Project Deliverable G: Prototype II and Customer Feedback

University of Ottawa

GNG1103: Intro to Engineering Design

Group 8 - BOOM

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Abstract

Deliverable G documents the group's production of Prototype II, which is derived from pre-existing user requirements, the group's expected metrics, and user feedback from Client Meeting II and III. This deliverable also outlines the prototype test plan for the following prototype. Throughout the testing phase, the group validated the project's feasibility based on the group's initial designs and received feedback from the client and peers alike. An additional emphasis on budget constraints, time constraints and resource management are placed in this deliverable and will remain a key emphasis for future deliverables to come.

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Introduction

Group 8 has completed a list of deliverables, which focused on interpreting user needs, deriving design requirements from such needs, conceptualizing the requirements into concrete ideas, and planning for prototyping.

Taking feedback from the client in Client Meeting II, the group has adjusted the initial global concept into a more suitable idea for the project, with Deliverable F providing a low fidelity, digital prototype (Prototype I) in each of the four aspects: storyboarding, CAD modelling, Robomaster coding, and laser cutting.

For Prototype II, such digital prototypes are attempted to be produced as physical models. For character and event cards, the group will attempt to cut and engrave on MDF boards; for Robomaster coding, the group will attempt to run the code on the actual Robomaster, and test its functionality along with MDF cards; for props, the group will attempt to produce some parts and test for their fragility.

1.1 Related Work

Six deliverables have been completed prior to Deliverable F, with certain deliverables imperative to the current stage in development, these include:

Deliverable B: This deliverable list user requirements we have collected during the Client Meeting. With further interpretation on the requirements, we also included additional ones to ensure the quality of the final product. Additionally, a problem statement is created to summarize the general requirements.

Deliverable C: This deliverable adds on to Deliverable C by assigning expected metrics to design requirements. The requirements are then ordered in a priority list to generate major focus points of the group's design. Benchmarking is also expanded by evaluating existing products with the group's expected metrics. This allows us to better understand whether it is reasonable to set such standards for the group's final product.

Deliverable D: This deliverable focuses on generating conceptual ideas from existing design requirements and criteria. Such ideas revolve around four major subsystems: storyline, interaction between players, players' interaction with the game, and the implementation of Robomaster S1. Three global concepts are then generated by creating amalgams of the group's respective concepts, and one final concept is subsequently chosen.

Deliverable E: This deliverable focuses on the group's plan for the following weeks and method of executing the project with consideration to budget constraints and time limitations. Risks, contingency plans, and expenses are also included in this deliverable.

Deliverable F: This deliverable documents the steps and results of Prototype I, a digital and low-fidelity representation of the group's conceptual idea.

Appendix I, II, III: Since Deliverable F, the group has received feedback and updates in schedules and budgeting. To keep the most updated information available, such updates are included in appendixes. These appendixes consist of the link to the group Trello board, the updated task schedule, and the bill of materials.

Appendix IV: The fourth appendix consists of a handwritten Fishbone diagram derived from the group's Predictive Failure Modes and Effects (PFME) analysis. This demonstrates the potential aspects of the

production that may lead to critical failure, allowing the group to have a more focused baseline for future prototyping.

Client's Feedback

2.1 Written Recordings of Feedback

In Client Meeting #3, the client and potential customers raised their concerns in the time required for the 3D printing of props. From our research and potential customers experience, the required time would take around 3-4 days. The client also pointed out that the availability of the 3D printers before Design Day would be a deciding factor on whether we would be able to complete production within the time constraints.

2.2 Feedback Analysis & Implementation

Following the client meeting II everything for our team's simulation was approved by the client except for the 3D printing due to the time restraint. After further consultation and discussion among group members, the group has decided to pivot from 3D printing an entire prop to laser cutting parts, subsequently assembling them together. This can ensure our production can be done prior to Design Day.

Prototype II

3.1 Prototyping Objectives

- Create laser cutting documents for props
- Create physical MDF props, Character Cards and Event Cards prototypes, and test for fragility
- Test for Robomaster code functionality and compatibility with Character Cards

3.2 Prototype

3.2.1 Props (Laser Cutting)

Following Client Meeting #3, the group has decided to pivot from 3D printing to laser cutting prop parts. The parts will then be assembled to form box-like buildings. In Prototype II, Inkscape documents are created and put into production.

