Northeastern University
College *of* Engineering

DEVELOPMENT OF A SOLUTION FOR TRACKING LUGGAGE

Tracking Misplaced and Lost Luggage at Airports Using RFID Device

Submitted by - Team 3

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Term - Summer 2 2017
Submitted to - Dr. Tristan Johnson

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Name	Draft 1	Draft 2	Final Draft
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Akshay Patil	• Team Credentials • Purpose and Objectives	• Technical Overview	• Editing and Formatting
Jason Fernandes	• Table of Contents • Proof Reading and Editing • Team Credentials	• Implementation Plan	• Editing, Formatting and Proof Reading
Aditya Kiran	• Introduction • Purpose and Objectives • Team Credentials	• Technical Overview	• Letter of Transmittal
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Table of Contents

Letter of Transmittal

August 24, 2017
Dr. Tristan Johnson
Northeastern Graduate School of Engineering
130 Snell Engineering
360 Huntington Avenue
Boston, MA 02115

Subject: Project proposal for tracking the luggage

Dear Dr. Johnson,

Nowadays with all the advancement in the modes of transportation for humankind, the airplane is fastest and most convenient way to travel across the globe. Aviation operates not only people but the major part of foreign trades including cargo & goods. This exponential increase in air traffic needs to be managed by applications of technology & automation to serve the customer in a fast, safe and reliable way. But in recent times, the overload of traffic, resulting in time & space constraint is leading to the dysfunctionality of the baggage system. The airport baggage system is one of the underrated but very crucial automated processes which deliver luggage to the respective destination of the customer. It is an awful experience when airline misplaces or loses luggage, and it happens to thousands of passengers. Airlines also spend an enormous amount of compensation towards the misplacement & loss of luggage. It directly affects the reputation & economy of airlines. Constant monitoring by automation is the simple and optimum solution to this problem.

This is a funding proposal for the development of a solution for tracking luggage using RFID device. Our system is to implement RF applications for seamless monitoring of valuables to minimize the luggage misplacement & loss. This will enhance the customer experience and fulfill the mission & commitments towards the air travel by centralizing the dynamic data storage system.

The procurement of the proposed budget will be able to produce a system which enhances the luggage security & time management. It ultimately increases the Airline profit by reducing power consumption & seamless operation of luggage process.

Sincerely,
Apoorva Gajendragadkar
Jason Fernandes
Mayur Garudi
Himadri Sardana
Akshay Patil
Shrikesh Mundra
Aditya Kiran

Executive Summary

One of the biggest sources of travel woes for a passenger on a flight is misplaced/lost baggage. The team's mission is to layout the perfect solution to a traveler's nightmare. This team is dedicated to enhancing the traveler's experience by helping him/her access information related to luggage location in real time with live updates at different stages of the journey.

The purpose of this project is to help the airline provide its customers with the best flying experience as promised in the company's mission. We plan on making this a reality by taking the Radio Frequency tag approach that will replace the current automated baggage system. This new system will help monitor the bags carefully resulting in a decrease of misplaced luggage.The project will run on strict guidelines for implementation of procedures, a well-structured financial plan and a sufficient allocation of resources and time. Major phases this project will undergo are the initiation phase where the charter is developed, information is gathered, and a team is formed, the design and development phase, testing phase, implementation phase and the project termination phase. We plan on allotting 90 days to design and develop the new system with meticulous planning and designing keeping in mind a customer's view and 40 days towards testing of the product to ensure a smooth transition to this new system with no glitches. We strive on covering all bases and not leave any room for errors to occur once the new system is in place.

The project will be closely monitored and evaluated regularly to keep in check the progress and ensure successful completion on proposed time without risking the quality of the final product. We have taken into consideration various risk factors and will be prepared to act accordingly.

We propose a timeframe of 26.4 weeks to complete the project on a budget of $608,268 including the cost of labor, equipment, travel expenses for executives, office stationery and other miscellaneous costs.

This project has great value and will be of great importance in enriching customer experience with the airline by making the passenger's journey hassle-free and will also benefit the airline in cutting costs that they spend on luggage revival and transportation of lost and found luggage. Using the approach proposed in this project, the team aims to provide a whole new level of customer service resulting in the best flying experience for a passenger.

1.0 Introduction

1.1 Problem

The number of lost and mishandled luggage in airports is tremendously increasing nowadays [1] and thus raising its associated costs including:

- Compensation for loss of baggage
- Insurance claims
- Transportation of lost and found luggage.

Airlines are compensating passengers [2] for "provable loss" resulting from delayed, lost or damaged baggage up to $3,300 per passenger for domestic flights and up to $1,742 for international flights. There are several devices in the market that provide a solution to this problem, but all have some problems such as power consumption, location, portability, etc.

Our current proposal provides a novel idea (constant monitoring) to track the luggage in real time with the help of a radio frequency tag reader, novel corresponding to the groundbreaking technique of using radio frequency instead of optical card readers. Using wireless communication techniques, the proposed system has been designed to efficiently track bags and have them delivered to the right location on time. Power consumption is one of the main features in the luggage tracking system. Hence, we propose low frequency and high bandwidth radio frequency sensors which are highly energy efficient. The proposed system increases the monitoring detail when compared to current monitoring systems because it allows the individual tracking of luggage.

1.2 Approach

To create a solution that will reduce the number of baggage losses, we propose a Radio Frequency tag approach that will replace the present automated baggage system. The radio frequency tag will help monitor the bags closely resulting in a decrease of misplaced luggage.

1.3 Product Features and Advantages

The product will be a tiny device along that will be installed in the suitcase/handbags, and it will then be able to get tracked from a suitable reader, and then the passenger can use the user interface to check the status of his/her baggage. All the data that is received from the device will be stored in a database. It has numerous advantages that include live tracking that can be obtained from the readers and uploaded to a big database that is handled by the airline carrier. The tracking data stored in the database is relayed to an application on the passenger's phone with a live tracking status of the luggage.

2.0 Purpose, Goal, & Objectives

2.1 Purpose

A missing bag causes a whole lot of stress when traveling, especially for important business meetings and conferences. Survey results have shown that passengers are willing to pay extra for tracking systems if it means their baggage will arrive at the destination on time. Their money is not worth the stress that comes with waiting at an empty carousel hoping for a bag to show up.

The purpose of this project is to help the airports and airlines overcome this ever-increasing problem of growing baggage loss complaints by a new radio frequency based tags that will be used to track and electronically cross check a bag against a database to make sure that the baggage is in sync with the passengers' itinerary. This would, in turn, help travelers to keep track of their luggage and thereby help the airlines to reduce its costs in paying up to customers for loss of baggage.

2.2 Goal

The project goal is to design and develop a system to track luggage in real time including a RF tag for suitcase/handbags and a big database that collects and interface to monitor and control.

2.3 Objective

The scope of this project includes research on different radio frequency technologies available in the market that will serve the purpose of the project. The key deliverables that the object of this project revolves around are:

- Design the system
    - Determine the best technology that can be used to develop the RF based tag readers.
    - Design the database so that it can cope up with the continuous requests from the RF tags.
    - Create a user-friendly interface so that users can check the status of their luggage.
- Develop the system
    - Integration and testing
    - Acceptance installation and deployment
- Implementation
    - Replace existing optical tag readers with radio frequency based tag readers

3.0 Technical Overview

3.1 Project Flow Chart

Technology Advancement has bought everything at the tip of our finger. With the use of such advancement, we are now able to track our luggage using smart phones. The use of RF tags for the luggage generates innumerous amount of data from thousands of passengers every moment; which makes it mandatory to have a good data storage technology.

