SmartHome+: A Smart Home Platform

1. INSPECTION SUMMARY REPORT

*Note: Each team member's individual Defect and inconsistency lists are all appended as an Appendix to this document.

Project: Smart Home+

General:

Total Number of open defects_____5_____
Total Number of open conflicts___0_____
Total Number of close defects_____21_____
Total Number of close conflicts____10_____

Summarize number of defects by defect type and conflict type

Defect type	Number of open defects	Number of close defects
Forward Reference	0	3
Unintelligibility	0	4
Omission	0	4
Poor Structuring	0	4
Ambiguity	0	1
Incomplete	1	0
Unfeasibility	2	1
Opacity	2	0
Over-specification	0	1
Inadequacy	0	2
Noise	0	1

Conflict type	Number of open conflicts	Number of close conflicts
Strong Conflict	0	5
Weak Conflict	0	1
Designation clash	0	1
Terminology clash	0	2
Overlapping	0	1

Total Person-Hours expended in inspection ~ 7 hours

2. DOCUMENTING CONFLICTS USING INTERACTION MATRIX

An Interaction matrix (Kotonya & Sommerville, 1997) has been linked here which was prepared based on the information generated in task 1 (using features set listed within the vision document)

Note: **Sign-in to git and click on the direct link to view the entire spread sheet.
Direct link: https://github.com/sakibshuvo/SOEN-6481-SRS/blob/master/Deliverable-2/InteractionMatrix/Interatction%20Matrix.xlsx?raw=true

Features	S No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	Total
Local access to the controller using Touch panel / Keypad or Voice based assistants.	1	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
Remote Internet based Access.	2	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
Surveillance Cameras in the home.	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	2000
Main gate access	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Door Access Control	5	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
Home Alarms	6	0	0	0	0	1000	0	1000	0	0	0	0	0	0	0	1000	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5000
Intrusion Detection	7	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	5000
Smart irrigation and automated gardening.	8	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
Automated swimming pool Maintenance	9	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
Automated window blinds	10	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1001
Automated Rain Water Harvesting	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Time of Day usage Analytics	12	0	0	0	0	0	0	0	1000	1000	1000	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	6000
Air flow monitoring	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000
Managing Alternative Energy harness systems	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Smoke/Gas leakage Detection.	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	3000
CO level detection.	16	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3000
Water leakages / Water level detection.	17	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3000
Automated Air Conditioning system	18	0	0	0	0	0	1000	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000
Automation of the Lightning of the room	19	0	0	0	0	0	0	0	0	0	1	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1001
Automation in cooking (Like a smart microwave)	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Smart Home theater	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Multi room audio	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SMS	23	0	0	0	0	0	0	1000	0	0	0	0	1000	0	1000	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5002
Email	24	0	0	0	0	0	0	1000	0	0	0	0	1000	0	1000	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5002
WI-FI	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
4G-LTE/5G	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
Bluetooth	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	0	0	0	0	0	0	2000
Passcode	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	0	0	1000	1000	0	0	4000
Fingerprint	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	1000	0	0	0	0	0	0	0	0	1000	1000	0	0	4000
Facial Recognition	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	0	0	0	1000	0	0	0	0	0	1000	1000	0	0	5000
User control mode	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	1	0	0	0	0	0	0	0	0	0	0	1001
Self-Evolving mode	32	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1002
Local Storage	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cloud Storage	34	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000
Kitchen Inventory Management.	35	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	2000
Automated feeding plan for pets.	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medicine Inventory Management.	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	1000
Simple interface to connect to third party / new devices.	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Single user mode	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	0	0	0	0	0	0	0	0	0	1	0	0	3001
Multi user mode	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	1000	0	0	0	0	0	0	0	0	1	0	0	0	3001
Automated call to 911 in case of intrusion/break-in	41	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1003
Automated call to fire control department	42	0	0	0	0	0	0	1000	0	0	0	0	0	0	1000	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2003
Total		1000	1000	2000	0	1000	5000	5000	1000	1000	1001	0	6000	2000	0	3000	3000	3000	2000	1001	0	0	0	5002	5002	1000	1000	2000	4000	4000	5000	1	1002	1000	1000	2000	1000	1000	0	3002	3001	1003	2003	80018

Total Overlapping	80
Total Conflicts	18

3. CONFLICT RESOLUTION
AND
4. EVALUATION

Following is the list of identified conflicts which have further been taken into consideration for resolution and they are evaluated using **weighted matrices.**

$$totalScore(opt) = \sum_{crit} (Scores(opt, crit) \times Weight(crit))$$

Conflict 1: Multiple users can trigger contradictory commands for the same room.

