimized by software gives all details about resource and budget plan.

To be sure that calculation cost on each activity was done correct, Resource Budget table can be optimized to find cost for each resource and sum to find overall expected cost of resources. The following table (Table 9: Extracted Resource Budget Cost Calculation) extracts all resource cost, both for material and workers. In the end value should match, previously calculated cost on activities, which is £149185,0.

Table 9: Extracted Resource Budget Cost Calculation

Name	Resource Cost
Project Manager	£500,0
Data Analytics Engineer	£700,0
QA Engineer	£1690,0
Backend Engineer 1	£1890,0
Backend Engineer 2	£1650,0
Frontend Engineer 1	£1350,0
Frontend Engineer 2	£1470,0
Frontend Engineer 3	£1620,0
Management Consultant	£480,0
Cybersecurity Engineer	£2160,0
Administrator	£240,0
Database Engineer	£1025,0
Biogenetics Engineer	£800,0
Network Installer	£2030,0

Name	Resource Cost
Lawyer	£640,0
UI Engineer	£1470,0
AI Engineer 1	£2610,0
AI Engineer 2	£1710,0
Sensor	£600,0
Cable	£50,0
AI Chatbot	£8500,0
Computer Setup	£102000,0
Router	£250,0
MS Office	£1100,0
Transport	£150,0
Design Tool	£600,0
Servers	£8000,0
Frontend Tool	£2400,0
Backend Tool	£1500,0
Total cost	**£149185,0**

This subtitle gives extracted information form larger Budget Resource table. Once again, it is confirmed that Computer Setup will take by far the most money, as it represents that primary resource material for this project, which is needed by every team member at any time. Also, good fact, and reason for making table, is prove that overall budget activity cost is equal to overall budget resource cost. This means that expected calculation were performed well, and if implementation of activities would follow expected network diagram and time duration, with clear and expected resource percentage, expectation that cost will be around calculated number.

In conclusion, Budget Plan provides clear image on expected cost for each resource and activity. Following Budget Plan, will make project much easier to implement and finish, as there are not as much worries about financial problems and implementation problems, as there will always be Gantt Chart with resource table provided, so that each worker can be sure if the job doing is good, or if there are some potential issues.

5.3 PROJECT CRASHING (TIME COST TRADE OFFS)

Project crashing or time cost trade offs is one of the most common techniques in project management that helps to reduce the length of the project by increasing resources or by decreasing critical activities time. It requires the determination of the activities that are on the critical path and then an addition of resources like manpower or equipment to lessen the time taken to complete the activities within the network path in addition to the cost that is incurred in the process. Crashing on the other hand is all about reducing the time that will be taken to complete the project while still maintaining the same scope of the project and the quality of the result.

The significance of project crashing is to provide for a situation where there is a need to complete a project in a shorter time or where a project is faced with externalities that make time a sensitive factor. For instance, when the implementation of a project is likely to cost extra time and the opportunity to capture a strategic market window or to meet contractual obligations is likely to be lost, crashing can be useful. As much as it may be expensive to deliver on time, it may be quite justifiable especially when there are repercussions to reputation or to risk of not meeting financial targets.

Talking about this project in particular, Project Crashing is important as for some activities workers might work overtime changing budget structure completely. Next table (Table 10: Resource Plan Table with Overtime Rate) represents updated Resource Table, with extra column, Overtime Rate. This column will play significant role afterwards when making calculation for Crash cost. Also, table will show as baseline for paying workers doing overtime.