The following process chart is a detailed view of RF tag implementation and it monitoring

A. The passenger arrives at the airline counter for boarding.
B. The passenger checks in his/her luggage.
C. Airline tags the luggage with the RF tag and links it with the boarding pass issued to the passenger.
D. The passenger can check the baggage location once it reaches the security check. This is the first checkpoint to monitor the bag status. This information can be accessed using the airline app by scanning the barcode on the boarding pass.
E. The second checkpoint to track the baggage is when the bag is being transferred to the flight.
F. Depending upon the flight halt or layover we can have the third checkpoint as follows.
    i. Luggage transferred to another flight.
    ii. Luggage reaches the destination.
G. The final checkpoint to track the luggage is at the carousel upon arrival at the destination.
H. The passenger claims the baggage.
Z. All the above tracking data is stored on the servers for the passengers to access it with the airline app.

The RF tags on the luggage are scanned at the different checkpoints using the RF scanners installed at these checkpoints.

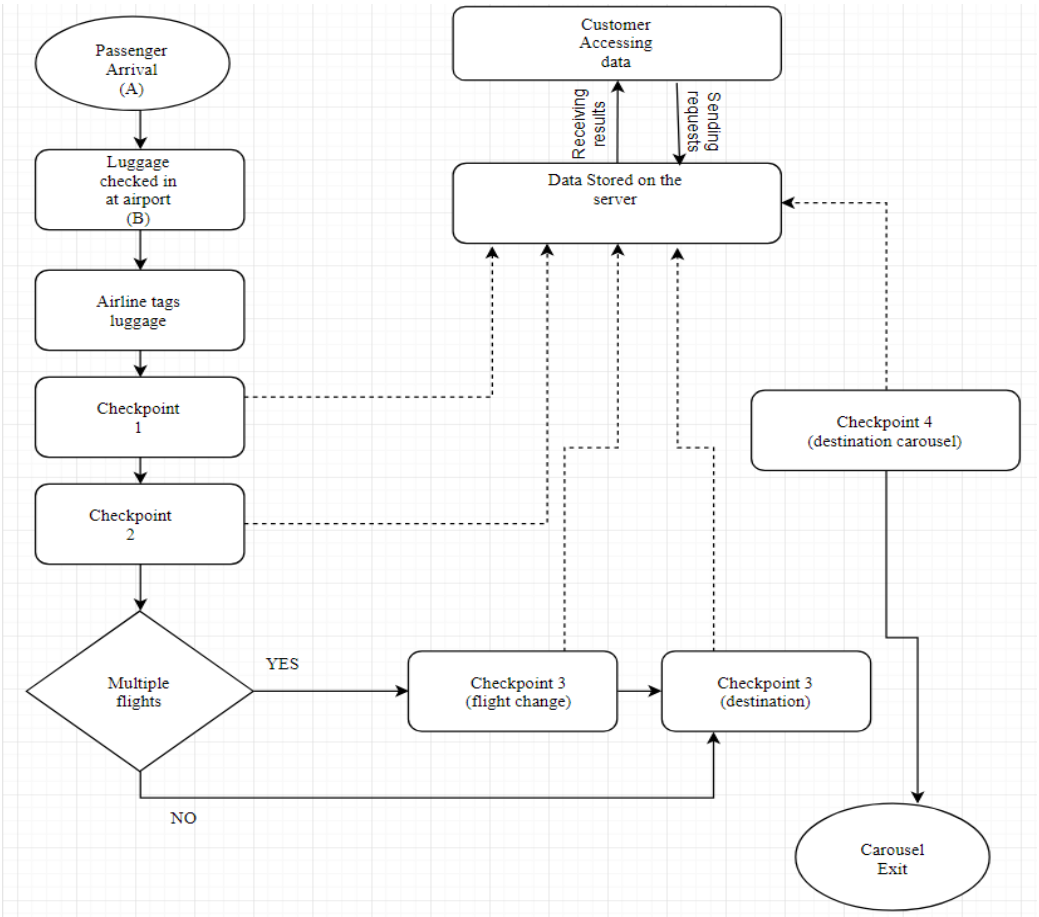

Fig. 3.01 Flow diagram

3.2 Data Storage on Server

A. All the RF data generated upon scanning of RF tags on the baggage is received at the data center of the airline technology department.
B. The data received passes through the load balancer to divide the high velocity of data received at the servers.
C. Next, there are three servers C1, C2, C3 which will create logs of incoming data and all the primary applications of the project will be stored on the servers. The servers will be of Sun Microsystems and Red Hat Linux will be the operating system installed on it.
D. The next step is the actual data storage compartment where the data generated from the RF tag scanning gets stored as MongoDB (NoSQL) database. Related information is stored together for fast query access through the MongoDB query language.[3]
E. The database storage technique also provides a standby database for breakdown conditions.

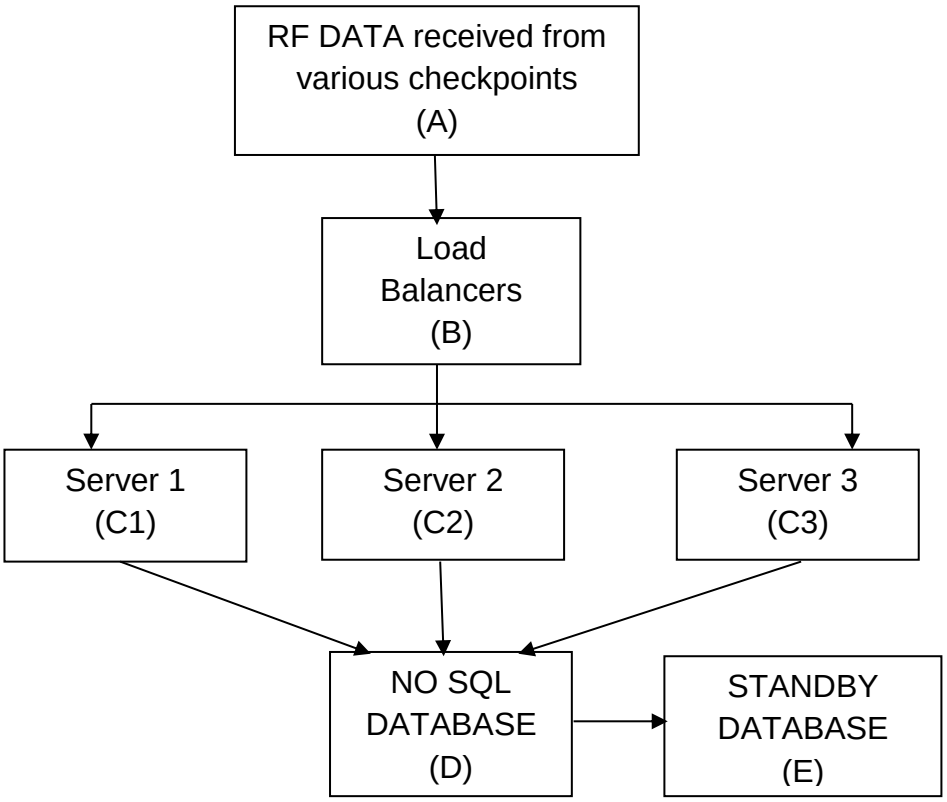

Figure 3.02 Storage of data

4.0 Implementation Plan

4.1 Work Breakdown Structure

A hierarchical approach is the most suitable approach which should be adopted for the project planning. Work Breakdown Structure (WBS) is one of the most important tools which we use for managing the projects. Per PMBOK, WBS is defined as deliverable oriented hierarchical decomposition of the work to be executed by the project team. In WBS, the task is divided into the sub tasks. 2 is the minimum level, whereas 20 is the maximum level for the breakdown of the work. Tracking of the project, managing the schedule and the budget becomes easy due to WBS. In this project, the activities are classified into five different WBS levels. The detailed WBS for the project is presented in Table 4.01.

