Shopping Assistant System

Translation

Navigation

Payment

Searching

Sensor

Recharge

Database

Online Service

Personnel

Inspection

Replace

Repair

Recycle

Team #7
Yufeng Sun
Yuhan Liu
04/29/2019

Motivation

Background - huge international tourism market

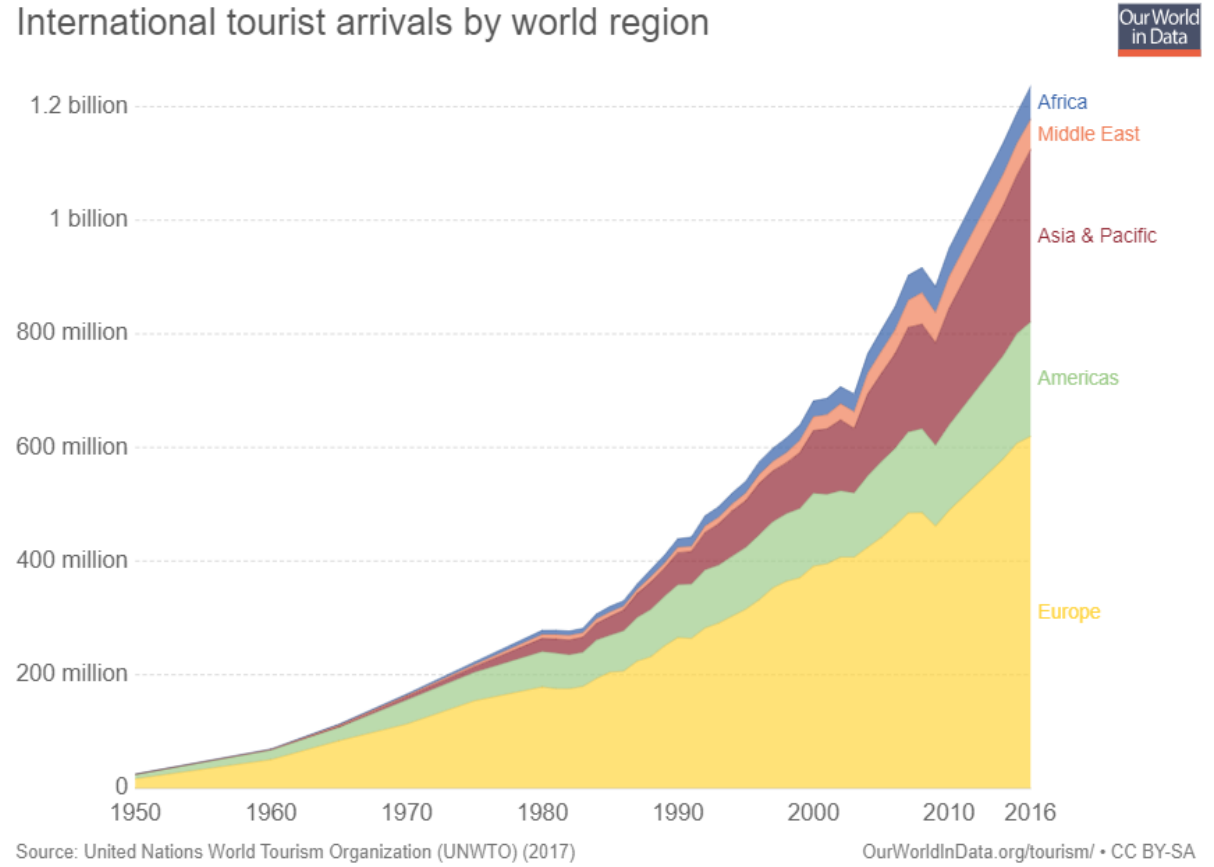
- Billions of international tourist every year
- 6 million overseas tourist in SBM, Shanghai

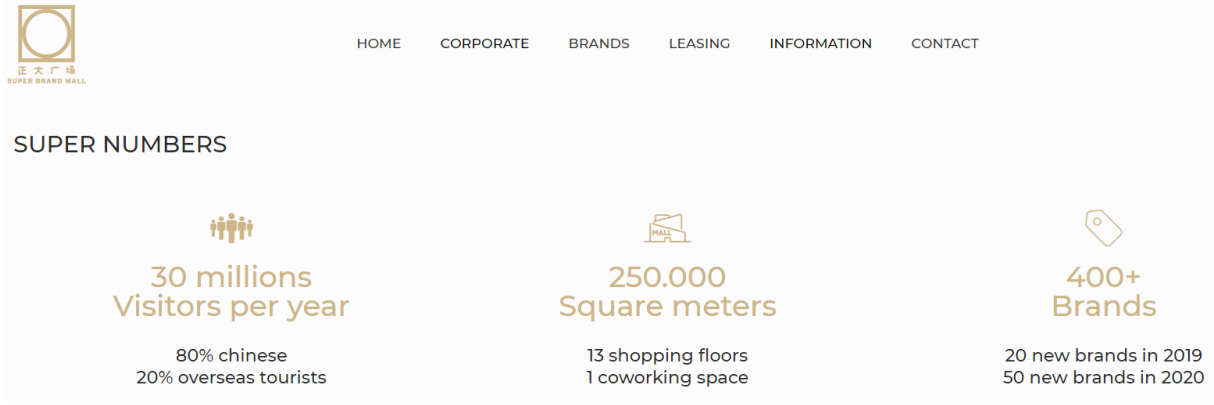
Address customer (international tourist) needs