- **Conflict Resolution:**
    1. Provide a basic status of presently active conditions in the room to all the application users, so users can make more aware decisions regarding which command to execute at any given point of time.
        - **Tactic used – Add new requirement to weaken the conflict**

    2. Prepare an exhaustive list of contradictory commands which might be executed in the same room and define rules in the system to give an error to the users if they try to execute any such contradictory combination.
        - **Tactic used – Add new requirement to avoid conflict**

- **Conflict Evaluation:**

Evaluation criteria (NFR)	Significance weighting	Give user the present status and let them decide	Prepare set of contradictory rules and implement
Cost	0.7	.7	.3
Usability	0.3	.6	.4
Total	**1.0**	**.59**	**.33**

Option1 - Give user the present status and let them decide contributes more in terms of improving the Non-Function Requirements so is a better alternative.

Conflict 2: Emergency Detection and Intrusion detection at the same time.

- **Conflict Resolution:**
    1. In case of any fire/smoke related emergency, system notifies the users and put out the smoke or fire using home water sprinklers without immediately unlocking the point of entries automatically.
        - **Tactic used – Add new requirement to weaken the conflict**

    2. If an intrusion and smoke (fire) emergency is detected at the same time, use sprinklers but do not allow auto-unlocking of any point of entries, only users can unlock them.
        - **Tactic used – Add new requirement to avoid conflict**

- **Conflict Evaluation:**

Evaluation criteria NFR	Significance weighting	Try to tackle fire using sprinklers before auto unlocking point of entries.	Use sprinklers but only allow manual unlocking if intrusion and smoke (fire) emergency occur together.
Security	0.5	.3	.6
Safety	0.5	.4	.7
Total	**1.0**	**.35**	**.65**

Option2 - Use sprinklers but only allow manual unlocking if intrusion and smoke (fire) emergency occur together contributes more in terms of improving the Non-Function Requirements and so is a better alternative.

Conflict 3: Automation of the Lightning of the room and Automated window blinds

- **Conflict Resolution:**
  1. Close the window blinds before adjusting the lightning of the system in self- evolving mode.
     - ➢ **Tactic used – Restore conflicting statements** i.e. the conflicting statements satisfy each other soon after the boundary condition has occurred**.**

  2. When the user tries to on/off the light and if the blinds are open/close popup a notification regarding the state of the blinds and expected action.
     - ➢ **Tactic used - Add new requirement to weaken the conflict**

- **Conflict Evaluation:**

Evaluation criteria NFR	Significance weighting	Close Blinds	Send notifications
Reliable outcome	0.7	0.2	0.7
Usability	0.3	0.6	0.3
Total	**1.0**	**0.32**	**1.39**

Sending notifications contributes more in terms of improving reliability of the system and so it's the better option.

Conflict 4: Emergency Notification & Safety measures

- **Conflict Resolution**
    1. In case of emergency, trigger alarms and send notifications to customers. If the alarm was not stopped within a predefined time duration (Ex 10mins), then trigger an automated call to 911 emergency services.
        - ➢ **Tactic used - Add new requirement to weaken the conflict**

    2. The controller will operate in two states armed (full protection) and disarmed (minimal protection). Automated calls to 911 will occur only during armed state.
        - ➢ **Tactic used - Avoid boundary condition**

- **Conflict Evaluation:**

Evaluation criteria NFR	Significance weighting	Armed State	Time given to cancel alarms
Reliability	0.5	0.5	0.6
Usability	0.3	0.4	0.4
Minimal inconvenience	0.2	0.6	0.4
Total	**1.0**	**0.49**	**0.5**

Time given to cancel alarms contributes more in terms of improving the Non-Function Requirements so is a better alternative.

Conflict 5: Third party devices may not be compatible with the self-evolving mode of the system.