Table 10: Resource Plan Table with Overtime Rate

Code	Name	Type	Initials	Max.Units	Standard Rate	Overtime Rate
1	Project Manager	Work	PM	100%	£100.00/day	£115.00/day
2	Data Analytics Engineer	Work	DAE	150%	£60.00/day	£69.00/day
3	QA Engineer	Work	QAE	300%	£65.00/day	£74.75/day
4	Backend Engineer 1	Work	BE1	250%	£90.00/day	£103.50/day
5	Backend Engineer 2	Work	BE2	300%	£90.00/day	£103.50/day
6	Frontend Engineer 1	Work	FE1	200%	£90.00/day	£103.50/day
7	Frontend Engineer 2	Work	FE2	150%	£90.00/day	£103.50/day
8	Frontend Engineer 3	Work	FE3	250%	£90.00/day	£103.50/day
9	Management Consultant	Work	MC	100%	£80.00/day	£92.00/day
10	Cybersecurity Engineer	Work	CE	400%	£90.00/day	£103.50/day
11	Administrator	Work	A	100%	£60.00/day	£69.00/day
12	Database Engineer	Work	DE	250%	£75.00/day	£86.25/day
13	Biogenetics Engineer	Work	BE	200%	£80.00/day	£92.00/day
14	Network Installer	Work	NI	400%	£70.00/day	£80.50/day
15	Lawyer	Work	L	100%	£80.00/day	£92.00/day
16	UI Engineer	Work	T	300%	£70.00/day	£80.50/day
17	AI Engineer 1	Work	AIE1	300%	£90.00/day	£103.50/day
18	AI Engineer 2	Work	AIE2	300%	£90.00/day	£103.50/day
19	Sensor	Material	S		£200.00	
20	Cable	Material	C		£10.00	
21	AI Chatbot	Material	AI		£500.00	
22	Computer Setup	Material	CS		£3000.00	
23	Router	Material	R		£50.00	
24	MS Office	Material	MS		£100.00	
25	Transport	Material	T		£150.00	
26	Design Tool	Material	DT		£200.00	
27	Servers	Material	SR		£1000.00	
28	Frontend Tool	Material	F		£300.00	
29	Backend Tool	Material	B		£300.00	

New table is the same as Resource Table, with only difference implementing Overtime Rate column which will be important for further calculation. Expectation for the project is that there will be cases when workers will work overtime and ensuring that rate is known before project starting for this as well. This will clearly happen in activities which are expected to be done around the same time in calendar, or activities that require larger resources and greater duration time. For purpose of this project, it is measure in days, same as standard rate, meaning worker will do overtime on project, minimum one day and be paid additionally for it.

To calculate Overtime rate formula is used:

$$Overtime\ Rate = Standard\ Rate\ \times 15\%$$

Where:

$Standard\ Rate$ – Rate given by project management team for standard activity work.

$15\% -$ Percentage of increase for Overtime Work.

$Overtime\ Rate$ – Rate for overtime work, calculated from given formula.

Furthermore, the calculation of the actual overtime rate is very crucial so that the Crashed Cost can be determined. Crashed Cost is the cost overrun that is necessary when an activity or a task is compressed in order to shorten its time take. It is arrived at by adding the Normal Cost of the activity with the incremental cost resulting from the overtime rate or any other method adopted to fast forward the work. Moreover, Crash Time is directly related to the Crash Cost. It represents the reduction in the duration of an activity, measured in time units, achieved through the application of additional resources to the schedule. The shorter the crash time, the greater the increase in costs due to the resources required to achieve the expected timeline.

Lastly, after determining both the Crashed Cost and Crash Time, the slope is calculated. The slope represents the cost per unit of time saved and provides a measure of cost-efficiency for reducing the activity's duration. It highlights the trade-off between time and cost, guiding project managers in selecting the most economical activities to crash while minimizing the overall project duration. This ensures that time-saving measures align with the project's budget constraints and objectives. To calculate slope, following formula is used:

$$slope = \frac{Crashed\ Cost - Normal\ Cost}{Original\ Time - Crashed\ Time}$$

Where:

$Original\ Time -$ Duration time calculated within network diagram.

$Normal\ Cost -$ Expected budget cost for an activity.

$Crashed\ Cost -$ Total, more expansive, cost when reducing activity’s duration below normal time.

$Crashed\ Time -$ The shortest duration to complete activity by utilizing more resources and overtime work.

By using this formula slope of project’s activities can be calculated and information on whether from financial point of view, it is reasonable, to speed up the work and finish activity earlier.

Following table (Table 11: Slope Calculation) gives values of all variables and slope for critical path activities. Only critical path activities are included because these directly influence the overall project duration. Non-critical activities have slack time, meaning they can be delayed without affecting the project completion time. Since the primary goal of project crashing is to reduce the total project duration, efforts are focused exclusively on optimizing the critical path activities, where time reduction has the most significant impact.