- Time saving on searching right information
- Energy saving on entire shopping time
- Unique experience in shopping

Potential benefits to society

- Differentiate mall in competition
- Improve city image in global tourism
- Attract more international tourists





Purpose of the system

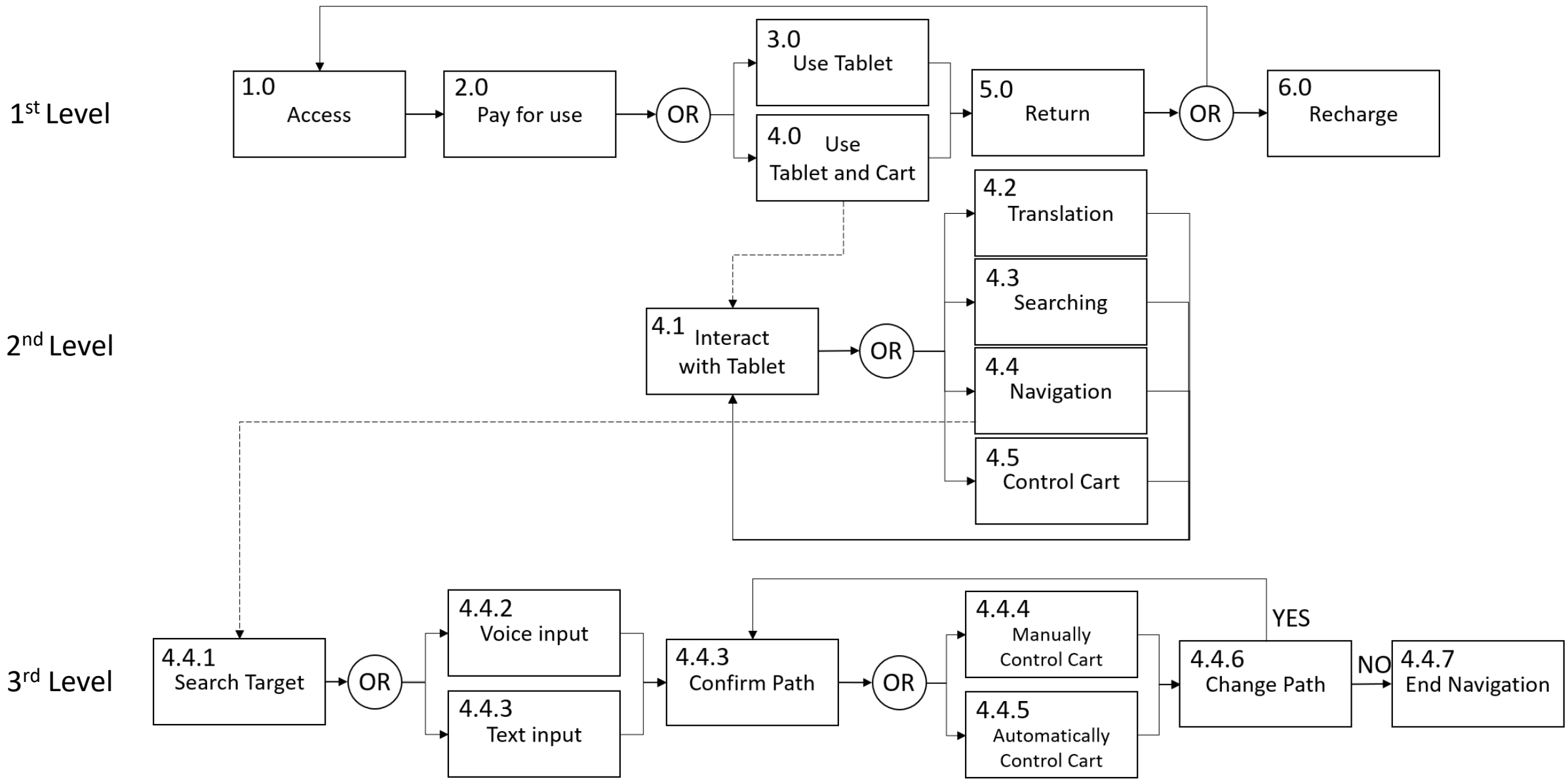
Provide an easy method for international tourists to save their time on searching right information and physical energy during shopping in a big mall like Super Brand Mall, Shanghai, hence to provide them an unique shopping experience.

When you are lost at the big mall and someone ask who you are looking for ?