- **Conflict Resolution**
    1. Provide a List of Third-Party Devices to users, which would be more compatible with the self-evolving mode of the System.
        - ➢ **Tactic used - Add new requirement to weaken the conflict**

    2. Allow only those Third-Party Devices which do not depend on the self-evolving mode of the system.
        - ➢ **Tactic used - Avoid boundary condition**

- **Conflict Evaluation:**

Evaluation criteria NFR	Significance weighting	Provide a List of Third-Party Devices to users.	Allow only those Third-Party Devices which do not need the self-evolving mode feature of the system.
Minimal inconvenience	0.3	.6	.4

Usability	0.4	.7	.3
Cost	0.7	.3	.7
Total	**1.0**	**.55**	**.45**

Option 1- Provide a List of Third-Party Devices to users contributes more in terms of improving the Non-Function Requirements so is a better alternative.

Conflict 6: Self evolving mode can perform some unauthorized tasks when the user is not around.

- **Conflict Resolution**
    1. Users will provide a set of rules that the system should follow before performing the tasks in self-evolving mode
        - ➢ **Tactic used - Add new requirement to weaken the conflict**
    2. System will always prompt the user for the authorization of the task to be performed in self-evolving mode.
        - ➢ **Tactic used – Avoid boundary condition**

- **Conflict Evaluation:**

Evaluation criteria NFR	Significance weighting	System will always prompt the user for the authorization of the task to be performed in self evolving mode.	Users will provide a set of rules that the system should follow before performing the tasks in self evolve mode.
Reliable	0.6	.6	.4
usability	0.4	.5	.5
Total	**1.0**	**.56**	**.44**

Option 1- System will always prompt the user for the authorization of the task to be performed in self-evolving mode contributes more in terms of improving the Non-Function Requirements so is a better alternative.

5. RISK MANAGEMENT

Below given table provides a reference for the various risk likelihood levels that have been considered here. Table reference has been taken from: https://ehealthresearch.no/files/documents/Appendix-Definitions.pdf

Table 1: Definition of likelihood levels

Likelihood	Frequency	Ease of misuse and motivation
Very high	Very often, occurs more often than every 10th connection, i.e. more frequently than 10 % of the time/cases.	Can be done without any knowledge about the system; or without any additional equipment being used; or it can be performed by wrong or careless usage.
High	Quite often. Occurs between 1 % and 10 % of the time/cases.	Can be done with minor knowledge about the system; or without any additional equipment being used; or it can be performed by wrong or careless usage.
Moderate	May happen. Occurs between 0.1 % and 1 % of the time/cases.	Normal knowledge about the system is sufficient; or normally available equipment can be used; or it can be performed deliberately.
Low	Rare. Occurs less than 0.1 % of the time/cases.	Detailed knowledge about the system is needed; or special equipment is needed; or it can only be performed deliberately and by help of internal personnel.

Risk 1: Maximizing the number of features might lead to an increase in overall cost of the solution, which defeats one of the core objectives of delivering a low-cost solution.

- **Related Non-Functional Requirement: Cost**

- **Risk Type**: Process Related Risk

- **Risk Likelihood** - High.
  Development of this solution involves a direct relationship between adding features to increase the usability of the solution and the cost/effort invested in implementing those features.

- **Qualitative assessment:**

Consequences	Likely	Possible	Unlikely
Increase in Cost	High	Moderate	Low
Delay in product delivery	High	Moderate	Low
Business loss by losing customers	Severe	High	Low

- **Rationale**:
  1. Increasing the number of features to handle special edge cases and some highly customer specific scenarios, would highly increase the overall cost of the solution.
  2. It takes time to develop new features which highly impacts the possibility of developers meeting the delivery deadlines for the solution.
  3. In long run, consequences like 1 and 2 get piled up and significantly increase the time to market the solution. This seriously impacts the overall business creating losses and losing presence in market to other competitors.

- **Counter Measure 1:** Try to keep the requirement set as generic as possible so it addresses the needs of a wider section of users.
  - ➢ **Tactic used: Reduce risk likelihood**

- **Counter Measure 2:** Ensure the product development phase operates on Agile a based model (like KanBan, Scrum), which would prioritize important features in earlier deliveries and less important ones in later deliveries.
  - ➢ **Tactic used: Reduce risk likelihood**

- **Counter Measure 3:** Try convincing the users and avoid working on any highly customer specific features which can be managed manually with minimal efforts.
  - ➢ **Tactic used: Avoid risk**

- **Counter Measure Evaluation:**

Evaluation criteria NFR	Significance weighting	Generic Requirement Set	Agile Based Model	Avoid specific customer features
Cost	0.4	0.4	0.7	0.3
Reliability	0.6	0.5	0.8	0.5
Total	1.0	0.44	0.7	0.42

- **Most Cost-Effective Measure:** Based on the weighted matrix above and considering cost and reliability the counter measure **agile based model** would be more effective.