WBS Code	Phases	Definitions	Duration
1	Initiation Phase	Development of project charter, requirement gathering, project planning, team formation	5 Weeks
2	Design and Development	Design and development of server, database, and application, interfacing, selecting and designing RF tag and scanner	18 Weeks
3	Testing	Software testing, hardware testing, bug fixation, code modification and approval	8 Weeks
4	Implementation	Software implementation and hardware implementation	4 Weeks
5	Project Termination	Final review of documents and preparation of user manual	2 Weeks

Table 4.01. Detailed WBS Structure

4.2 Schedule

The PM and the team face lots of difficulties while coordinating in an organization. The situation is even worse for large and complex projects. Hence, scheduling is important in project management. WBS created in this project consists of 5 initial levels. Initial levels are further divided into multiple sub levels. The detailed schedule for the project is presented in the table 4.02

WBS Code	Task	Start Date	End Date	Duration
1	**Initiation Phase**	**09/04/2017**	**10/06/2017**	**25 days**
1.1	Project Charter	09/04/2017	09/08/2017	5 days
1.1.1	Project Charter Development	09/04/2017	09/06/2017	3 days
1.1.2	Project Charter Approval	09/07/2017	09/08/2017	2 days
1.2	Project Planning	09/11/2017	10/06/2017	20 days
1.2.1	Team Formation	09/11/2017	09/13/2017	3 days
1.2.2	1st Team Meeting	09/14/2017	09/14/2017	1 day
1.2.3	Requirement Gathering	09/15/2017	09/21/2017	5 days
1.2.4	Planning, Analysis, and Development	09/22/2017	10/04/2017	9 days
1.2.5	Approval	10/05/2017	10/06/2017	2 days
2	**Design and Development**	**10/09/2017**	**02/09/2018**	**90 days**
2.1	Development and Design of Server	10/09/2017	10/27/2017	15 days
2.1.1	Researching Server	10/06/2017	10/20/2017	10 days
2.1.2	Selecting Server	10/23/2017	10/25/2017	3 days
2.1.3	Approval	10/26/2017	10/27/2017	2 days
2.2	Application Development	10/30/2017	11/24/2017	20 days
2.2.1	IOS	10/30/2017	11/10/2017	10 days
2.2.2	Android	11/13/2017	11/24/2017	10 days
2.3	Database Development	11/27/2017	12/08/2017	10 days
2.3.1	Selection of a Database	11/27/2017	12/08/2017	10 days
2.4	Hardware Designing	12/11/2017	01/12/2018	25 days
2.4.1	Selection of RF and Scanner	12/11/2017	22/11/2017	10 days
2.4.2	Approval	12/25/2017	12/26/2017	2 days
2.4.3	Designing	12/27/2017	01/12/2018	13 days
2.5	Interface	01/15/2018	02/09/2018	20 days
2.5.1	Software Interface	01/15/2018	01/26/2018	10 days
2.5.1.1	Application with Server	01/15/2018	01/19/2018	5 days
2.5.1.2	Application with Database	01/21/2018	01/26/2018	5 days
2.5.2	Hardware Interface	01/29/2018	02/09/2018	10 days
2.5.2.1	Scanner with DB	01/29/2018	02/02/2018	5 days
2.5.2.2	Scanner with Server	02/05/2018	02/09/2018	5 days
3	**Testing**	**02/12/2018**	**03/30/2018**	**40 days**
3.1	Software Testing	02/12/2018	03/16/2018	30 days
3.1.1	Application Testing	02/12/2018	02/16/2018	5 days
3.1.2	Database Testing	02/19/2018	02/23/2018	5 days
3.1.3	Bug Fixing	02/26/2018	03/14/2018	13 days

3.1.4	Approval	03/15/2018	03/16/2018	2 days
3.2	Hardware Testing	03/19/2018	03/30/2018	10 days
3.2.1	Scanner and Tag	03/19/2018	03/23/2018	5 days
3.2.2	Fixing issues	03/26/2018	03/28/2018	3 days
3.2.3	Approval	03/29/2018	03/30/2018	2 days
4	**Implementation**	**04/02/2018**	**04/27/2018**	**20 days**
4.1	Software Implementation	04/02/2018	04/13/2018	10 days
4.2	Hardware Implementation	04/16/2018	04/27/2018	10 days
5	**Project Termination**	**04/30/2018**	**05/11/2018**	**10 days**
5.1	Review Meeting	04/30/2018	05/04/2018	5 days
5.2	User Manual and Final Documentation	05/07/2018	05/11/2018	5 days

Table 4.02 Schedule Details

The proposed Gantt chart schedule for the project based on the WBS is displayed in the fig 4.03