Requirements Analysis

Customer Requirements		System Requirements		Design Requirements	
CR1	The system shall be easy for international end-users to interacted with.	SR1	The system shall provide language service for interaction and translation.	DR1	The system shall provide interaction with English, Chinese, German, Japanese and Korean.
				DR2	The system shall be able to translate English, German, Japanese and Korean to Chinese and Chinese to English, German, Japanese and Korean.
CR3	The system shall be able to carry shopping bags.	SR6	The system shall provide space to place certain amount weight shopping bags.	DR10	The system payload shall be at least 20 kg.
CR4	The system shall provide capability of searching availability, price and user comments of products and services.	SR7	The system shall provide an application for end-users to search information of products and services in the mall.	DR11	The system shall provide a product/service search application.
				DR12	The system shall provide a searching application that will give a recommendation based on end-users' search criteria.
CR5	The system shall provide capability of navigation.	SR8	The system shall provide an application for navigating end-users to the store or spot where they want to go based on latest facility information.	DR13	The system shall provide an indoor navigation application.
CR6	The system shall be cheap to use.	SR9	The system shall be cost effective.	DR14	The system total cost should not exceed 1000$/per device.
CR7	The system shall be able to be used for single purpose.	SR10	The system shall be able to operated at least 12 hours a day.	DR15	The system shall provide a long-hour battery to support 12 hours operation.
		SR11	The system shall provide detachable parts for different usages.	DR16	The system shall consist of a payload device and a detachable controller.

Functional Analysis



Conceptual Design

To address customer needs for carrying bags, navigation, translation, and information searching, existing technologies and devices were investigated.

Shopping Cart

Navigation

IPS

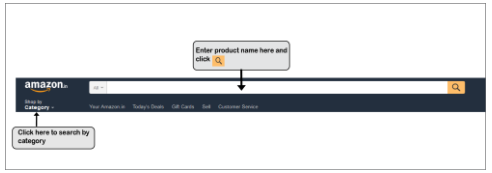
GPS

Translation

5. Translation API

Google Cloud Platform

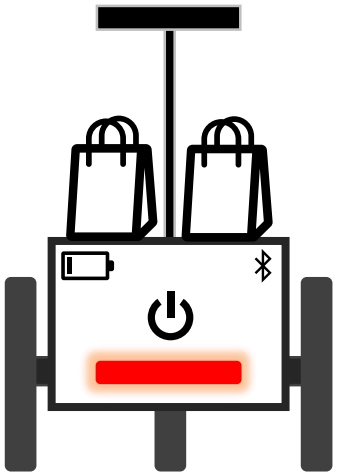
Information Searching



Conceptual Design

Combine all translation, navigation and information searching in one Software App
Develop a light-weight, autonomously moveable cart which fits in mall

Light-weight
Autonomous
Fit in mall



Robotic Cart

+

Tablet / Smart Phone

+

Translation service or
Based on translation API provider

Indoor Positioning System based
On BLE or Wi-Fi

Product Searching
based on specific Mall

Software App

Risk Management Matrix

	Marginal	Critical	Catastrophic
Probable		1	
Infrequent		2,3	
Remote		4	
Improbable		5,6	

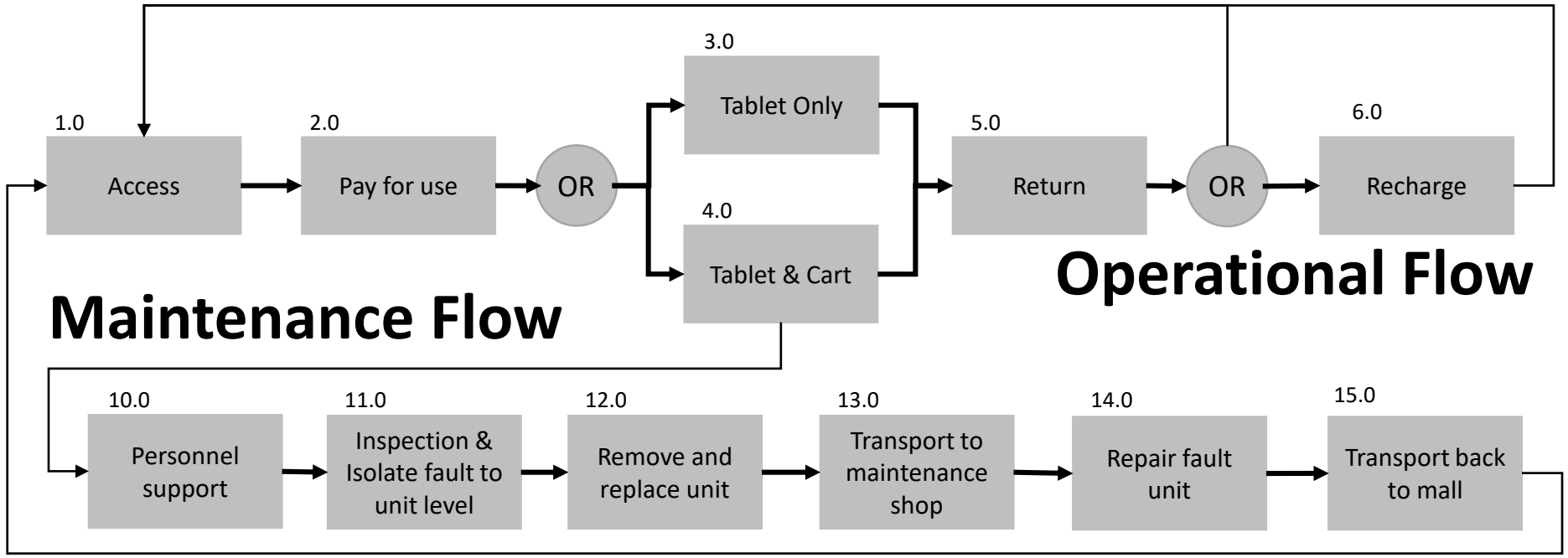
Key Activities

- Robotic cart design, build and test
- Software Application design, develop and test
- Information system design, develop and test
- Recharge system design, build and test
- Payment system design, develop and test
- System integration and test
- Robotic cart manufacturing
- System deployment
- Personnel training