Risk 2: Unauthorized access to any of the installed devices using default password used for connectivity.

- **Related Non-Functional Requirement: Security**

- **Risk Type**: Product Related Risk

- **Risk Likelihood** - Low.
  The attacker needs to possess sufficient technical skill/knowledge to exploit this security loophole and not every individual will have that kind of expertise so marking it as Low.

- **Qualitative assessment:**

Consequences	Likely	Possible	Unlikely
Loss of security	Catastrophic	Catastrophic	Severe
Loss of privacy	Severe	Severe	High
Gain access to other devices in network	High	High	Low
Use the devices as bots for security attacks	Low	Low	Low

- **Rationale**:

  1. Loss of privacy and security defeats the whole vision of the product and it can result in catastrophic outcomes like break in, burglary, violence etc.
  2. Gain access to other devices in the network - A hacker can gain access to other devices in the network and use it inappropriately. Though it's not catastrophic it will have a high impact on user experience of the system.
  3. Use the devices as bots for security attacks - Users may not have any impact on user experience or the impact can be low like high bandwidth usage. In some cases, users may not even be aware of the impact.

- **Counter Measure 1:** Controller resets the default password of the smart device with a uniquely generated password as soon as the device is successfully paired with the controller.

  ➢ **Tactic used: Avoid risk**

- **Counter Measure 2:** Display warnings to the user via the mobile app, local monitor or the voice-based assistants that the smart device has the default password and the user needs to reset it. User is given the option to fix it or snooze the warning.

  ➢ **Tactic used: Reduce risk likelihood**

- **Counter Measure Evaluation:**

Evaluation criteria NFR	Significance weighting	Auto Reset of Default Password	Notify users
Cost	0.3	0.7	0.7
Security	0.5	0.7	0.4
Usability	0.2	0.6	0.3
Total	**1.0**	**0.68**	**0.47**

- **Most Cost-Effective Measure:** Based on the weighted matrix above and considering security is the most important aim of the product, the counter measure **Auto Reset of Default Password** would be more effective.

Risk 3: Loss of camera footages or usage pattern data when storage is full (applies to both local and cloud storage)

- **Related Non-Functional Requirement:** Performance

- **Risk Type**: Product Related Risk

- **Risk Likelihood** - High.
  Most users may not have the habit of freeing up the storage space regularly. They may depend on some form of notification or the system automatically frees up space when storage is full.

- **Qualitative assessment:**

Consequences	Likely	Possible	Unlikely
Loss of footages	Severe	High	High
Loss of surveillance	Severe	Severe	High
Improper function of devices based on out-dated usage data	Severe	High	Moderate
Low performance of controller in case of retries to store/upload data	Low	Low	Low

- **Rationale**:
    1. Loss of surveillance and footage are deemed severe since the customer will lose the sense of safety and security of the home.
    2. If the device learns from out-dated usage data, the actual output can severely affect the user experience.
    3. In some cases, multiple retries by the controller to store/update data can affect performance.

- **Counter Measure 1:** Clear the storage when it reaches a specified threshold in the order of earliest data first until the available storage comes below the threshold.

    ➢ **Tactic used: Avoid risk**

- **Counter Measure 2:** Display warning to the user that storage is full, and they need to clear it or it will result in loss of data.

    ➢ **Tactic used: Reduce risk likelihood**

- **Counter Measure 3:** Before applying modifications to the device based on the usage pattern in self-evolving mode check if the data used include the latest hour data.

    ➢ **Tactic used: Reduce risk consequence likelihood.**

- **Counter Measure Evaluation:**

Evaluation criteria NFR	Significance weighting	Auto clear storage	Notify users	Check data timestamp
Cost	0.3	0.7	0.7	0.5
Reliability	0.5	0.7	0.4	0.2
Usability	0.2	0.6	0.3	0.4
Total	**1.0**	**0.68**	**0.47**	**0.18**

- **Most Cost-Effective Measure:** Based on the weighted matrix above and considering reliability as the most important requirement, the counter measure **Auto clear storage after a specified threshold** would be more effective.