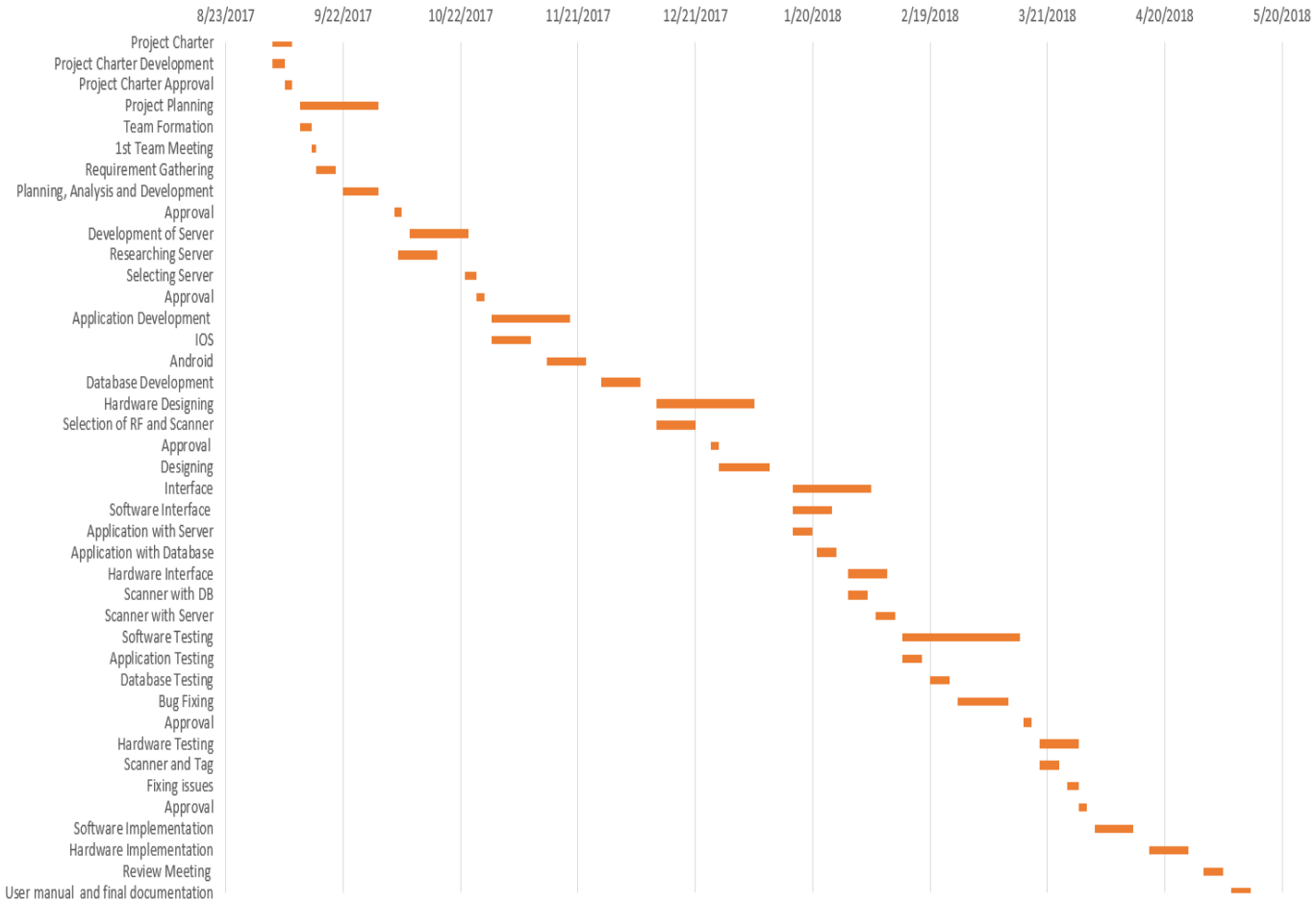

Fig. 4.03 Gantt Chart

4.3 Responsibility Matrix

The purpose of the responsibility matrix is to identify early on which departmental roles or individuals will be assigned to complete certain categories of activities. Next, define the extent of responsibility and the relationships among groups.[5]

The chart, known as a RACIS matrix, takes the work breakdown structure format and specifies the responsible, accountable, consulted and informed parties on each of the tasks.

The following is the RACIS Matrix:

WBS Code	Task Name	Project Manager	PMO	Customer Service Engineer	Sr. Software Developer	Software Engineer	Sr. Software Testing Engineer	Senior Hardware Engineer	Engineer -1	Engineer -2	Software Intern 1	Software Intern 2	Software Intern 3	Engineer Intern 4
1	**Initiation Phase**													
1.1	Project Charter													
1.1.1	Project Charter Development	R,A	R,S		C		C	C						
1.1.2	Project Charter Approval	R,A	S											
1.2	Project Planning													
1.2.1	Team Formation	R	S		C	C	C	C						
1.2.2	1st Team Meeting	R	S	C	C	C	C	C	C	C				
1.2.3	Requirement Gathering	R	S	C	C	C	C	C	C	C				
1.2.4	Planning, Analysis and Development	R,A	R,S	C	C	C	C	C	C	C				
1.2.5	Approval	R,A	S											
2	**Design and Development**													
2.1	Development and Design of Server													
2.1.1	Researching Server	I				R,A		C			S			
2.1.2	Selecting Server	I				R,A		C			S			
2.1.3	Approval	I				R,A								
2.2	Application Development													
2.2.1	IOS	I			R,A	C	C				S	S		
2.2.2	Android	I			R,A	C	C				S	S		
2.3	Database Development													
2.3.1	Selection of a Database	I			C	R,A	C				S	S		
2.4	Hardware Designing													
2.4.1	Selection of RF and Scanner	I						R,A	S					S
2.4.2	Approval	I						R,A						

2.4.3	Designing	I						R,A	C	S				S
2.5	Interface													
2.5.1	Software Interface													
2.5.1.1	Application with Server	I			R,A	R	C	C			S	S		
2.5.1.2	Application with Database	I			R	R,A	C	C			S	S		
2.5.2	Hardware Interface													
2.5.2.1	Scanner with DB	I			C	R	C	R,A	S	S	S	S		S
2.5.2.2	Scanner with Server	I			R	C	C	R,A	S	S	S	S		S
3	**Testing**													
3.1	Software Testing													
3.1.1	Application Testing	I					R,A	C				S	S	
3.1.2	Database Testing	I				R,A		C				S	S	
3.1.3	Bug Fixing	I				R,A		C				S	S	
3.1.4	Approval	I				C	R,A	C				S	S	
3.2	Hardware Testing													
3.2.1	Scanner and Tag	I					C	R,A	C	C	S			S
3.2.2	Fixing issues	I					C	R,A	C	C	S			S
3.2.3	Approval	I					C	R,A			S			S
4	**Implementation**													
4.1	Software Implementation	I			C	R,A	C	C			S	S		
4.2	Hardware Implementation	I			C	C	C	R,A	C	C	S	S		
5	**Project Termination**													
5.1	Review Meeting	C			R	S	S	S	S	S				
5.2	User Manual and Final Documentation	R			C	R	C	C	C	C				

Table 4.04 RACIS Matrix

R	Responsible
A	Accountable
C	Consult
I	Inform
S	Support

4.4 Resource Allocation

The resource allocation table for the project was created using the project schedule and is presented in table 4.05.

Recourse Code	Role	Departments
B-01	Project Manager	Business
B-02	PMO	Business
C-01	Customer Service Engineer	Customer Service
D-01	Sr. Software Developer	Development
D-02	Software Engineer	Development
T-01	Sr. Software Testing Engineer	Testing
H-01	Senior Hardware Engineer	Hardware Implementation
H-02	Engineer -1	Hardware Implementation
H-03	Engineer -2	Hardware Implementation
I-01	Software Intern 1	Development
I-02	Software Intern 2	Development
I-03	Software Intern 3	Testing
I-04	Engineer Intern 4	Hardware Implementation

Table 4.05 Resource Allocation.

4.5 Stakeholder Register

S. No.	Stakeholder Position/ Role	Type of Stake holder	Stakeholder Expectations	Stake holder Interests	Influence on Project Result	Stakeholder management strategies
1	Project Sponsor	Internal	Successful development of a solution for tracking luggage.	High	High	Manage Closely: ● Bi-weekly meeting and status updates of the progress
2	Project Manager	Internal	High interest and expect to achieve milestones within stipulated time and budget	High	High	Manage Closely: ● Collect the requirements as soon as possible ● Bi-weekly team meetings face-to-face for status update ● Control contingency
3	RFID Vendor	External	On- time payments and fulfillment of contract	Medium	Medium	Keep informed: ● Bi-weekly meetings face-to-face ● Provide product's features and unique sales points

4	Finance Department/Other Departments	Internal	Ensure sufficient budget is available to provide to vendors as needed	High	Medium	Keep informed: ● Monthly team meetings ● Approve each expense by the PM and the Finance Department ● Have the financial reports each month
5	Technology Department/Other Departments	Internal	Provide the tracking application with high quality for customers	High	High	Manage Closely: ● Bi-weekly meetings face-to-face ● Provide the sponsors' business requirements ● Provide weekly test reports
6	Testers/Other Departments	Internal	Act as a user to verify the application and provide feedbacks of the product	Medium	High	Manage Closely: ● Bi-weekly meetings face-to-face ● Coordinate with technology department and set up an appointment after each phase is completed
7	End users	External	The product will be efficient and increase convenience for the end users	High	Medium	Manage Closely: ● Feedback collection
8	The Procurement Department	Internal	Select the right vendor for the project to achieve the best outcome	High	High	Manage Closely: ● Provide timely notification of material and service requirements
9	Service Delivery team	Internal	Provide the opportunity for our team to express the value of the product to customers.	High	Medium	Keep informed: ● Weekly group meetings towards the end of the project ● Provide product-specific information ● Schedule ahead for the project's delivery time

10	Customer service department	Internal	Keeping the customers happy and satisfied	High	Medium	Keep informed: ● Provide product-specific information and predefined SOP ● Seek further support by all means
11	Competitors	External	Compete with the company and look forward to earning market shares	High (they want to know about our product)	Medium	Monitor: ● Monitor the competitor's reaction. ● Ensure company information and data remains intact and secure.
12	Airport Authorities	External	The product should comply with the government rules and regulations.	Low	Medium	Keep informed: ● Stay informed with them about the requirements for their works.