However, due to time constraints and technical problems, the physical MDF cutting was unsuccessful and cannot be included within Prototype II. This will be moved to Prototype III. Nonetheless, Prototype II demonstrated that the conceptual designs of the props are feasible. The digital document of a prop can be seen below.

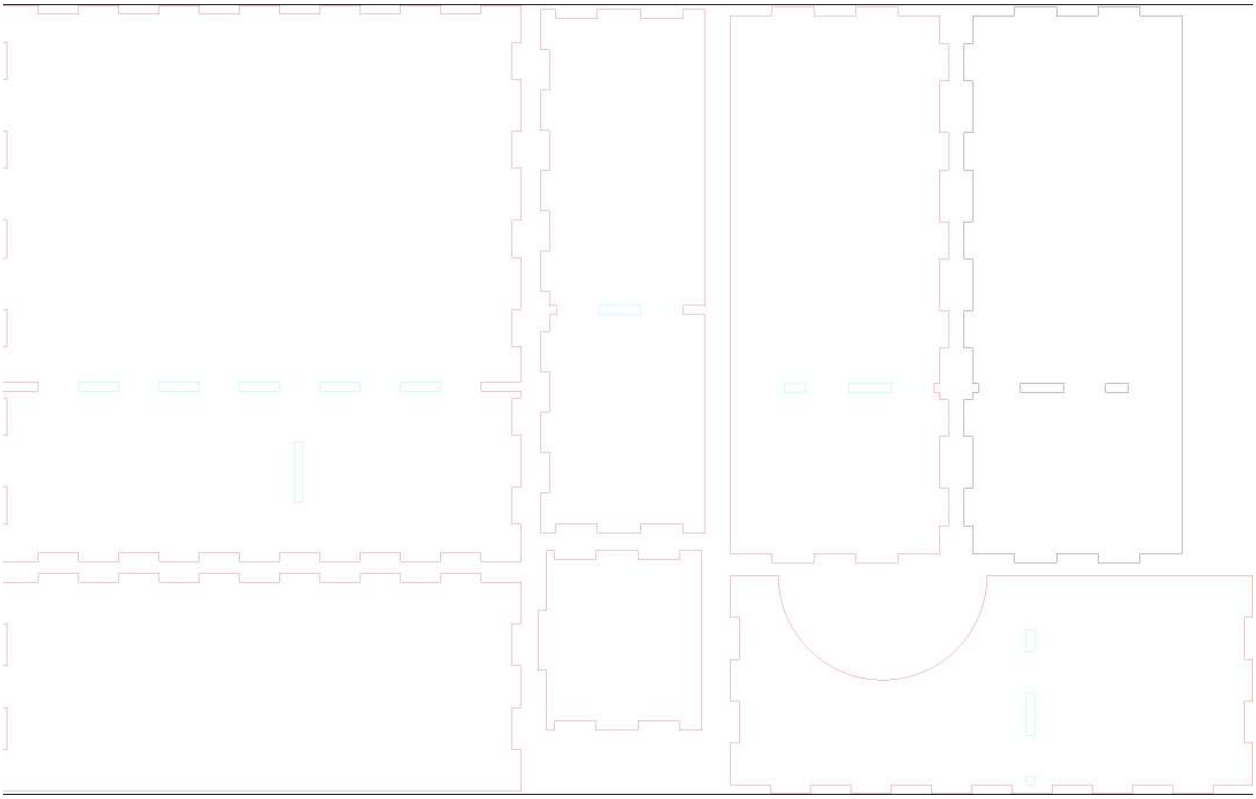


Figure 1: Digital prototype for props

3.2.1.1 First Trial

Criteria	Metrics	Test and Result	Pass/Fail
Size	Area (cm^2)	The laser cutting document is put into production. The final product is then measured to ensure it can easily fit in a backpack. While the pieces are proven to capable of fitting in a regular backpack, the laser cut was not successful in this trial. Due to time constraints, physical tests will be done for the following prototype.	**Partial PASS**

Table 1: Trial 1 test results for props

3.2.2 Cards (Laser Cutting)

In Prototype II, Character and Event Cards are produced with MDF boards. Such cards are then placed under physical tests to determine whether they are durable enough for the project.