Risk 4: System will entirely shutdown when there is a power failure and the back-up battery run out as well**.**

- **Related Non-Functional Requirement:** Reliability

- **Risk Likelihood:** Moderate
  There are moderate chances of having a power outage and the back-up battery getting exhausted at the same time.

- **Qualitative assessment:**

Consequences	Likely	Possible	Unlikely
Loss of Security and Safety	Severe	High	High
Loss of Automation	Moderate	Moderate	Low

- **Rationale**:
  1. System shut down makes the entire house vulnerable to any types of attack (like fire, flood, theft or intrusion).
  2. All the Automation would stop and the mundane activities are to be performed by the user which they might not like after getting used to of automation.

- **Counter measure 1:** Make sure that only the most necessary services are consuming the battery, when there is a power failure. This can help to extend the usage of the battery. The system can also notify the users regarding the battery levels.

  - **Tactic used:** Reduce Risk Likelihood

- **Counter measure 2:** Fuel based battery can be used. The system can notify the user to refuel the battery before it runs out.

  - **Tactic used:** Avoid Risk.

- **Counter Measure Evaluation:**

Evaluation criteria NFR	Significance weighting	Low Consumption of Battery	Fuel based battery
Cost	0.4	0.7	0.2
Reliability	0.5	0.7	0.4
Usability	0.1	0.6	0.3
Total	**1.0**	**0.68**	**0.31**

- **Most Cost-Effective Measure:** Based on the weighted matrix above and considering both cost and reliability as the important aspect, the counter measure **Low Consumption of Battery** would be more effective.

Risk 5: Unstable internet-based connectivity can interfere with smooth inter-operation between smart home solution and other connected devices.

- **Related Non-Functional Requirement:** Reliability

- **Risk Type**: Product Related Risk

- **Risk Likelihood** – Very High.
    1. Internet based connectivity issues are quite common given that it involves a third party Internet Service Provider.
    2. Prone to downtimes and any other hardware failure at Internet Service Provider's end.
    3. Prone to hardware failures at user's end, say a modem failure.

- **Qualitative assessment:**

Consequences	Likely	Possible	Unlikely
Loss of connectivity and Messaging/Notification delays	Severe	High	High
Devices need to be restarted and synced every-time after losing connectivity	Moderate	Low	Low
Impact on Intrusion Detection	Catastrophic	Moderate	Moderate
Loss of recorded data	Moderate	High	High

- **Rationale:**
    1. Loss of connectivity might prevent users from sending commands remotely which in case of an exigency might have serious consequences.
    2. Delays in receiving notifications on proper time, might lead to consequences and customers losing their faith over the accuracy of the system.
    3. Some smart devices on account losing connectivity might need to get restarted over and again which might annoy end users.
    4. Any flaw in the system related to intrusion detection pose a serious threat to safety and security.
    5. Poor internet connection might lead to problems related to data storage and retrieval over the cloud.

- **Counter Measure 1:** Automatically switch over to a different mode of connectivity (4G, 5G) using the SIM card installed within the controller.

    ➤ **Tactic used: Avoid risk**

- **Counter Measure 2:** Make sure all the services and devices are capable of reconnecting and synchronizing with controller automatically after regaining access to the connectivity.

  - ➢ **Tactic used: Reduce risk likelihood**

- **Counter Measure Evaluation:**

Evaluation criteria NFR	Significance weighting	Automatic switch over to another connectivity mode	Reconnection of devices
Cost	0.5	0.4	0.6
Reliability	0.5	0.8	0.4
Total	**1.0**	**0.6**	**0.5**

- **Most Cost-Effective Measure:** Based on the weighted matrix above and considering reliability as the important aspect, the counter measure **Automatic switch over to another connectivity mode** would be more effective.

Risk 6: Automatic window control feature needs to consider scenarios where there is any obstacle on path or resistance on the way.

- **Related Non-Functional Requirement:** Safety

- **Risk Type**: Product Related Risk

- **Risk Likelihood** – High.
  Automatically opening or closing the window has fair chances of some object getting stuck on window's path.

- **Qualitative assessment:**

Consequences	Likely	Possible	Unlikely
Safety concerns for kids, elders pets and flying birds.	Catastrophic	Severe	High
Object providing resistance might break.	High	Moderate	Low
Windows might be damaged	High	Moderate	Low

- **Rationale:**
  1. Kids and elders unknowingly blocking windows with their hands or our pets like cat or some birds sitting on the window might injure themselves which might become a serious concern.
  2. Either the window or the blocking object itself might get damaged, which would then incur repairing costs for both.