4. 6 Communication Matrix

Items/Event (What)	**Target Parties** (Whom)	**Key Message / Content** (Why)	**Medium/Channel** (How)	**Place** (Where)	**Owner** (Who)	**Timing & Frequency** (When)
Internal Kick-off Meeting	Project Manager, Team, and Sponsor	Project introduction Collect the requirements from the sponsors	Face-to-face	At the company	Project Sponsor	Once at the beginning
Contractual Meeting	RFID Vendor, Procurement Department, and Project Manager	Negotiate the contract Sign the contract	Face-to-face	At the company	Project manager	Once, while discussing final terms
Status Meeting	Project Manager/ Finance, Technology and Procurement Department	Progress update Discussions on issues or concerns.	Face-to-face and virtual conference alternative weeks	At the company	Project manager	Bi-weekly
Status Meeting with the vendor	Procurement Department and Vendor	Progress update Discussions on issues or concerns Check whether allotted work is completed or not.	Face-to-face or Virtual conference	At the company	Project manager	Monthly During Execution Phase
Client Meeting	Airlines, Airports and Project Manager	Introduce the company and the new product Set up an appointment for the meeting	Teleconference	At the company	Sales Manager	Bi-weekly twice before execution phase starts.
Change control meeting	Change control board	Ask for approval on any changes Keep the project plan up-to-date on any changes made after approval	Face-to-face with presentation	At the company	Project Manager	A change request is initiated.

5.0 Execution Plan

5.1 Project Monitoring and Controlling

Project Monitoring and Controlling is one of the fundamental aspects of Project Management. Monitoring and controlling will be used throughout the project. For this project, we are planning to monitor and control the following: –

1) Scope – The scope of the project has been finalized already. Based on that we developed the work breakdown structure. The project execution rests upon the sequence presented in the WBS. The main aim is to verify the scope bi-weekly with the WBS and make sure that there is no way for scope creep. If we implement the things which are not in the project scope and WBS, then the chances are that we might need extra budget and schedule to do the things which were not planned initially. We have divided the major phases of the project as *Initiation, Design & Development, Testing, Implementation and Project Closure.*

2) Budget – There are many ways to track the project budget. But we have selected Earned Value Management (EVM) for this project. On the last working day of every month, there will be a project status meeting to know the spending and forecasting. As the budget is already decided for the individual items in the WBS, the actual expenses concerning the planned expenditures will be tracked. EVM is an excellent tool to carry out this. As it will be done every month, there will be a clear picture if there is any huge variation between the planned and actuals. New planning can be immediately done to bring the budget on track. The other advantage is, the budget can be forecasted during completion, whether it will complete within existing budget or would require any extra approvals for the additional budget. *Total budget for this project is $608,268.00*

Budget Checklist

S. No.	Cost Category	Estimated Cost	Actual Cost	% Variance
1	Labour	$396,718.00		
2	Material & Equipment	$161,550.00		
3	Miscellaneous Costs	$50,000.00		
4	Total	$608,268.00		

Table 5.1 Budget Checklist

By developing relevant KPI's, we can monitor the project budget. Some of the KPI's are -
Actual cost (AC) - actual cost of work performed (ACWP), shows how much money has been spent on a project to date.
Cost variance (CV) - whether the estimated project cost is above or below the set baseline.
Earned value (EV) - the budgeted cost of work performed (BCWP), shows the approved budget for performed project activities up to a particular time.
Planned value (PV) - the budgeted cost of work scheduled (BCWS), is the estimated cost for project activities planned/scheduled as of reporting date.
Return on investment (ROI) - a project's profitability and whether the benefits have exceeded the costs.

3) Schedule – The dates are mentioned in the WBS. The WBS is made after decomposing the work to its lowest level. After developing the WBS, the sequence of activities is prepared, the duration and lastly, relationships between the activities is also added. With the help of WBS, the variation in the schedule will be tracked. The same thing will be done in the monthly status meetings.
The project start date is 09/04/2017, and the estimated project end date is 04/27/2018.

Project Phases	**No. of days**
Initiation Phase	25
Design & Development	90
Testing	40
Implementation	20
Project Closure	10
Total (Days)`	**185**

Table 5.2 Schedule Overview

Described below is the Milestone Checklist:

WBS Code	**Task**	**Estimated End Date**	**Actual End Date**
1	Initiation Phase	10/06/2017	
2	Design and Development	02/09/2018	
3	Testing	03/30/2018	
4	Implementation	04/27/2018	
5	Project Termination	05/11/2018	

Table 5.3 Milestone Checklist

The variance in schedule can be monitored by

- Following the start and end dates for each activity in the project
- By tracking the milestones in the project
- By following the critical path

If there is a variation in the project schedule, then the same can be controlled by the following approach

- Every activity will be given a unique code.
- The planned and actual start date and the end date will be noted.
- The interdependent activities will be identified, and the above two steps are repeated.
- All the causes for delays are identified.
- A new plan will be devised, and revised dates will be determined to correct the activities.

Some of the necessary formulas used to monitor cost and schedule are [6] –

Name (Abbreviation)	Formula	Interpretation
Schedule Performance Index (SPI)	SPI = EV/PV	< 1 behind schedule
		= 1 on schedule
		> 1 ahead of schedule
Cost Performance Index (CPI)	CPI = EV/AC	< 1 Over budget
		= 1 On budget
		> 1 Under budget
Schedule Variance (SV)	SV = EV – PV	< 0 Behind schedule
		= 0 On Schedule
		> 0 Ahead of schedule
Cost Variance (CV)	CV = EV – AC	< 0 Over budget
		= 0 On budget
		> 0 Within budget
Estimate at Completion (EAC)	EAC = AC + New ETC	if the original estimate is based on wrong data/assumptions or circumstances have changed
Estimate at Completion (EAC)	EAC = AC + BAC – EV	the variance is caused by a one-time event and is not likely to happen again
Estimate at Completion (EAC)	EAC = BAC/CPI	if the CPI would remain the same until the end of the project, i.e., the original estimation is not accurate
Estimate at Completion (EAC)	EAC = AC + [(BAC - EV)/(CPI*SPI)]	use when the question gives all the values (AC, BAC, EV, CPI, and SPI). Otherwise, this formula is not likely to be used.
To-Complete Performance Index (TCPI)	TCPI = (BAC – EV)/ (BAC – AC)	< 1 Under budget
	TCPI = Remaining Work/Remaining Funds	= 1 On budget
		> 1 Over budget
Estimate to Completion	ETC = EAC –AC	
Variance at Completion	VAC = BAC – EAC	< 0 Over budget
		= 0 On budget
		> 0 Under budget

Table 5.4 Cost and Schedule Monitoring Formulas

EV = Earned Value
PV = Planned Value
AC = Actual Cost
New ETC = New Estimate to Completion
BAC = Budget at completion
CPI = Cost performance index
SPI = Schedule Performance Index

4) Quality – The quality of the project will be monitored and controlled by using the project quality plan described below. For all the major deliverables of the project, the acceptable quality level has been already identified. The quality standards and customer satisfaction criteria are established for the project deliverable. The quality control will be conducted once the deliverable is completed. If there is a significant quality issue, a Plan-Do-Check-Act or Ishikawa diagram to identify and overcome the issues will be used. Some of the major quality checkpoints in the project are *Software testing (30 days) and Hardware testing (10 days).*

Project Quality Plan:

- Measurement of quality will be in terms of % deviation from the obtained results from the tracking of luggage and make sure to meet all requirements in the mentioned scope.
- Assuring to maintain focus on 0% loss of luggage and meeting the criteria as mentioned.
- Development of a reliable and fool proof tracking methodology meeting all customer requirements and at the same time complying and abiding by government regulations through timely test conduction and audit
- Internal audit of processes and materials

Object of Quality review	**Quality Measure**	**Quality Evaluation Methods**
Project Deliverables	In terms of % compliance and correctness with documented framework and WBS	Quality Control Activities and audit
Project Processes	In terms of % compliance with the hardware and software requirements for luggage tracking	1. Quality Assurance Activities and Audit 2. Testing

Table 5.5 Project Quality Plan

5) Risk –The risk register (Table 6.3) has been made, which is having all the risks associated with any activity of the WBS. The same will be monitored. If the chances of the risk turning into the issue, then the already mentioned mitigation steps will be used for reducing the effects of the risks. The risk register will be updated after the completion of every activity. The risks associated with completed activity will be removed from the register.