Figure 2: Prototype for a Character Card

3.2.2.1 First Trial

Criteria	Metrics	Test and Result	Pass/Fail
Can the MDF cards withstand the average weight of a player?	Weight (kg)	When average human male (50-60 kg) steps on the MDF card for 3 times, there is no observable damage.	**PASS**
Do the MDF cards easily get scratched from sharp objects?	Boolean	When the cards are scratches with sharp nails and keys, there are no observable changes.	**PASS**

Table 2: Trial 1 test results for cards

3.2.3 Robomaster Testing

In Prototype II, the written code is uploaded into the Robomaster and its functionality is put to test. A major criterion is of focus in testing: whether the Robomaster can run the written code and demonstrate non-targeting features.

3.2.3.1 First Trial

Criteria	Metrics	Test and Result	Pass/Fail
When the Robomaster runs the code, does it demonstrate non-targeting features?	Boolean	The Robomaster is capable of rotating. However, due to the design of the Robomaster, its rotation is not smooth. Nonetheless, the group expects this to be a minor problem and will not pose as an obstacle in the final product.	**PASS**

Table 3: Trial 1 test results for Robomaster Testing

3.3 Evaluating Prototyping Objectives

Create laser cutting documents for props	Successful ☑
Create physical MDF props, Character Cards and Event Cards prototypes, and test for fragility	Partially successful ☒
Test for Robomaster code functionality and compatibility with Character Cards	Successful ☑

3.3.1 Skills Acquired/Improved in Prototyping

3.3.1.1 Props

- **Mass produce**: As the number of parts is of a considerable amount, the group designed a format for parts to be repeatedly replicated for future designs.
- **Predicting outcome**: The Inkscape software is only capable of showing black and white lines and cannot display the appearance of the final product. As a result, the group must use knowledge from previous lab sessions to assume whether the design would be feasible.

3.3.1.2 Cards

- **Method of Testing:** In the testing phase, the group made use of different approaches to test for the durability of the MDF boards. When one approach fails to yield expected results, the group pivots to a second trial that can provide information the group needs.

3.3.1.3 Robomaster

- **Predicting outcome**: While the DJI Edu Hub includes a simulation feature, allowing the code to be run through a simulated environment of the Robomaster S1, the functionality of the code remains uncertain. As a result, the group is needed to trace the code manually after the simulation to ensure the execution meets the expected outcome.
- **Debugging**: During the coding process, the group encountered several logical obstacles. However, with repeated testing, the group soon became more familiar with the coding environment of the DJI Edu Hub. This allows following coding to be much smoother.

User Feedback

To gather feedback for Prototype II, the group had conducted an online google survey, gathering responses from peers within the age range of potential users.

Link to Google Survey: https://forms.gle/LmQ7DitPe24xhxcTA

4.1 Results from Survey

Questions	Answers		
Do you think the physical components of the project can give an	"Yes, I believe that this game could be pretty immersive as the laser printing will most likely allow for larger	"Yes, since the 3d buildings offer a realistic experience that adds to the overall design."	"I feel that making this game actually immersive will be difficult with the restrictions on time and budget. But with the given time and materials the idea your team

immersive experience?	props making it seem more realistic."		came up with should work just fine."
Do you believe that switching from 3D printing to Laser Cutting was a good idea due to the time constraint?	"Yes, laser printing is known to be much faster than 3D printing as well as more reliable, therefor is the problem is time, laser printing is the obvious better choice."	"Of course, waiting for 3 months for something to print would be horrifying. Cardboard building is much simpler and faster method."	"Yes, laser printing is the better option in the end as, cardboard building is much simpler and faster to make then plastic ones."
Do you believe that our design is too complicated?	"No, the design itself is simple but should effectively demonstrate the problems with LAWS."	"No not really. The design is very simple and functional."	"No, your idea should work fine. The complexity is just right for the idea presented."
Will we still be able to explain our design effectively within the available time?	"As was said in the last survey I took as long as you condense the speech part of it will be able to be effectively done within the proper time frame."	"As was said in the last survey I took as long as you condense the speech part of it will be able to be effectively done within the proper time frame."	"Yes, trying to explain such a small game shouldn't take too long."