Risk and mitigation plan

Risk #	Description	Severity	Likelihood	Risk Value	Mitigation
1	Software development fall behind schedule	Critical	Probable	8	Include 20% more time in the project timeline to account for the delays
2	Fail to develop translation service	Critical	Infrequent	6	Integrate online translation service for back up plan
3	Fail to develop autonomous move	Critical	Infrequent	6	Include manually control mode of the robotic cart in design
4	Navigation failure	Critical	Remote	4	Include the floor plan in the app
5	Battery dead	Critical	Improbable	2	Include manually control mode of the robotic cart in design
6	Unable to operate the system	Critical	Improbable	2	Design a help button on the cart for asking personnel support

TPM Allocation



Shopping Assistant System

A0 = 12 hours/day
MTBM = 4380 hours
McT = 72 hours
MLH/OH = 0.004

Legend

A0 = Operational availability
MTBM = Mean time between maintenance
McT = Mean corrective maintenance time
MLH/OH = Maintenance labor hours per operational hour
FR = Failure Rate
MRT = Mean Response Time

Equipment
A0 = 12 hours/day
MTBM = 8760 hours
McT = 72 hours
MLH/OH = 0.008

Software App
A0 = 12 hours/day
MTBM = 8760 hours
McT = 12 hours
MLH/OH = 0.001
MRT = 0.5 seconds

Hardware System
A0 = 12 hours/day
MTBM = 8760 hours
McT = 72 hours
MLH/OH = 0.008

Recharge System
A0 = 12 hours/day
MTBM = 4380 hours
McT = 72 hours
MLH/OH = 0.016

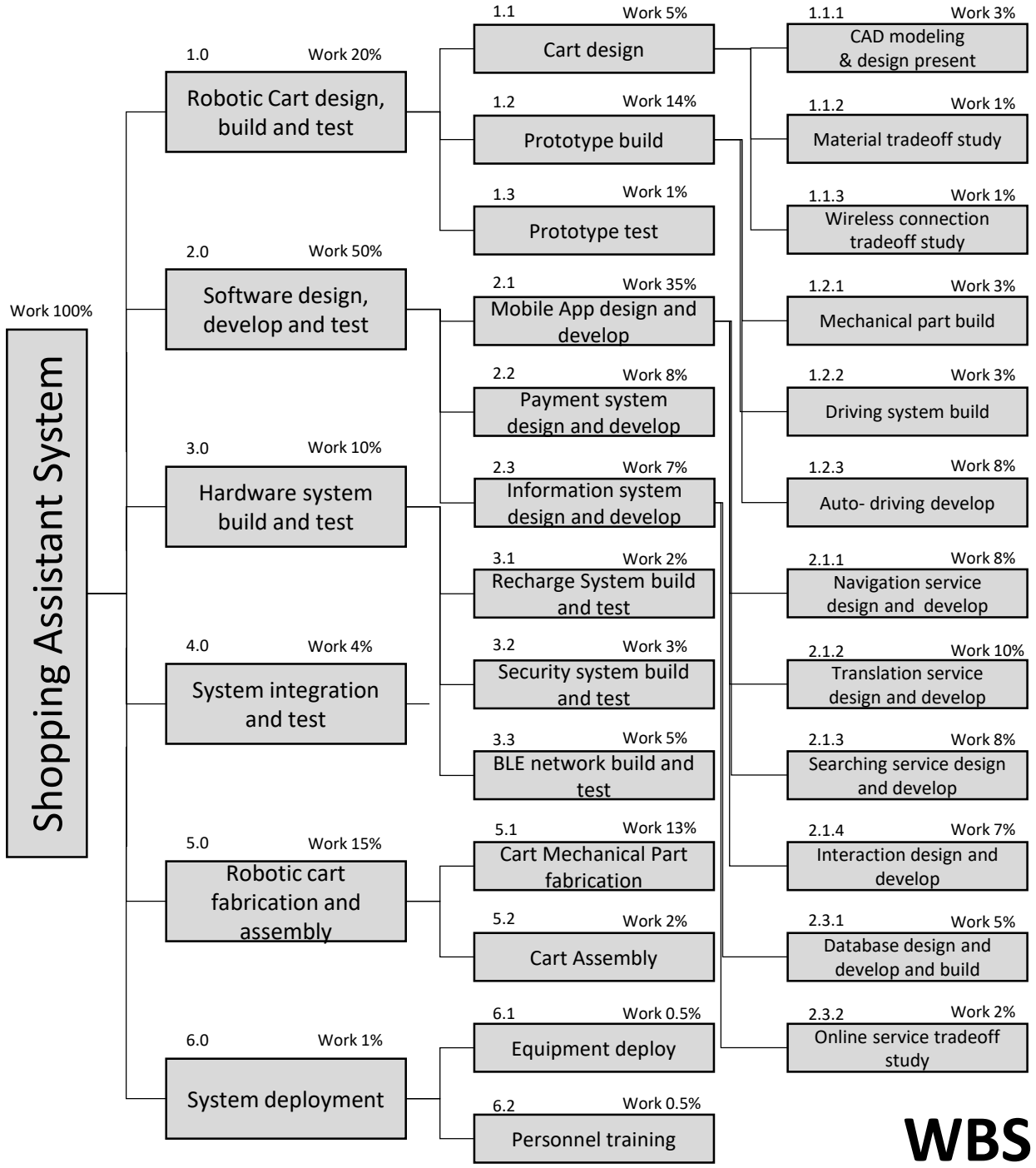
Driving System
McT = 72 hours
MLH/OH = 0.008
FR = 0.0004