Table 11: Slope Calculation

Activity ID	Normal Cost	Original Time	Crashed Cost	Crashed Time	Slope(£/day)
1.1.1	£3320,0	4	£3440,0	3	120
1.1.3	£3730,0	6	£4000,0	4	135
1.2.1	£4080,0	8	£4430,0	5	117

Activity ID	Normal Cost	Original Time	Crashed Cost	Crashed Time	Slope(£/day)
2.1.1	£4110,0	9	£4500,0	6	130
2.1.3	£3850,0	5	£4075,0	3	113
2.1.4	£1520,0	8	£1930,0	4	103
2.2.1	£5060,0	14	£6100,0	9	208
2.2.3	£4200,0	10	£4750,0	6	138
2.2.4	£1640,0	9	£1850,0	7	105
2.2.5	£4470,0	11	£4925,0	8	152
2.3.3	£4680,0	11	£5270,0	7	148
3.1.1	£4310,0	9	£4670,0	6	120
3.1.3	£3950,0	5	£4200,0	3	125
3.1.4	£4220,0	8	£4520,0	5	100
3.1.5	£3950,0	10	£4580,0	6	158
3.2.1	£4610,0	9	£5100,0	6	163
3.2.3	£3755,0	7	£4125,0	4	123

This table retrieves data for activities on a critical path diagram. From the numbers looking, it is easily concluded that each crashed cost is greater than normal cost, which is logical as it used more resources and overtime work. Same for crashed time, which has to be lower than original time, as the aim is to make activity finishes faster and greater efficiency. Moreover, slope is directly proportional to cost, meaning greater slope will influence greater cost per day. For example, activity 2.2.1 has the largest slope meaning the most amount of money per day will be need to crash this activity. It is quite logical, as this activity has the biggest normal cost, £5060,0, and also time consuming to finish this activity is decreased for even 5 days, from 14 to 9. Even though time is reduced a lot, it is up to project manager and team to decide whether it is efficient enough for the project to take additional cost. On the other hand, activity with smallest slope is 3.1.4. The value is 100 and it is by more than 50% lower than previous one, 208. Time duration is crashed by 3 days, and whether it is right decision to crash activity, once again depends on the project manager and experts. All team members must agree on which circumstances some of activities should crash like: should slope be lower that average slope, is that activity very important, like beginning of milestone, what are predecessors and successors of activity. In conclusion, the slope table offers a plenty of benefits as well as information and data that helps to make decision whether it is worthwhile to incurred further costs in order to accelerate the critical path activities. The slope table helps the project managers understand that much cost is incurred for certain unit of time to be saved, and therefore they can rank the activities, depending on their cost effectiveness of bringing down the project duration. This leads to efficiency in resource utilization and optimization of time cost balance which is an essential ration in any construction project. Finally, this data is a key enabler of project objectives in terms of time and cost.

Furthermore, after calculating and finding crashed time for critical path activities, if that critical path activity is crashed, time duration will change. What will happen, is that new time duration for each critical path activity will be crashed time. So, our previous network diagram with critical path must be updated as duration for critical path activities will change.

Following network diagram (Figure 10: Network Diagram with Crashed Time) represents new diagram after crashing. Because of this process it might happen that logical path change, especially, if normal time is reduced and crash was big. Also, with larger number of activities, as this project as well, expectation is to see change in critical path.