Table 4: User comments from survey

4.2 Analysis of Results

Based on the survey responses, here is an analysis of the feedback received:

1. Immersive Potential of Physical Components

Most respondents believe the project will feel immersive, especially with elements like laser printing and 3D building models. They believe these components make the experience feel more realistic. For instance, one respondent mentioned that larger, realistic props could help make it feel like a real space. However, one person pointed out that limited time and budget could make creating a truly immersive experience tough. This suggests that even though the physical components are a good choice, they might still be limited by what we can achieve in the timeframe.

2. Switching from 3D Printing to Laser Cutting

Everyone seems to agree that moving from 3D printing to laser cutting was the right call. Laser cutting is faster and more efficient, which really matters when time is tight. A few respondents highlighted that using materials like cardboard, which is quick and easy to work with, makes things simpler and faster. This shows that people see laser cutting as a practical choice that fits well with the project's time constraints.

3. Complexity of the Design

There's a clear agreement that the design is simple and functional, rather than too complex. Respondents all agreed that the design is straightforward and should get the idea across. One person even mentioned it

effectively demonstrates the issues with LAWS (Lethal Autonomous Weapon Systems). This feedback suggests that we've hit the right balance: the design is clear enough to work well but isn't overly complicated.

4. Explaining the Design Within Time Limits

People think explaining the design in the time we have is totally doable, especially if we keep the explanation short and to the point. A few people repeated that if the presentation is brief, it can fit into the time frame. This suggests that keeping things clear and concise will help make sure we can present everything effectively.

Overall Takeaways

Overall, the feedback shows that our choices for materials, production methods, and design simplicity are working well for what we want to achieve. While time and budget are constraints, they don't seem like deal-breakers as long as we stay practical. To make the most of our time, we should focus on keeping the explanation clear and finding the right mix between making it realistic and practical.

Prototype III Test Plan

Test ID	Test objective (Why)	What is being figured out (what)	Testing Method (How)	Attributes to Observe / Record	Duration (When/How Long)
1	Test if the physical pieces can withstand normal wear and tear.	Do the pieces break easily when humans step on them?	Physical testing with group members applying force on MDF pieces.	If there are any observable changes.	After physical production is completed. 5 minutes.
2	Test if the Robomaster can work properly on the character cards.	Can the Robomaster detect the character cards, if so, does it continue to run its following code?	Physical testing with prototype character cards.	If the Robomaster can execute its code as expected.	30 minutes,
3	Test if the assembly can be stored in required size of containers.	Can the assembly parts be stored within a backpack?	Use group members' backpacks to attempt to store assembly parts.	If all the parts can fit within the backpacks.	After physical production is completed. 5 minutes.

4	Test if the written instructions can be followed easily without confusion.	Are the instructions simple and easy to follow?	Provide the instruction manual to other users and record what they say.	Ask users what they think about the manual, if it was easy to follow, how to improve it.	Test each prototype manual with users until 80% or more deem the instructions simple. If it is not reached the manual will have to be updated.
5	Test if the assembly can be done within time constraints.	Can the assembly be done within 1 minute?	Attempt to assemble ourselves and unfamiliar users. Note the time required.	Time (s)	After an instruction manual is written. 30 minutes.

Table 5: Prototype III Test Plan

Project Plan

The following includes the detailed tasks and work distribution between team members. The following tasks are expected to be completed on or before Design Day. For future deliverables, further tasks regarding Prototype III will be included. The following list is tentative and may subject to change in personnel.

Task	Description	Duration	Group Member(s)	Status
Prototype I				
Storyboarding	Storyboard on the existing storyline in Prototype I	2 hours	I. Chan	Completed
Robomaster Coding	Draft a prototype code for the Robomaster and test through DJI Edu Hub simulations	2 hours	A. Nasimi	Completed
CAD Model Sketch	Sketch the CAD for the props that will be produced in future prototypes	2 hours	T. Lo	Completed
Laser Cutting	Design character, elimination, and event cards on Inkscape	1 hour	I. Chan	Completed
User Feedback	Create a Google Form to collect feedback from potential users and analyse the result	2 hours	S. Irwin	Completed
Prototype II Test Plan	Create a test plan that outlines the following prototype	0.5 hours	A. Nasimi	Completed