6) Change Management – The project will have a change management board. The change management board will be consisting of three key individuals. The change management board will evaluate and decide the need for change. All the changes will be monitored, and the change management board will assign an individual to monitor the successful implementation of the modification. The required budget and cut off time will be specified. Once the change is successfully implemented, the individual will report to the change management board and take the sign off. All the changes will be updated in the project documentation.

5.2 Project Auditing

The project audit will be conducted after the project is successfully handed over to the client. The audit will be carried over by the core project team. The project audit can also be conducted by an external agency if one of the conditions mentioned below is realized: -

- Major change in the core project team
- Project manager is no longer a part of the project
- Major variation in the project budget/schedule
- Quality of the project deliverables is not met
- Some of the major risks are converted to issues.

Purpose/ Benefits of project Audit –

- Inform client about project status.
- To verify and Control scope and to avoid scope creep.
- To detect changes in the project plan from actuals.
- To evaluate the performance of the project team.
- To increase cost savings.
- To find ways to improve project performance.
- To find the means to increase stakeholder satisfaction.

5.3 Project Termination

The project will be terminated if: -

- The same kind of product released into the market before us for less price
- The client is no longer having the interest or funding for the project
- The major supplier backed away from the project
- Occurrence of unforeseeable circumstances like a flood, volcanoes, etc.

If the project is terminated, then the following steps will be followed –

- Project Lead / Project Manager will collect the written approval from the client.
- All the project activities and related activities will be stopped immediately.
- The payment vouchers will be collected from the vendors.
- All the due payments will be gathered from the client.
- The entire project related documents and materials will be handed over to the client.
- All the resources will be discharged.
- The project manager will take the final sign off and get released from the duties.

6.0 Risk Assessment Management Plan

According to the book Project Management for Instructional Designers, **t**he purpose of risk management plan is to assign project resources to key risk areas. The key risks are identified, and a plan to manage those risks is created. This ensures a comprehensive understanding of the entire project and each key risk. Risk identification, qualitative and quantitative risks analysis and risk response planning are particularly used to manage risks thoroughly.

6.1 Risk Identification

Risks are categorized into internal, external and technical based on the nature of risk. The following risks were identified for our project.

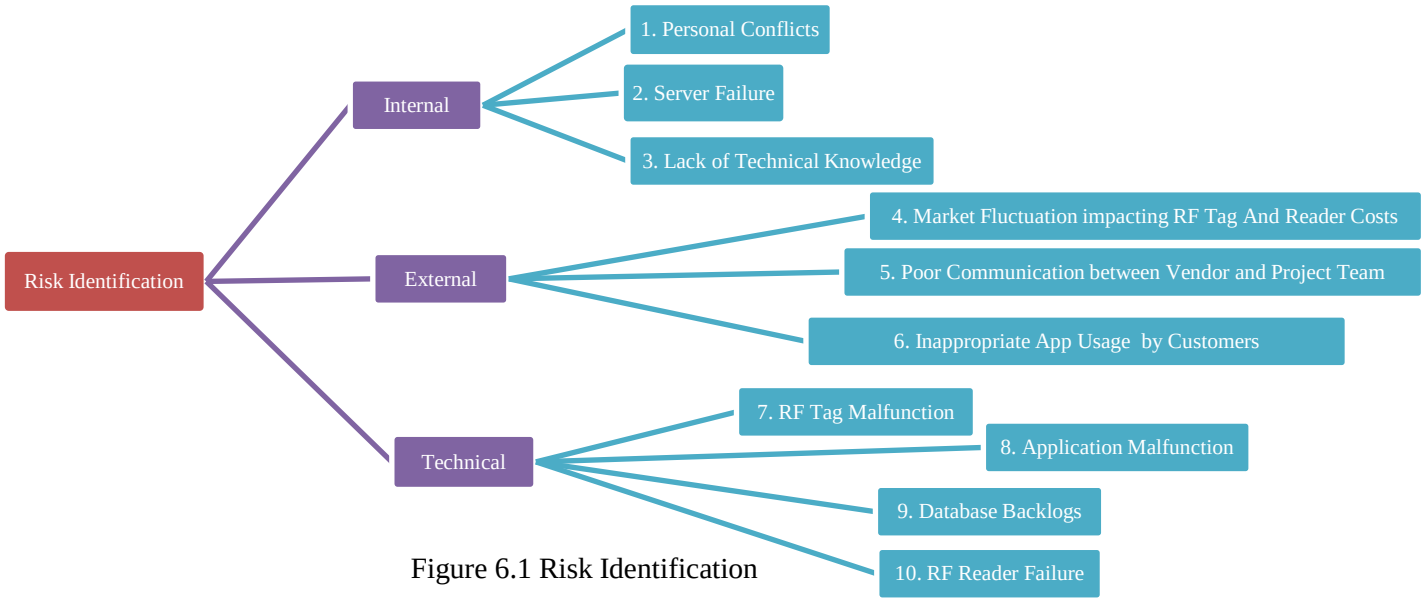

Figure 6.1 Risk Identification

6.2 Qualitative Risk Analysis

Risks identified in section 6.1 are mapped into Risk Matrix according to their probability and impact. Risks are classified as high, medium and low. For this project, we considered the following criteria:

1. High risks: Major financial loss with the frequency of occurrence 1 in 10 times.
2. Medium risks: Moderate financial loss with the frequency of occurrence 1 in 100 times.
3. Low risks: Insignificant financial loss with the frequency of occurrence 1 in 1000 times.

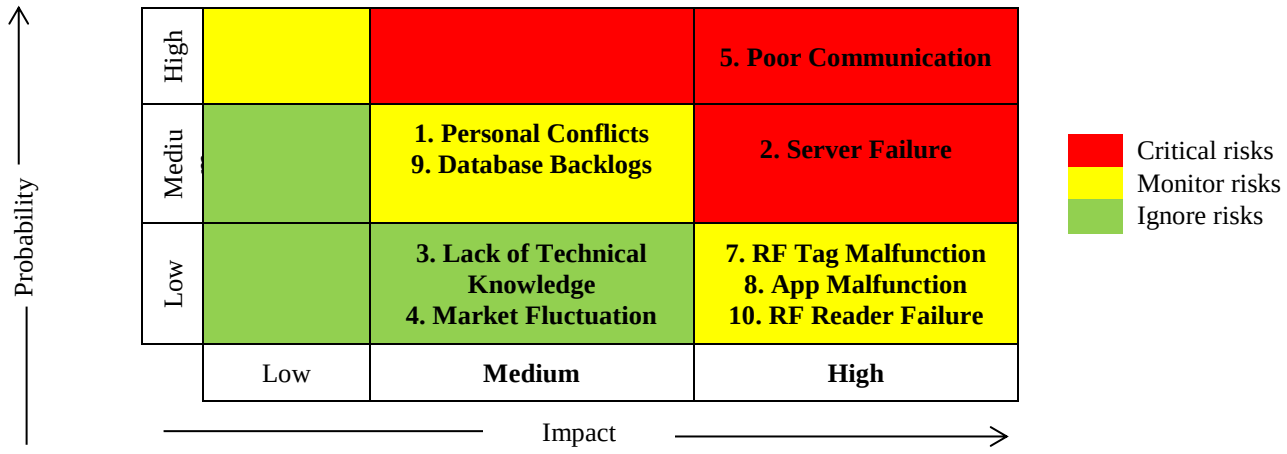

Figure 6.2 Risk Matrix

6.3 Quantitative Risk Analysis

Failure Mode and Effect Analysis (FMEA) is used to quantify criticality and monitor threats.