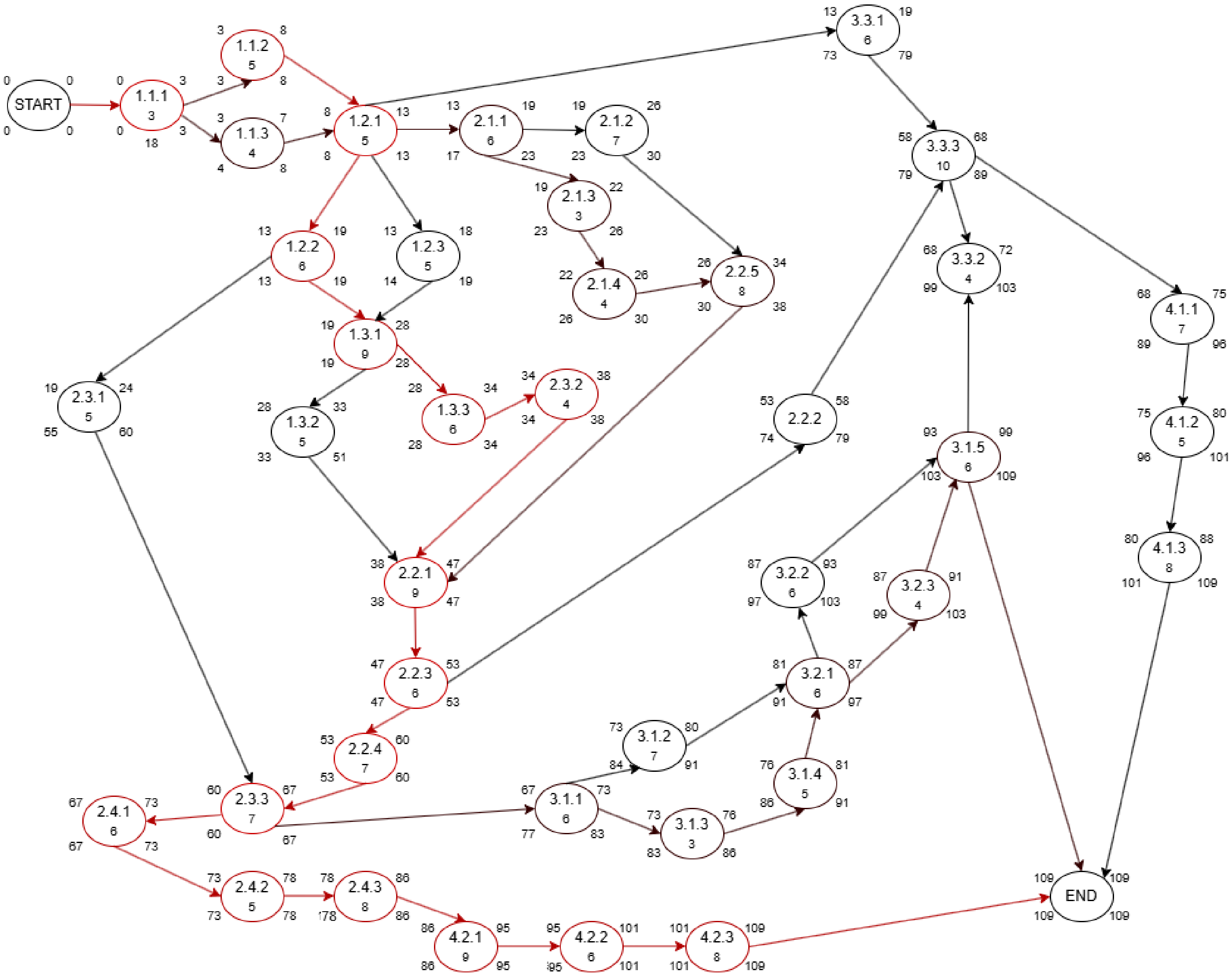


Figure 10: Network Diagram with Crashed Time

This new diagram will stay the same as the previous one regarding the number of nodes, predecessors, arrows, and connections; the only difference that can occur is the change of the critical path. After incorporating the crashed time and recalculating variables such as earliest start, earliest finish, latest start, and latest finish, it turns out there is a new critical path. The reason for this change is rooted in how critical paths are determined based on numerical outcomes.

Examining the network diagram, it is evident that three activities are connected to the end node. In the initial diagram, activity 3.1.5 was part of the critical path. However, it is no longer on the critical path in the revised diagram because of its reduced earliest finish time. Previously, activity 3.1.5 had an earliest finish (EF) of 143 days, which has now been reduced to just 99 days. Consequently, activity 4.2.3 now completes the critical path instead.

Another important node to consider is 2.3.3, which separates two paths, one leading to the left and the other to the right. Initially, the critical path extended to the right, but after the crash, the time durations for most nodes on the left path decreased significantly. On the right side, however, the time durations remained unchanged, with the activities mainly following a sequential order. This led to the largest final EF and determined the new critical path.

Interestingly, six nodes now remain in the new critical path: 1.1.1, 1.2.1, 2.2.1, 2.2.3, 2.2.4, and 2.3.3. For nodes 1.1.1 and 1.2.1, their inclusion is logical, as these are essential for forming the critical path. Node 1.1.1 is the only one connected to the starting point, while node 1.2.1 acts as a root node with four successors, creating four potential critical paths. The remaining four nodes connect two paths containing the highest number of nodes, leading to the greatest potential to form a critical path. Notably, this revised critical path still includes 17 nodes, the same number as in the previous network diagram, providing a consistent structure for comparison.