Update Project Plan	Update task schedules to accurately demonstrate the week of Prototype I	0.5 hours	I. Chan	Completed
Prototype II				
Purchase materials on Bill of Materials	Consult TA and purchase materials	2 hours	S. Irwin	Completed
Find suitable audio files	Find suitable audio files (gunshots, explosions, robot moving) in the public domain	0.5 hour	S. Irwin	Completed
Laser Cutting (Cards)	Create physical prototypes from pre-existing Inkscape documents for character and/or event cards	1 hour	I. Chan	Completed
Robomaster Testing	Test whether the program works properly on the physical Robomaster	1 hours	A. Nasimi S. Irwin	Completed
Props	Create laser cutting document of prop parts	1 hours	T. Lo	Completed
Future Prototypes				
Laser Cutting (Props)	Create physical prototypes from pre-existing Inkscape documents for props	2 hours	I. Chan T. Lo	Incomplete
Write Instruction Manual	Create instruction manual that explains the actual operation of the game	2 hours	S. Irwin	Incomplete
Assembly and Storage	Create an assembly package and test if it meets design requirements	3 hours	I. Chan T. Lo	Incomplete
Aesthetics	Modify prototypes into products	2 hours	A. Nasimi	Incomplete

Table 6: Task List

Conclusion

In conclusion, Deliverable G allows Group 8 to observe the physical products and modify designs to further fit requirements and feasibility. Group 8 has been able to adhere to the budget constraint of $25 without deviating much from the group's digital prototypes, with only suitable changes done to reflect user and client feedback.

During the production of Prototype II, three major aspects of the product is further discussed: props, cards and Robomaster. The production and testing of the prototype allowed each member of Group 8 to have an opportunity to have a visual understanding of whether the designs are feasible in our case. It is believed that this understanding paves the way for a product of higher quality.

Deliverable G also focuses on gathering as much feedback from clients and potential users as possible. From Client Meeting III, the group received technical concerns from the client, with this deliverable

adjusting certain aspects of the project to alleviate this concern and ensure the product is produced on time. Deliverable G serves as a benchmarking point in the production of "The Grand Extraction." Not only did it assist Group 8 in ensuring the quality of products, but also clarify the group's uncertainty in the implementation of ideas.

Appendix I – Trello Link

Click here for the link to the Group 8 Trello board.

Appendix II – Updated Task Schedule

The following table lists the upcoming tasks that Group 8 in the following weeks. The list begins in the week of October 20 – 26, and includes deliverables, client feedback, and prototyping steps. Aside from the order of tasks, their dependencies, due date, duration, and the group member-in-charge (only for certain tasks) are also included. For simplicity, the order of tasks listed below are in order of the due date.

#	Task	Dependencies	Due Date	Duration	Group Members
0	*Deliverable D*	*Deliverable D is done prior to the range of this table*			
1	Client Meeting #2	Task 0	2024-10-24	1 session	Everyone
2	Adjust Global Concept	Task 0, 1	2024-10-26	2 days	Lo
3	Deliverable E: Project Plan & Cost	Tasks 0, 1, 2	2024-10-27	7 days	Everyone
4	Build Prototype I	Task 3	2024-10-31	4 days	Everyone
5	Customer Feedback (Prototype I)	Task 4, 5	2024-11-02	1 day	Chan
6	Deliverable F: Prototype I and Customer Feedback	Tasks 4, 5	2024-11-03	7 days	Everyone
7	Client Meeting #3	Task 0	2024-11-05	1 session	Everyone
8	Build Prototype II	Task 7	2024-11-08	5 days	Everyone
9	Customer Feedback (Prototype II)	Task 8	2024-11-09	1 day	Nasimi
10	Deliverable G: Prototype II & Customer Feedback	Tasks 7, 8, 9	2024-11-10	7 days	Everyone
11	Deliverable J: Project Presentations	Task 10	2024-11-15	4 days	Everyone
12	Build Prototype III	Task 10	2024-11-22	12 days	Everyone
13	Customer Feedback (Prototype III)	Task 12	2024-11-23	1 day	Irwin
14	Deliverable H: Prototype III & Customer Feedback	Tasks 12, 13	2024-11-24	14 days	Everyone
15	Deliverable I: Design Day Presentation Material	Task 14	2024-11-27	3 days	Everyone
16	Design Day	Task 15	2024-11-28	1 session	Everyone
17	Deliverable K: User & Product Manuals	Task 16	2024-12-03	*TBA*	Everyone

Table A: Plan for Upcoming Tasks from October 20 to December 7, 2024

Appendix III – Bill of Materials

The following table outlines the required materials for the final product, how such materials will be incorporated in the product, the source for the purchase, and the price of the material. The total budget is of $25.