- **Counter Measure 1:** While opening and closing the window, windows should reverse back if any obstacle is found on the path of movement.

  - ➤ **Tactic used: Reduce risk likelihood by adding a new requirement**

- **CounterMeasure-2:** Check using sensors and execute window opening and closing commands only if the pathway is free, otherwise notify user about the blockage and let them remove it first.
  - ➤ **Tactic used: Avoid risk by adding a new requirement**

- **Counter Measure Evaluation:**

Evaluation criteria NFR	Significance weighting	Reverse operation	Notify users
Cost	0.2	0.5	0.5
Reliability	0.5	0.8	0.4
Usability	0.3	0.7	0.4
Total	**1.0**	**0.71**	**0.42**

- **Most Cost-Effective Measure:** Based on the weighted matrix above and considering reliability and usability as the important aspect, the counter measure **Reversing window operations in case of obstacles** would be more effective.

Risk 7: Automated pet feeding station can raise pet safety concerns. Food can get polluted and wasted by external factors like wind, rain, dirt, inedible particle etc.

- **Related Non-Functional Requirement:** Safety

- **Risk Type**: Product Related Risk

- **Risk Likelihood** – Moderate
  1. Environmental factors like rain, dust, dirt, heat at times can pollute the food.
  2. Pets at times can try to fiddle around with the automated feeding station.

- **Qualitative assessment:**

Consequences	Likely	Possible	Unlikely
Polluted food	Severe	High	High
Pets getting injured while trying to fiddle with feeding station	High	Moderate	Moderate
Pets damaging the feeding station.	High	Moderate	Moderate

- **Rationale**:
    1. Polluted food can raise serious concern regarding pet's health.
    2. While playing with food station equipment pets might injure themselves.
    3. Feeding station needs to be repaired every-time a pet damage it. This might become a recurring cost.

- **Counter Measure 1:** Notify user daily to inspect feeding station for its cleanliness, set the station indoor.
    - ➢ **Tactic used: Reduce risk likelihood**

- **Counter Measure 2:** Ensure feeding stations make use of more durable and harmless build material like plasticized rubber.
    - ➢ **Tactic used: Reduce risk likelihood**

- **Counter Measure Evaluation:**

Evaluation criteria NFR	Significance weighting	Notify users	Material property
Cost	0.4	0.7	0.4
Safety	0.5	0.8	0.4
Usability	0.1	0.5	0.7
Total	**1.0**	**0.73**	**0.43**

- **Most Cost-Effective Measure:** Based on the weighted matrix above and considering safety of the pets as the important aspect, the counter measure **Notify users** would be more effective.

Risk 8: Customers can be forced to use the system by attackers without their consent.

- **Related Non-Functional Requirement:** Safety and Security

- **Risk Type**: Product Related Risk

- **Risk Likelihood** – Moderate
  Attacks like this are not that frequent in a normal society. But again it also depends on the crime rate of the area.

- **Qualitative assessment:**

Consequences	Likely	Possible	Unlikely
Loss Of life	Catastrophic	Catastrophic	Severe
Theft	Severe	High	High
Violence and injury	Severe	High	High
Damage to Property	Severe	High	High

- **Rationale**:
    1. Once the attacker gains access to the home through forced entry he/she can indulge in any kind of attack including but not limited to Loss of live, theft, violence, injury and damage to property.

- **Counter Measure 1:** Include one more modes of access using the **duress-code (a covert distress signal used by an individual who is being forced to do something against his/her will)** or password. When the system is accessed using the duress-code, an automated call will be sent to 911 but no alarms will be triggered and the system will behave as normal.

    > **Tactic used : Reduce risk consequence likelihood**

- **Counter Measure 2:** In the local monitor and remote app include the option to call 911 without unlocking the system.

    > **Tactic used: Reduce risk consequence likelihood**

- **Counter Measure Evaluation:**

Evaluation criteria NFR	Significance weighting	Duress-Code	Extra option
Security	0.4	0.5	0.2
Safety	0.5	0.5	0.2
Usability	0.1	0.5	0.7
Total	**1.0**	**0.5**	**0.25**

- **Most Cost-Effective Measure:** Based on the weighted matrix above and considering safety and security of the customers as the important aspect, the counter measure **duress-code** would be more effective.