In conclusion, when the time for the crashed activities was incorporated into the critical path analysis, a new critical path emerged, displaying a more accurate project schedule and updated activity durations. This revised network diagram illustrates the concept of time-cost trade-offs effectively, providing project managers with valuable insights into how project acceleration impacts scheduling. By identifying the new critical path, project managers can focus resources on the most critical activities while considering the associated costs. Furthermore, the diagram underscores the importance of flexibility and precision in project management, ensuring that adjustments made during the project lifecycle led to timely and cost-effective outcomes.

By leveraging such analyses, teams can maintain a proactive approach to managing project constraints, ultimately enhancing overall efficiency and achieving project objectives with greater confidence.

6 RISK MANAGEMENT

Risk represents an uncertain event or condition that can have either positive or negative outcomes, impacting the progress and success of a project. The main role of a project manager and team workers is to control risks, minimizing threats, while maximizing the number of beneficial consequences. Although risks are often perceived as negative, they can also have a positive nature, presenting opportunities for growth and innovation.

Positive risks include following nature:

- Exploit: Taking all benefits of a situation and aiming to get the most of resources and budget situation.
- Enhance: Improving chances of positive risks, like entering to the new market.
- Share: Make collaboration with present and future stakeholders to enhance budget scalability and improve financial outcomes.
- Accept: Recognize opportunities provided by risks and take full advantage of them.

Negative risks include following nature:

- Avoid: Taking proactive steps to reduce and ty to avoid any potential threats in a project.
- Transfer: Targeting to shift risks to external fields, like insurance companies.
- Mitigate: Involving stakeholders that might take portion of risk and invest, so in future targeting project positive risks and profitable points.
- Accept: Address potential risks, and hope it will not have such a big influence to project.

Risk management is crucial for the accomplishment of the goals since it enables the identification of the risks and open paths to mitigate them, guaranteeing the stability of the project. That is why it is necessary to have a development of an in-depth risk management plan, as this allows coming up with a clear structure that will help break risks down and determine ways to approach their further management. Risk should be initialized at the planning stage and stored in a registry, usually in the form of a database to monitor and track the risk at all the stage of project development. The risk management plan should contain the qualitative risk analysis for the likelihood and the impact of risks in order to categorize the risks according to the level of their importance. It should also include the quantitative risk analysis that involves the use of numeracy in order to assess the impact of the risk evaluating the potential outcome. Also, the plan should have provisions for risk monitoring, control and response which are ongoing activities of identifying new and recognized risks as well as developing ways in which these risks can be managed adequately as they occur. This helps to ensure that the project will be more responsive to change and protect the success of the project.

There is one tool that is crucial if one wants to properly evaluate the risks and that is the Risk Breakdown Structure (RBS). RBS is an easily understandable approach that organizes risks into hierarchical tiers providing a systematic view of possible difficulties. It is important to understand the basic characteristics of risks in order to be able to name and classify potential risks that may threaten the project and put stakeholders and shareholders in unpleasant position. The following figure (Figure 11: RBS - Risk Breakdown Structure) highlights the RBS of negative risks where it is crucial to evaluate only the negative occurrences as defined in a project and deal. RBS is of great importance as it gives specific information to the members of the team and stakeholders and the threats which maybe present are known to the team and their consequences. The RBS should be closely followed since it provides a guide on the most suitable types and degrees of mitigation that should be used to improve the project team's overall security and preparedness.