Mechanical Structure
McT = 72 hours
MLH/OH = 0.008
FR = 0.0001

Searching
McT = 12 hours
MLH/OH = 0.001
FR = 0.0004
MRT = 0.5 seconds

Translation
McT = 12 hours
MLH/OH = 0.001
FR = 0.0004
MRT = 0.2 seconds

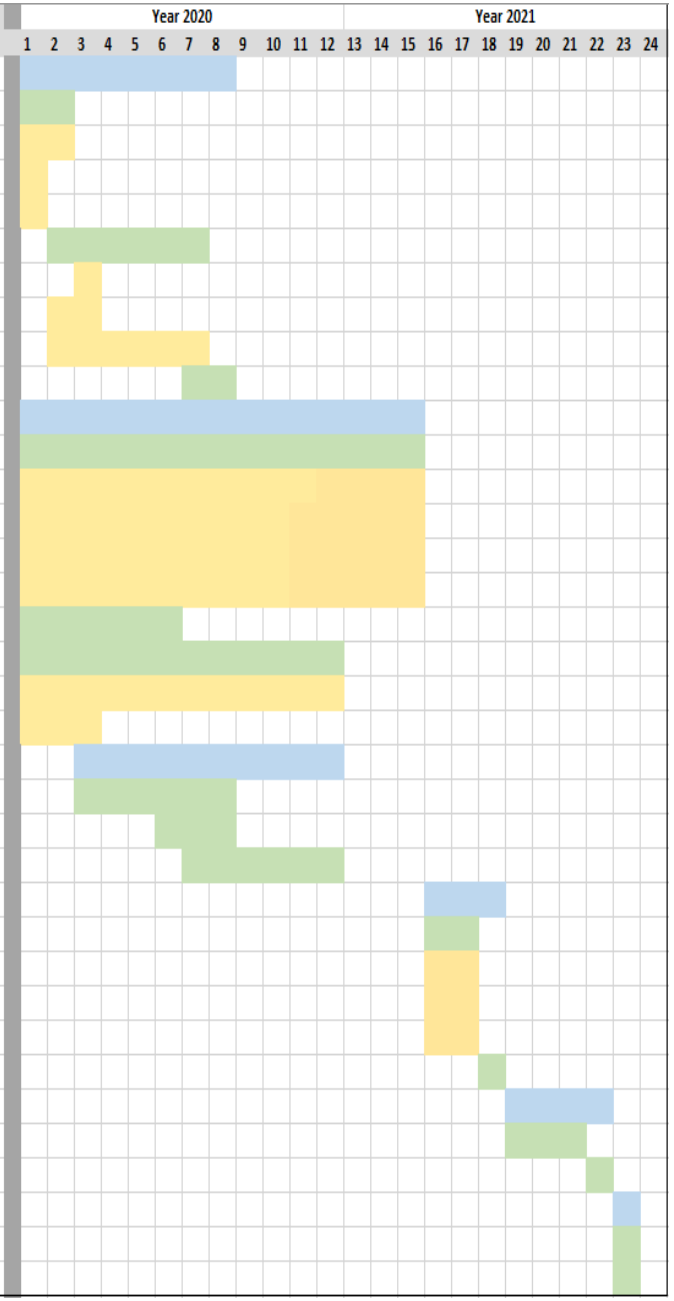
Navigation
McT = 12 hours
MLH/OH = 0.001
FR = 0.0004
MRT = 0.5 seconds