APPENDIX 1

INDIVIDUAL DEFECT AND INCONSISTENCY LISTS

Project: Smart Home+

Inspector: Apoorv Semwal   **Time spent by Inspector: 70mins**

Defect #	Location	Defect/inconsistency type	Classification	Author	Status	Date corrected
1	Section - 4.1 - Product Perspective – Usage of term IOT.	Forward Reference - No prior explanation /reference to it.	Minor	Apoorv	Closed – Added context to the statement	16-Jul-2020
2	Section - 4.3 - Needs and Features – Security Measures - Home Alarms.	Unintelligibility - Stating just a device name is not enough to define it as a feature and its purpose.	Minor	Divya	Closed – Rephrased feature to better state its intent	16-Jul-2020
3	Missing feature for Window access control	Omission – No specific feature mentions anything about an automated Window access control	Major	Nikhil	Closed – Added a new feature	16-Jul-2020
4	Section - 4.3 - Needs and Features – Multi User Mode of Operation and Household Automation.	Strong Conflict – Multiple users can trigger contradictory commands for the same room. Say switch on the AC and Open Window	Major	Sakib	Closed	16-Jul-2020
5	Needs and Features - Security Measures – Exploiting Emergency Detection for doing an Intrusion.	Strong Conflict – An intruder might try to create an emergency like situation say a small fire to trigger Emergency Detection system to open all doors and windows.	Major	Manik	Closed	16-Jul-2020

Inspector: Divya Bhagavathiappan Shiva   **Time spent by Inspector: 80 mins**

Defect #	Location	Defect/inconsistency type	Classification	Author	Status	Date corrected
1	Assumptions: Controller and the smart devices both provide support for connectivity using Wi-Fi/Bluetooth	Poor Structuring Assumption does not differentiate local and remote connectivity	Minor	Divya	Closed – Assumption modified to clearly indicate local and remote connectivity.	16-Jul-2020
2	Mode of connectivity	Ambiguity. Connectivity can be interpreted as both local connectivity and remote connectivity. For ex: Bluetooth can only be used for local connectivity whereas Wifi can be used for both local and remote connectivity.	Minor	Nikhil	Closed – Modified Connectivity feature into 2 different features for Local and Remote Connectivity.	16-Jul-2020
3	Emergency Detection	Incomplete - Does not provide insight on how to notify emergencies	Major	Nikhil	Open – Will be taken care in the next delivery as we provide some specific use cases.	16-Jul-2020
4	Automation of the Lightning of the room and Automated window blinds	Strong Conflict - Lighting in a room can be affected by natural light	Minor	Manik	Closed	16-Jul-2020
5	Emergency notification	Omission - Emergency notifications should also be displayed in local monitors and through voice based assistants	Major	Sakib	Closed– Added other modes to communicate notification	16-Jul-2020

| 6 | Expandable Controller | Unfeasibility. An interface which can access and control both third party devices (i.e non supported devices) and new devices(i.e supported devices) is not feasible. | Minor | Nikhil | Closed – Split feature into two for better understandi ng. | 16-Jul-2020 |
| 7 | Emergency Notification & Safety measures | Weak Conflict - Automated calls should not happen if the customer takes responsibility for the emergency notification event. | Minor | Apoorv | Closed | 16-Jul-2020 |

Inspector: Sakib Shuvo   **Time spent by Inspector: 100 mins**

Defect #	Location	Defect/inconsistency type	Classification	Author	Status	Date corrected
1	Section: 3.2 User environment; Page 4 Self-evolving Mode	Forward Reference: Definition of self-evolving mode was given later in Appendix	Minor	Nikhil	Closed - Added explanation to the statement itself	15-Jul-2020
2	Section 4.4: Alternative and Competition: Bell canada Description	Unintelligibility	Minor	Nikhil	Closed – Modified self-references from competitor's details	15-Jul-2020
3	Section 4.3: Needs and Feature Mode of Operation for user vs device to work	Designation clash	Major	Apoorv	Closed – Rephrased the feature names to avoid confusion.	15-Jul-2020
4	Section 4.2 Dependency	Opacity - last point in dependency regarding Usage Pattern analyser is not clearly explaining the intent.	Major	Divya	Closed – Rephrased to clearly explain the dependency	15-Jul-2020