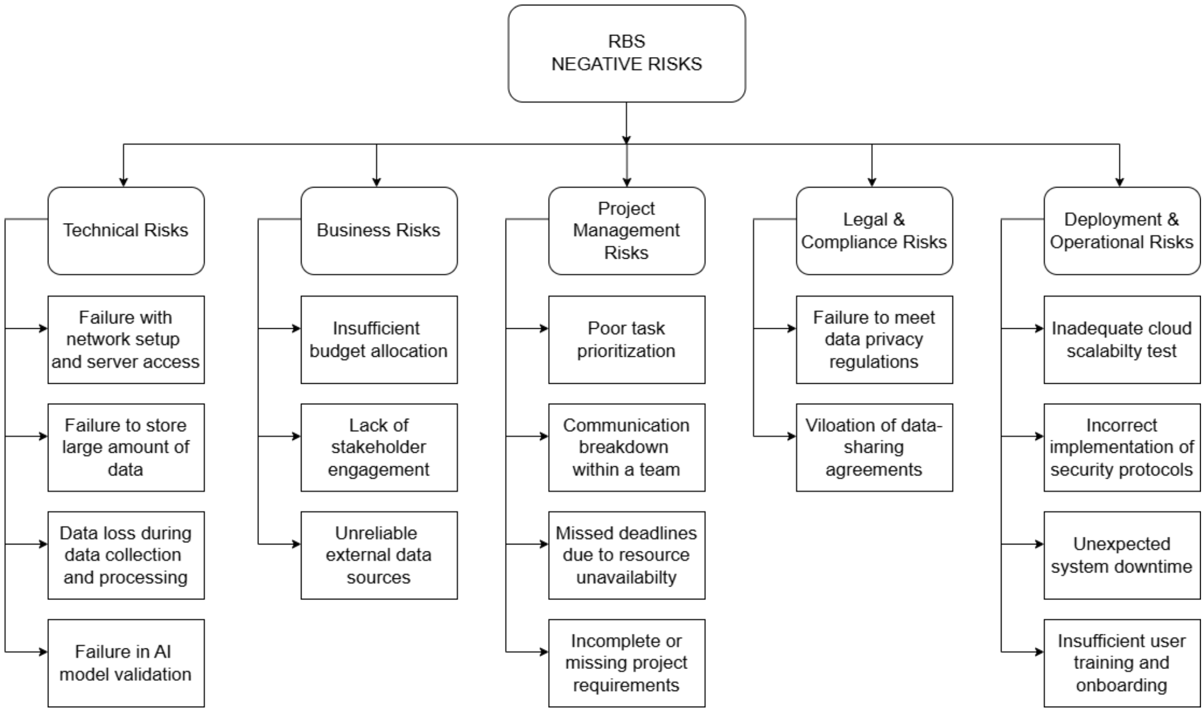


Figure 11: RBS - Risk Breakdown Structure

As it is mention, by implementation and deal done, only negative outcomes should be assessed. There are five main categories in which they are divided, each of which could potentially expose the project to risk at any stage of the project. These categories are much more straightforwardly linked to the likelihood of negative consequences and the activities carried out in the frame of the project. These seventeen are classified into said potential negative outcomes of the following categories. From the figure, although it is hard to deduce concrete priorities, it can be guessed that most of the risks are more likely to stem from technical or deployment related sectors. This is reasonable based on the fact that the project entails an establishment and implementation of an application and therefore these areas are most related to the project goals. For instance, technical risk, "Failure with network setup and server access", is attached to the activity "Procure and configure servers", and deployment risk "Inadequate cloud scalability", is attached to the activity "Test cloud scalability". These connections highlight the implication of activities with the risks they create, the rationale of which is the pertinent risks mitigation measures. Moreover, business and project management risks as far as they are not technical in their origins are no less critical because they impact core issues like budget and time. Examples of risks include; "Missed deadlines," "Insufficient budget allocation," or "Poor communication within the team" will have a ripple effect in the project success. These risks justify the need to encourage proper communication, proper planning, and overall proper utilization of resources in the course of the project. Therefore, the figure is useful for evaluating, classifying, and mitigating risk factors if implemented in a business. It is a primary reference tool for project teams to explain the source of threats and guide their actions to effectively address risks to complete the defined projects. In conclusion, the figure is a crucial tool for understanding risk origins, prioritizing mitigation strategies, and ensuring aligned efforts to achieve project success.

6.1 RISK LOG

Risk Log is an essential approach that must be used in order to document all of the potential risks to a project. It is used as a central reference point that keeps records of risks and the possible consequences, probability and controls for these risks. In risk log, project teams should keep records that show that no critical risk is left unmanaged and what action plan is to be taken. By using risk log, the accountability and communication throughout the stakeholders is provided which is crucial when it comes to project success. In addition, it maintains records of the risks that have been identified and documented in existing projects to support future lessons learned, risk management for new projects.