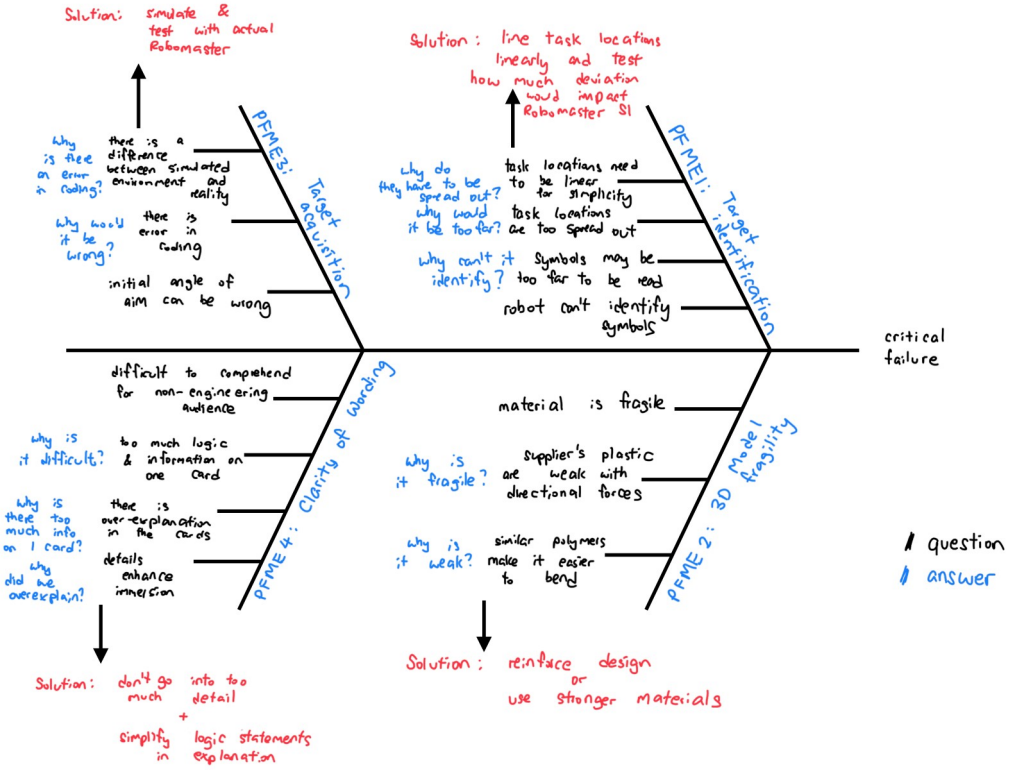
Material	Description	Quantity	Source	Price (CAD)
~~3D Print Material~~	~~Task location indicators, cards~~	~~1~~	~~Makerspace~~	~~Free~~
Card Material (MDF)	Character, Event Cards, and Props	5	Makerspace	Free
Rope	Used for Cards	1	Home Depot	$10.00
Super Glue	Used for glueing 3D prints and player cards	2	Home Depot	$12 (6$ each)
Scissors	Used for cutting rope and other materials	1	Provided by group	Free
Markers (Black Sharpie)	Used for outlining and defining shapes	1	Home Depot	$3

Table B: Bill of Materials required for final product

Appendix IV – PFME Analysis

The following consists of a Fishbone diagram derived from the group's Predictive Failure Modes and Effects (PFME) analysis. The Fishbone diagram narrows the potential risks down to four major PFMEs: target identification, 3D model fragility, target acquisition and clarity of wording. Each aspect is then further discussed to pinpoint the root problem.

With a clear idea of potential risks, each of the PFME is then given a score from 1 to 4 in terms of effect and mode. A table is then drawn to demonstrate which PFME, and its aspects are of utmost importance and should be a priority in prototyping.



PFME	Effect	Mode
①	4	3
②	3	2
③	2	4
④	4	4

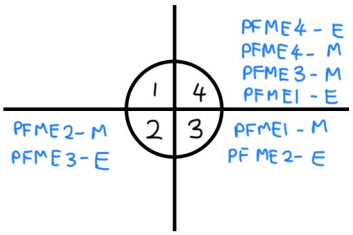


Figure A: Fishbone Diagram derived from PFME analysis