Risk	Severity, S	Likelihood, L	Ability to Detect, D	RPN
5. Poor communication caused due to improper definition of communication plan resulting in delay in scheduled tasks and activities	8	8	4	256
2. Server failure caused due to issues from server provider resulting in loss of important tracking or development information	8	6	5	240
6. RF tag malfunction caused due to defect in sensor resulting in improper or no tracking of the luggage	7	2	1	14
7. Application malfunction caused by error in code resulting in improper or no tracking of the luggage	7.5	3	2	45
9. RF Reader Failure caused due to defect in hardware resulting in improper or no tracking of the luggage	7	4	1	28
8. Database Backlogs caused due to overloading of data resulting in loss of information	6	7	4	168
1. Personal Conflicts caused by difference of opinions among the team members resulting in deviation from the scope	5	5	4	100

Table 6.3 Risk Register

Where Risk Priority Number (RPN) =S*L*D

Likelihood, L		Severity, S		Ability to detect, D	
Very Unlikely	1	Less severe	1	Very Unlikely	1
Somewhat unlikely	3	Somewhat severe	3	Somewhat unlikely	3
50-50 possibility	5	50-50 severity	5	50-50 possibility	5
Somewhat likely	7	Much severe	7	Somewhat likely	7
Very likely	9	Highly severe	9	Very likely	9

Table 6.3.1 Risk Scale

6.4 Risk Response Planning

The following summarized approaches will guide the project team when facing risk threats.

- **Avoid** – Eliminate the risk by doing what is necessary to prevent the team from encountering the threat in the first place.
- **Transfer** – Remove the project team from a direct threat. If situation renders, this necessary, another vendor may be contracted to work on parts of the project.
- **Mitigate** – Throughout the design process, many threats will arise, and the team will do their best to mitigate them. Thorough research and testing will provide the team with the necessary understanding to reduce the impact.
- **Accept** – For non-critical threats, if no other alternatives are available, or are available at too high a cost, the risk will be accepted.

Risk	**Response**
1. Personal Conflicts	Mitigate
2. Server Failure	Avoid
3. Lack of Technical Knowledge	Accept
4. Market Fluctuation Impacting RF Tag and Reader Costs	Accept
5. Poor Communication between Vendor and Project Team	Avoid
6. RF Tag Malfunction	Transfer
7. Application Malfunction	Transfer
8. Database Backlogs	Mitigate
9. RF Reader Failure	Transfer

Table 6.4 Risk Response Planning Table

7.0 Financial Plan with Budget

The budget of the project depends on the various tasks within the WBS. The budget includes the hardware (servers, RF tags, RF sensors), software (Red Hat Linux OS, MongoDB), IOS and Android phones to test the application. The cost of the entire project will be $608,268.00

We expect a total budget for wages to be $396,718.00 (http://www.payscale.com) and a budget of $161,550.00 for material and equipment.

Below is the project's Budget Summary, refer to Appendix A for the complete budget justification.

Types of cost	
Labour	$396,718.00
Material & Equipment	$161,550.00
Miscellaneous Costs*	$50,000.00
Total Cost	**$608,268.00**

Table 7.1 Budget Summary

Miscellaneous costs include

- Electricity & other utilities
- Administration cost
- Office Supplies/Books & Journals
- Equipment such as printers, copiers
- Travel allowance

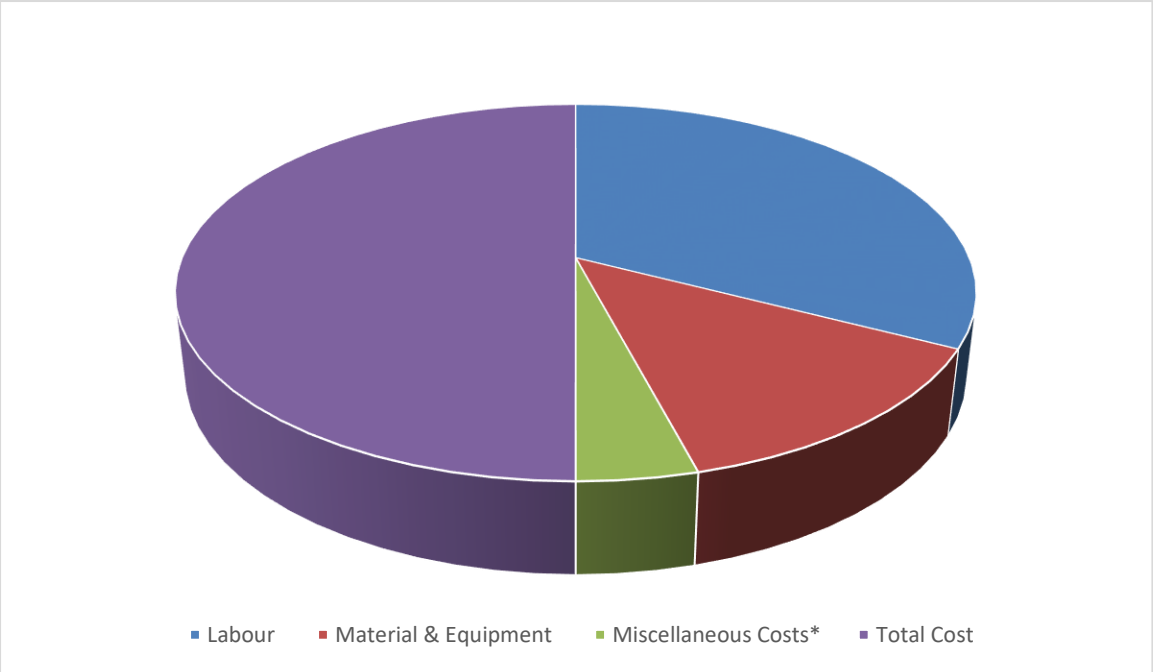

Figure 7.1.1 Budget summary chart

8.0 Team Credentials

Shrikesh Mundra is currently pursuing his Master of Science degree in Industrial Engineering. He is on a Co-op as a Supply Chain Planning Analyst with Johnson & Johnson and has a previous experience of Production Planning in NEI Limited, a bearing manufacturing company in India. He brings to the team his experience of working in a multicultural environment and efficient communication within a sizeable team. His experience of working in the large-scale manufacturing company will help the team in execution phase of the project. Shrikesh will be in charge for all the activities under the execution phase.

Jason Fernandes is currently pursuing his Master of Science degree in Engineering Management. Prior to this, he worked as a Systems Engineer at a major telecommunication firm in India where he helped in troubleshooting both systems and network related issues. He also worked as a software developer after his under graduation as an Electronics and Telecommunications engineer. Jason utilizes his technical qualities in the proposed project and uses his past professional experience in providing the technical solutions. Jason will focus on the building process, i.e., the implementation phase of the project.