The risk log can be evaluated in qualitative and quantitative approaches. The assessment of risks centered on likelihood and impact, which are analyzed qualitatively by using methods such as categorization or prioritization. Such an approach enables the determination of which risks are critical and should be addressed as soon as possible and the making of relevant decisions. Quantitative analysis on the hand uses numbers and statistical means to assess risks. This approach gives minute information relating to the possible benefits or forfeiture at risk and also the time required to handle such risks hence leads to efficient utilization of resources and planning on how to respond for such risks in advance. This ensures that risks and its potential impact on the project are understood fully, due to integration of both methods.

The following table (Table 12: Risk Log Plan) is a quantitative part of risk plan. It does not give specific figures about each risk outcome; however, it gives information on the status, response plan, and action type of each risk outcome. These details help build up a set of derived measures that create practical set-up for project teams to monitor the distribution and categorization of risks. For example, the Status column allows the team to quickly know how many risks are recorded as planned, in order to gain an overview of the situation. Likewise, the Action Type can be used in order to examine how many risks should be transferred. This data is useful in making sense of the general risk profile.

Table 12: Risk Log Plan

Risk Name	Risk ID	Status	Response Plan	Action Type
Failure with network setup and network access	R1.1	Active	Professional company for network infrastructure setup	Transfer
Failure to store large amount of data	R1.2	Planned	Perform regular data storage tests	Mitigate
Data loss during data collection and processing	R1.3	Monitoring	Introduce automated data backup systems	Mitigate
Failure in AI model validation	R1.4	Monitoring	Validate AI models using test environments	Mitigate
Insufficient budget allocation	R2.1	Active	Reevaluate budget allocation periodically	Avoid
Lack of stakeholder engagement	R2.2	Planned	Schedule stakeholder feedback sessions	Avoid

Risk Name	Risk ID	Status	Response Plan	Action Type
Unreliable external data sources	R2.3	Monitoring	Diversify data sources for improved reliability	Mitigate
Poor task prioritization	R3.1	Unlikely	Regularly update and communicate task priorities	Accept
Communication breakdown within a team	R3.2	Monitoring	Weekly team syncs and conflict resolution plans	Avoid
Missed deadlines due to resource unavailability	R3.3	Planned	Optimize resource management and allocation	Avoid
Incomplete or missing project requirements	R3.4	Monitoring	Conduct thorough requirement reviews	Mitigate
Failure to meet data privacy regulations	R4.1	Planned	Implement periodic privacy compliance audits	Mitigate
Violation of data sharing agreements	R4.2	Unlikely	Introduce legal checks for all data agreements	Accept
Inadequate cloud scalability test	R5.1	Unlikely	Conduct frequent scalability stress tests	Accept
Incorrect implementation of security protocols	R5.2	Monitoring	Perform routine security checks and audits	Mitigate
Unexpected system downtime	R5.3	Planned	Insurance company will be included	Transfer
Insufficient user training and onboarding	R5.4	Monitoring	Improve user training modules	Mitigate

As it can be also identified from the table, all outcomes of the Risk Breakdown Structure (RBS) have Risk ID for their identification and the list is systematically arranged. It helps in making sure that each and every risk possibility is always portrayed and analyzed and nothing is ever accidental as it can be. It means that each risk is given an identification number, with which members of the project team can efficiently monitor the risks during the project life cycle.

The first of them, Status, shows what stage or time period the risk is at. For instance, an Active status means that the risk is already unfolding, and it requires urgent management, while a Planned status means that the risk is expected to materialize at some time in the future. Notably, most risks in the table are under a Monitoring status, which aligns with the early phase of the project. This would imply that the project is in the risk identification phase as the risks are observed and assessed in the fact that there is still uncertainty as to how they will occur.

In addition, the table presents Response Plan where details of what should be done in case of the risk is highlighted. The method of handling the risk is outlined in the Action Type which each response plan is connected to. For example, an Action Type of Transfer is often accompanied by an Active status in which the risk is passed onto a third party such as an insurance company to deal with the risk. On the other hand, Accept is normally linked to risks which are classified as being Unlikely in nature, this is situations where the project manager believes that the risk is not likely to happen, so further action will not be done. Out of all the action types in the table, the most frequently observed one is Mitigate further highlighting that the identified risks are addressed by the stakeholders. Stakeholders are therefore able to transform the threats into positive results or opportunities through sharing and managing of portions of the risk. This approach shows that risk management is a teamwork affair and that it is through the support of various departments that ways of managing risks can be achieved in projects.