5	Section 4.4 Needs and Feature Mode of access control, remote vs local	Poor Structuring: both home and remote control are internet based	Major	Nikhil	Closed – Rephrased the feature to avoid any confusion	15-Jul-2020
6	Section 4.4 Needs and Feature: Security Measures Main gate access and door access	Overlapping Referring to the same door access feature	Moderate	Manik	Closed – Documented in interaction matrix.	15-Jul-2020
7	Section 4.4 Needs and Feature: Emergency detection CO level detection	Unintelligibility CO acronym is not defined	Moderate	Sakib	Closed – Added more context to provide missing information	15-Jul-2020
8	Section 4.4 Needs and Feature: Energy Management: Time of Day usage	Inadequacy	Moderate	Sakib	Closed – Added more context to provide missing information	15-Jul-2020
9	Section 4.4 Needs and Feature: Energy Management:	Poor structuring: Automated irrigation, swimming pool cleaning doesn't correspond to the category Energy management	High	Divya	Closed – Moved the mentioned features to household automation	15-Jul-2020

Inspector: Manik Hossain   **Time spent by Inspector: 80mins**

Defect #	Location	Defect/inconsistency type	Classification	Author	Status	Date corrected
1.	Need & Features: Automated call to 911 and fire department	**Overspecification**: Sometime fire alarm rings for a while but it can be easily control at home instead of disturbing these department	Major	Manik Hossain	Closed (Actually Cancelled)	16-Jul-2020
2.	Need & Features: Routine Activities like kitchen, medicine inventory management and automated feeding plan for pets.	**Opacity**: There is no specification of any real world scenarios on these topics.	Minor	Apoorv	Open as upcoming releases would be having more specific use case scenarios behind these features.	16-Jul-2020
3.	Need & Features: Smart irrigation and automated gardening, swimming pool maintenance	**Opacity**: There is no specification of any real world scenarios on these topics.	Minor	Apoorv	Open as upcoming releases would be having more specific use case scenarios behind these features.	16-Jul-2020
4.	Features and Need: Safety Measures	**Terminology Clash**: 911 and fire control department are same but used in different ways.	Minor	Nikhil	Closed – Merged into one feature to avoid the clash.	16-Jul-2020
5.	Needs & Features: Automated feeding plan for pets	**Unfeasibility**: it seems unrealistic because it cannot be implemented in terms of developer perspective.	Minor	Sakib	Open as upcoming releases would be having more specific use	16-Jul-2020

					case scenarios behind these features.	

Inspector: Nikhil Nikhil   **Time spent by Inspector: 120mins**

Defect #	Location	Defect/inconsistency type	Classification	Author	Status	Date corrected
1	Features for specially-abled members of the family.	Omission	Minor	Nikhil	Closed – New Feature with clear mention of support for specially - abled members.	15-July-2020
2	4.3 Needs and features: Self-evolving mode	Forward reference	Minor	Apoorv	Closed – Duplication for Defect 1 in **Sakib's List**	15-July-2020
3	5.2 and 5.3 Platform requirements: Mentions about Java and Linux which are more technical terms.	Unintelligibility	Major	Sakib	Closed – Added more context to provide missing information	15-July-2020
4	2.2: Product Position Who: talks only about managing devices and automation of tasks. Should mention security and other stuff.	Inadequacy	Minor	Manik Hossian	Closed – Rephrase statement to cover other aspects as well.	15-July-2020
5	Consideration for privacy of the users	Omission	Major	Nikhil	Closed – Rephrase statement to cover user's	15-July-2020

					privacy aspects as well.	
6	User environment: It should detail the current working environment of the user. Instead the document focuses on how user can access the smarthome+ system.	Poor structuring	Major	Divya	Closed – updated user environme nt	16-July-2020
7	Usage pattern Analyzer	Unfeasibility	Minor	Apoorv	Open – It'll be addressed in upcoming releases for the solution.	15-July-2020
8	Needs and Feature: Automated Rain harvesting , Alternative energy harnessing system, Is the same	Terminology clash	Major	Nikhil	Closed – Merged to one generic feature to avoid clash.	15-July-2020
9	Needs and Features: Self-evolving mode vs User Control mode	Strong Conflict	Major	Apoorv	Closed	15-July-2020
10	Needs and Features: Self-Evolving mode and Simple interface to connect Third-Party devices	Strong Conflict	Major	Nikhil	Closed	15-July-2020