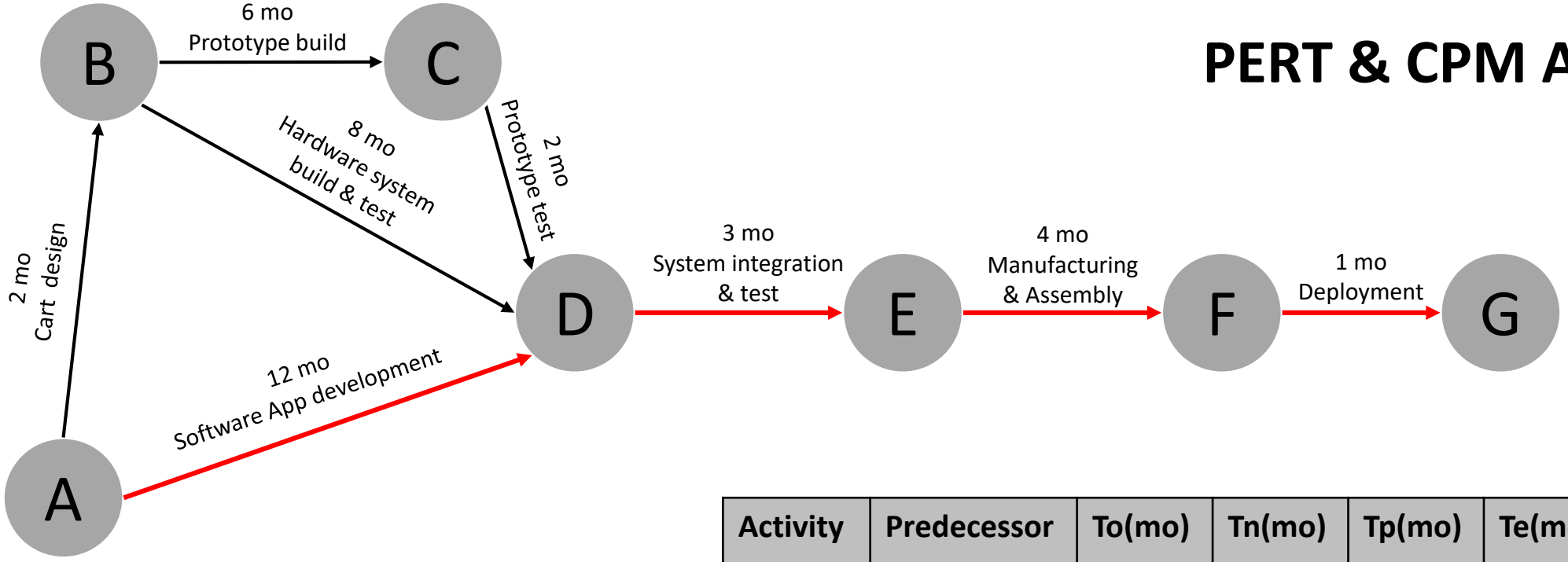
WBS

Gantt Chart

Task Name	START	FINISH
1.0 Robotic cart design, build & test	Jan '20	Aug '20
1.1 Cart design	Jan '20	Feb '20
1.1.1 CAD modeling & design present	Jan '20	Feb '20
1.1.2 Material tradeoff study	Jan '20	Jan '20
1.1.3 Wireless connection tradeoff study	Jan '20	Jan '20
1.2 Prototype build	Feb '20	Jul '20
1.2.1 Machnical part build	Mar '20	Mar '20
1.2.2 Driving system build	Feb '20	Mar '20
1.2.3 Auto-driving develop	Feb '20	Jul '20
1.3 Prototype test	Jul '20	Aug '20
2.0 Software design, develop & test	Jan '20	Mar '21
2.1 Mobile App design & develop	Jan '20	Mar '21
2.1.1 Navigation service design & develop	Jan '20	Mar '21
2.1.2 Translation service design & develop	Jan '20	Mar '21
2.1.3 Searching service design & develop	Jan '20	Mar '21
2.1.4 Interaction Interface design & develop	Jan '20	Mar '21
2.2 Payment system design & develop	Jan '20	Jun '20
2.3 Information system design and develop	Jan '20	Dec '20
2.3.1 Database design, develop and build	Jan '20	Dec '20
2.3.2 Online service tradeoff study	Jan '20	Mar '20
3.0 Hardware system build & test	Mar '20	Dec '20
3.1 Recharge system build & test	Mar '20	Aug '20
3.2 Security system build & test	Jun '20	Aug '20
3.3 BLE network build & test	Jul '20	Dec '20
4.0 System integration & test	Apr '21	Jun '21
4.1 Hardware system integration	Apr '21	Jun '21
4.1.1 BLW network installation	Apr '21	May '21
4.1.2 Security system installation	Apr '21	May '21
4.1.3 Recharge system installation	Apr '21	May '21
4.2 System test	Jun '21	Jun '21
5.0 Robotic Cart fabrication & assembly	Jul '21	Oct '21
5.1 Cart mechanical part fabrication	Jul '21	Sep '21
5.2 Cart assembly	Oct '21	Oct '21
6.0 System Deployment	Nov '21	Nov '21
6.1 Equipment deploy	Nov '21	Nov '21
6.2 Personnel training	Nov '21	Nov '21