Mayur Garudi is currently pursuing his Master of Science degree in Engineering Management. He has developed skills in Statistics, Machine learning, Business Analytics and corporate finance. He has a vast experience in B2B Sales, Marketing, Corporate finance & Project Management. He is skilled at overcoming complex business challenges and making high-stakes decisions using strong work ethic and flawless integrity. Currently, he is pursuing a Co-op as a Marketing Analyst with Systemair where he worked previously for more than two years in India. Along with the marketing, Mayur has an enormous experience in Finance department. Mayur will have a key role in product marketing, financial analysis, and budgeting.

Akshay Patil is currently pursuing his Master of Science degree in Engineering Management with a concentration in Supply Chain Engineering. He worked as a project trainee at BEML, where he gained enormous technical knowledge. Currently, he is pursuing a Co-op at IPC Global Solutions as a Supply Chain Coordinator, where he is in-charge of all technical aspects of the organization. Akshay is an out of box thinker, and his innovative technical ideas are always beneficial to the team. Akshay will be the Technical Lead of the project.

Himadri Sardana is currently pursuing his Master of Science degree in Engineering Management. Currently, she is on her Co-op at Vertex Pharmaceuticals as an Internal Audit-IT Intern, where she has gained problem-solving and risk assessment skills. Her experience as a TA in Reliability analysis and risk assessment course helps the team in dealing with all risk assessment and handling activities. Also, she assists Mayur in the financial department.

Aditya Kiran is currently pursuing his Master of Science degree in Engineering Management with a strong inclination towards data and business analysis. Currently, he is on a Competitive intelligence co-op at Wayfair, working with the competitive intelligence and Algorithms team to improve their matching algorithm. He is striving hard to achieve expertise in Python language. Aditya is responsible for handling the entire database of the project. He will be a Database Administrator for this project.

Apoorva Gajendragadkar is multifaceted Engineering Management graduate at Northeastern University. He has a strong background in electronics and management. He has an experience of working as a System Analyst in India's largest IT based Service company. He was a SPOC (Single Point of Contact) for his team in his organization. His experience as a SPOC helps the team in completing all the tasks before the deadline. Apoorva will be the Project Manager and will ensure that all the project activities will be carried out promptly. He will play a key role in balancing constraints of scope time and budget and creating the best possible equilibrium.

Appendices

Appendix A: Budget Justification Table

Labor Cost

WBS Code	Task	Labour														
		Hours	Project Manager	PMO	Customer Service Engineer	Sr. Software Developer	Software Engineer	Sr. Software Testing Engineer	Senior Hardware Engineer	Engineer -1	Engineer -2	Software Intern 1	Software Intern 2	Software Intern 3	Engineer Intern 4	Estimated Cost
Hourly Wage			$50.00	$30.00	$25.00	$61.96	$40.21	$45	$57.50	$31.70	$31.70	$24.30	$24.30	$24.30	$24.30	
1	**Initiation Phase**															
1.1	Project Charter	40	$2,000.00	$1,200.00	$0.00	$2,478.40	$0.00	$1,800	$2,300.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$9,778.40
1.2	Project Planning	160	$8,000.00	$4,800.00	$4,000.00	$9,913.60	$6,433.60	$7,200.00	$9,200.00	$5,072.00	$5,072.00	$0.00	$0.00	$0.00	$0.00	$59,691.20
															Total Phase Labour Cost	**$69,469.60**
2	**Design and Development**															
2.1	Development and Design of Server	120	$6,000.00	$0.00	$0.00	$0.00	$4,825.20	$0.00	$6,900.00	$0.00	$0.00	$2,916.00	$0.00	$0.00	$0.00	$20,641.20
2.2	Application Development	160	$8,000.00	$0.00	$0.00	$9,913.60	$6,433.60	$7,200.00	$0.00	$0.00	$0.00	$3,888.00	$3,888.00	$0.00	$0.00	$39,323.20
2.3	Database Development	80	$4,000.00	$0.00	$0.00	$4,956.80	$3,216.80	$3,600.00	$0.00	$0.00	$0.00	$1,944.00	$1,944.00	$0.00	$0.00	$19,661.60
2.4	Hardware Designing	200	$10,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$11,500.00	$6,340.00	$6,340.00	$0.00	$0.00	$0.00	$4,860.00	$39,040.00
2.5	Interface															
2.5.1	Software Interface	80	$4,000.00	$0.00	$0.00	$4,956.80	$3,216.80	$3,600	$4,600.00	$0.00	$0.00	$1,944.00	$1,944.00	$0.00	$0.00	$24,261.60
2.5.2	Hardware Interface	80	$4,000.00	$0.00	$0.00	$4,956.80	$3,216.80	$3,600.00	$4,600.00	$2,536.00	$2,536.00	$1,944.00	$1,944.00	$0.00	$1,944.00	$31,277.60
															Total Phase Labour Cost	**$174,205.20**

3	**Testing**															
3.1	Software Testing	240	$12,000.00	$0.00	$0.00	$0.00	$9,650.40	$10,800	$13,800.00	$0.00	$0.00	$0.00	$5,832.00	$5,832.00	$0.00	$57,914.40
3.2	Hardware Testing	80	$4,000.00	$0.00	$0.00	$0.00	$0.00	$3,600	$4,600.00	$0.00	$0.00	$1,944.00	$0.00	$0.00	$1,944.00	$16,088.00
														Total Phase Labour Cost		**$74,002.40**
4	**Implementation**															
4.1	Software Implementation	80	$4,000.00	$0.00	$0.00	$4,956.80	$3,216.80	$3,600	$4,600.00	$0.00	$0.00	$1,944.00	$1,944.00	$0.00	$0.00	$24,261.60
4.2	Hardware Implementation	80	$4,000.00	$0.00	$0.00	$4,956.80	$3,216.80	$3,600.00	$4,600.00	$2,536.00	$2,536.00	$1,944.00	$1,944.00	$0.00	$0.00	$29,333.60
														Total Phase Labour Cost		**$53,595.20**
5	**Project Termination**															
5.1	Review Meeting	40	$2,000.00	$0.00	$0.00	$2,478.40	$1,608.40	$1,800.00	$2,300.00	$1,268.00	$1,268.00	$0.00	$0.00	$0.00	$0.00	$12,722.80
5.2	User manual and final documentation	40	$2,000.00	$0.00	$0.00	$2,478.40	$1,608.40	$1,800.00	$2,300.00	$1,268.00	$1,268.00	$0.00	$0.00	$0.00	$0.00	$12,722.80
														Total Phase Labor Cost		**$25,445.60**
														Total Labour Cost		**$396,718.00**

Material and Equipment Cost

Material & Equipment			
Type	**Quantity**	**Estimated Cost**	**Total Cost**
Computer systems	50	$1,200.00	$60,000.00
Sun micro Systems server-SUN T-4 Spark	3	$4,500.00	$13,500.00
Red Hat IOS- Enterprise application platform	5	$8,000.00	$40,000.00
RF Tags	50	$10.00	$500.00
Mongo DB Database	2	$6,500.00	$13,000.00
RF Scanner -Motorola MC 9190	2	$1,200.00	$2,400.00
Smart Phones- I phone	10	$700.00	$7,000.00
Digital Circuit board	15	$250.00	$3,750.00
Communication System	3	$2,800.00	$8,400.00
Sensor Kit	10	$250.00	$2,500.00
Software testing kit	5	$850.00	$4,250.00
Hardware testing tool kit	5	$1,250.00	$6,250.00
Total Material Cost			**$161,550.00**