In general, the table plays a critical role in assessing the risk profile of the project. It serves as a centralized and comprehensive reference point, enabling project managers and stakeholders to effectively rank risks based on their severity, likelihood, and potential impact. By providing clear differentiation of risks along with their current status, associated response plans, and specific action types, the table becomes an indispensable tool in guiding decision-making processes.

Overall, the table is more than just a record of potential risks—it is a dynamic and essential part of the project’s risk management strategy. It not only aids in the identification and prioritization of risks but also ensures that the appropriate response measures are in place, contributing significantly to the overall success and stability of the project.

Furthermore, the qualitative approach will be implemented by using the Probability-Impact Matrix which is a standard technique in project risk management. The main importance of this method is that it offers a graphical way of presenting risks in terms of probability of occurrence and their impact on the project. The matrix is useful to manage risks in that it allows project teams to identify specific risks that could harm the project and allow prioritization of such risks be done in the right manner. The Probability-Impact Matrix is particularly important because it offers clear and concise information about the criticality of risks, helping decision-makers allocate resources and define response strategies accordingly. It simplifies the complex process of risk evaluation, translating it into an easily understandable format that aids in collaborative planning and execution.

The Probability-Impact Matrix is shown in the next figure (Figure 12: Probability-Impact Matrix). The risk management matrix is a 3 by 3 matrix involving nine fields in which the seventeen perceived risks are located depending on their probability and impact. The vertical axis represents Probability, while the horizontal axis represents Impact, both divided into three levels: Low, Medium, and High. This structured arrangement guarantees each risk to be assessed and allocated into the appropriate position in the matrix. From the matrix, it can then be addressed which risks are priorities, with both, high probability and impact. On the other hand, it can be deduced which risks will not affects project by too much, and these are with both, low probability and impact.

Also, terms like medium-medium, or medium-low, and more, will be analyzed to address and see why each of the risk outcome has particular position in a matrix. Probability-Impact Matrix enables the management to work smart in the allocation of resources, foster effective collaboration within the project teams and consequently, the achievement of project goals. With matrix, team workers can predict what will be probability and impact of particular risk, making it fast transformation and changing work on activity to utilize risk. After that, by following table, future actions can be predicted and also influence on resources, worker and materials can be optimized.

Probability				
	High	R5.2 R5.4	R2.1 R3.3	R1.1 R5.3
	Medium	R5.1	R1.3 R2.2 R3.2	R1.2 R3.4 R4.1
	Low	R4.2	R3.1	R1.4 R2.3
		Low	Medium	High
			Impact	

Figure 12: Probability-Impact Matrix

As it can be observed from the matrix here, all fields have been filled and nine fields are covered with the risks identified. Although the positions of R4.2, R5.1, and R3.1 typically represent risks that are more likely to result in positive outcomes, in this case, they correspond to risks that will not significantly impact the project. These risks have been classified under the accept action type as this implies that the risks are not likely to lead to major problem and therefore can be accepted without further action.

The highest risks are identified as active and falling into the high-high category of the risk matrix, including R1.1 and R5.3. Al these risks as we have seen demand urgent intervention and effective management. The best management strategy is to always transfer such risks in the market to other parties. In relation to this particular project, the third parties would an insurance and a networking infrastructure company, who can better manage these risks.

It further revealed that majority of the identified risks are medium probability with both medium and high impacts. This is reasonable, given the fact that the project environment is characterized by unpredictability; the medium risks may turn into greater threats if not controlled at the right time. It is therefore important to appreciate these risks and learn how to deal with them if the general stability and success of the project is to be achieved.

On a project level, both the workers and the project manager tend to focus on risks like R5.2 and R5.4. These risks are usually of high likelihood and low risk which is normally good. They are seen to be small and less likely to cause many setbacks, hence likely to produce positive outcomes with less impact to the project’s timeframe. In contrast, the potential risks that are associated with R1.4 and R2.3 are rare but have much higher levels of risk severity as compared to the other typical risks associated with any company. These risks are regarded to be less desirable because, in the worst case, they can affect important aspects of the project.

The probability-impact matrix is a very helpful in outlining the risks of the project as a means to manage the uncertainties of the project. It offers an integrated perspective of risk, damages possible and proper actions to be implemented.