PERT & CPM Analysis



Critical Path: A:D:E:F:G

With 20 months project time

Z = (20-20.07)/sqrt(1.78)=-0.05

The probability of meeting the schedule: **48%**

With 20% more time in Software App develop

Z = (22.4-20.07)/ sqrt(1.78)=1.75

The probability of meeting the schedule: **96%**

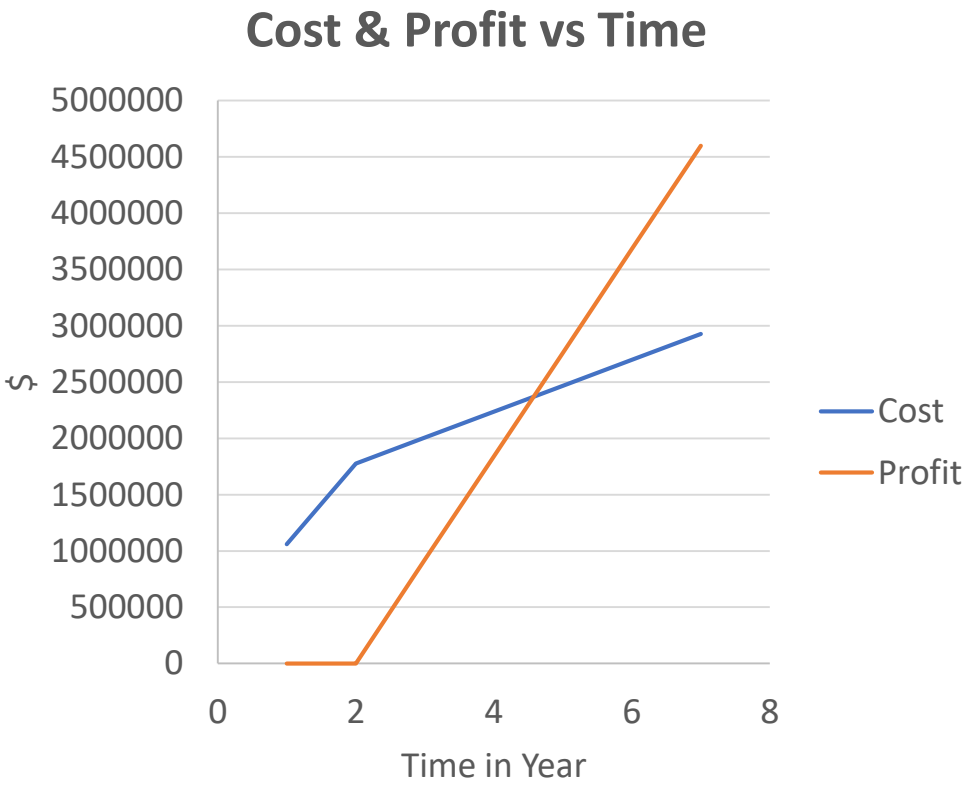
Activity	Predecessor	To(mo)	Tn(mo)	Tp(mo)	Te(mo)	Variance
A						
B	A	1	2	4	2.17	0.25
C	B	4	6	8	6	0.44
D	A,B,C	8	12	15	11.83	1.36
E	D	2	3	4	3	0.11
F	E	3	4	6	4.16	0.25
G	F	0.5	1	2	1.08	0.06

Engineering Economics

Items			Unit Price	Quantity	Cost ($)
Research & Development		Manager	100,690 $/yr	1*1.5 yr	151,035
		Architect	100,690 $/yr	1*1.5 yr	151,035
		Quality Team	100,690 $/yr	2*1.5 yr	302,070
		Robotic Cart Team	100,690 $/yr	2*0.5 yr	100,690
	Software Dev Team	Mobile Application	100,690 $/yr	4*1.5 yr	604,140
		Payment system	100,690 $/yr	1*0.5 yr	50,345
		Information System	100,690 $/yr	1*1 yr	100,690
	Hardware Develop	Recharge system	6,000 $/set	5 sets	30,000
		Security system	10,000 $/set	1 set	10,000
		BLE network	50 $/unit	3000 units	150,000
	Material & Equipment	Cart prototype	2,000 $/unit	1 unit	2,000
		Database & Support	80,000 $/yr	5 yr	400,000
	System Integration & Test	Hardware installation	20,000 $/event	1 event	20,000
		System test	10,000 $/event	2 events	20,000
Manufacturing		Tablet	150 $/unit	100 units	15,000
		Robotic Cart	500 $/unit	150 units	75,000
Operation & Maintenance		Software update	50,000 $/yr	5 yr	250,000
		Personnel training	2,000 $/event	2 events	4,000
		General Maintenance	100,000 $/yr	5 yr	500,000
				Total Cost($)	**2,936,005**

Assumptions:

- Average annual salary: 100,690 $
- SAS rent rate: 2 $ per hour
- 70% usage for each unit



Questions?

References

- https://en.wikipedia.org/wiki/Program_evaluation_and_review_technique
- https://en.wikipedia.org/wiki/Super_Brand_Mall
- https://en.wikipedia.org/wiki/Indoor_positioning_system
- https://senion.com/indoor-positioning-system/
- https://iamili.com/us/

Requirements Analysis

CR2	The system shall be easy to maneuver in the mall.	SR2	The system shall be able to accept voice input and text input.	DR3	The system shall be able to accept text input and recognize voice input and translate voice input to text.
				DR4	The system shall be able to accept credit card payment and mobile payment.
				DR5	The system shall be able to be returned in any appropriate spot in the mall.
		SR3	The system shall be easy to pay for use and easy to return.	DR6	The system shall be able to display remaining time for using.
				DR7	The system shall be able to track the end-user and be able to follow the end-user autonomously.
				DR8	The system shall be able to switch between autonomous control and manually control.
		SR4 SR5	The system shall be able be controlled autonomously and manually. The system shall be lightweight and in appropriate small size.	DR9	The system shall weigh no more than 8 pounds in total and system size shall not exceed 10 inches width, 20 inches length and 30 inches height.

Design Options and Tradeoffs

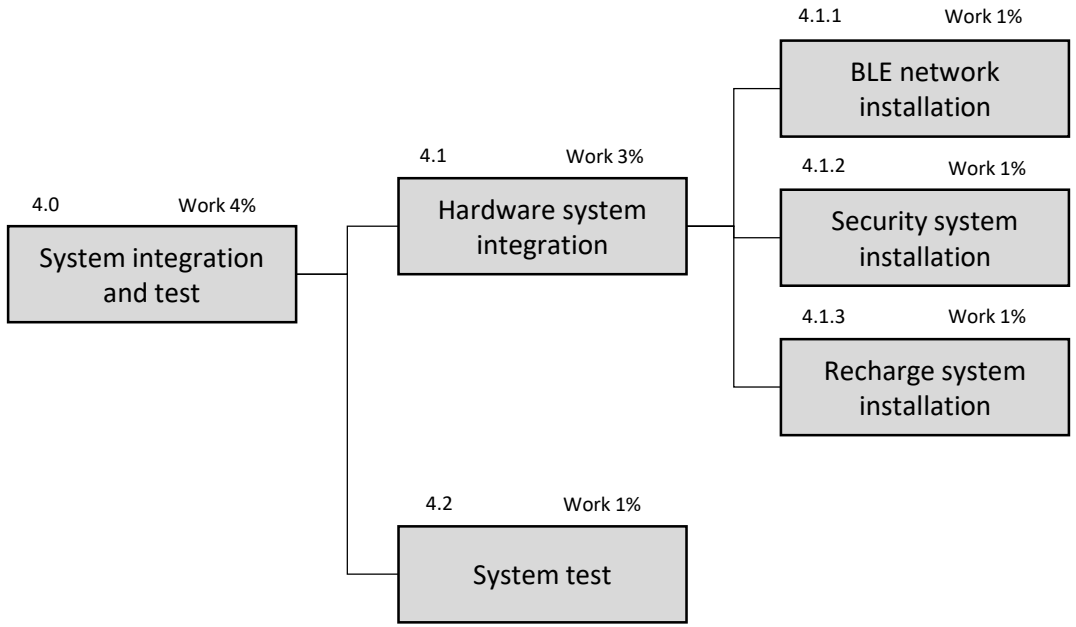
	Shopping Cart	Navigation	Translation	Information Searching
Design Option1	Existing cart: • Existing shopping cart, just take • too big and unwieldy to move • not fashion enough	IPS: (based on Wi-fi or BLE) • We can use Indoor Position System to navigate inside mall	Translation device: • Existing translation device on the market. • Expensive as the price is at least above 120 $ each	Develop searching service like online shopping searching: • Need database • Cost time and money in developing
Design Option2	Design new cart • Cost more time and Money • Specific shape to fit in mall	GPS: • It can not be used indoor as there usually no GPS signal inside the building.	Existing Translation API: • Develop translation based on the existing API • Cost a little time and money in developing • Pay for using the translation based on words count	Specific Brand Searching: • Good to find product of specific brand • Not specific to the product in the mall • Two many brands and no comparison

Design Options and Tradeoffs

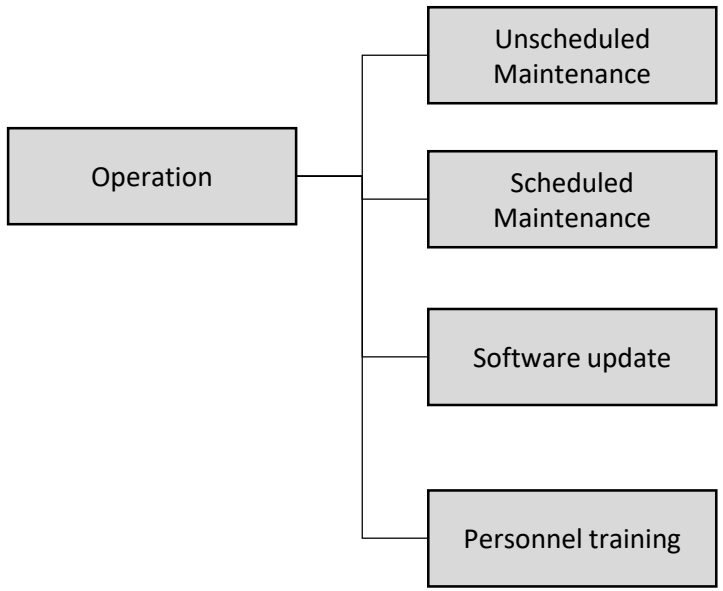
Indoor Positioning System

	Wi-Fi	**Bluetooth Low energy**
Speed	< 1.3 Gps, ideal for bigger files and data	1 Mbps, small data
Accuracy	Use ISM radio band to communication, does not rely solely on the proximity of the user.	Location accuracy ensured by a unique UID number
Transmission Range	160 ft indoor, depending on frequency and power	50 feet ~ 1500 feet
Power Consumption	10 times more than BLE	Lower power consumption, can run single battery for over 2 years
Deployment Costs	Needs router configuration and power source	Less costly, no configuration is required

WBS


4.0
Work 4%
System integration and test
4.1
Work 3%
Hardware system integration
4.2
Work 1%
System test
4.1.1
Work 1%
BLE network installation
4.1.2
Work 1%
Security system installation
4.1.3
Work 1%
Recharge system installation

WBS in operation



Motivation

Challenges

- The software service development is the biggest challenge in this project as it leverage new technologies such as indoor positioning with BLE, translation with voice input, navigation path planning in a multiple floors building and autonomously moving robot.