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### **Smart Home-Issue of Adoption**

#### **Design Thinking Project**

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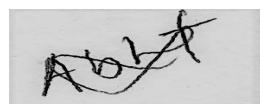
## Declaration

I hereby declare that the following project is a joint initiative, and a qualitative outcome of our perseverance, applied design thinking skills, and team spirit. This work was not published elsewhere and does not bear traces of plagiarism.

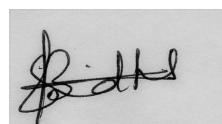
Signature of the Project Team



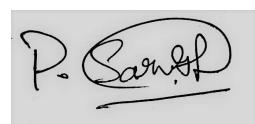
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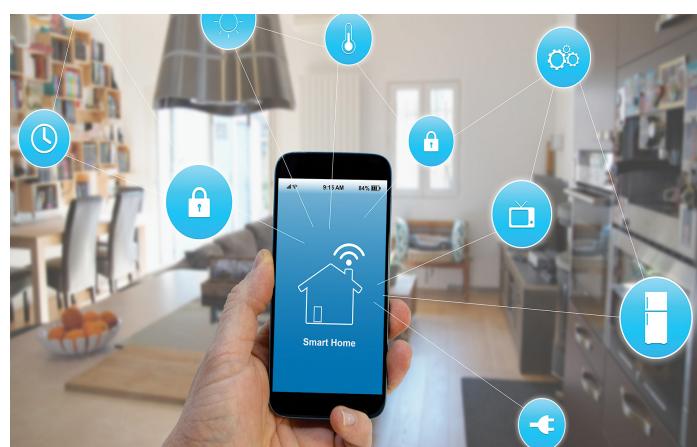
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## Smart Home-Issue of Adoption

### The Scenario:

By introducing automated appliance control, comfort, safety, and assistive services, smart homes can provide a better quality of life. Smart Home Technologies (SHTs) include monitors, interfaces, sensors, appliances, and devices networked to make automation possible as well as remote control of the domestic environment. Despite their numerous potential benefits, there are substantial gaps in the existing knowledge on the design of smart homes that bring user-centric and sustainable visions together. Steve Jobs said “Design is not just what it looks and feels like. Design is how it works”. How we make those designs work in our product is where we use Design Thinking. To understand what we need to do from a Design Thinking perspective in smart homes, we first need to understand where we stand from a technology adoption perspective. In India, we are past the early innovation stage of the Smart Home Technology lifecycle and we are on the verge of early adoption. But over the years, the majority of Indians have not shown interest in adopting Smart Home Technology. We, through the process of Design Thinking, are going to analyse this scenario from a user perspective.



## **Design Thinking-A Brief Introduction:**

It is an extremely useful approach in tackling complex problems by understanding the human needs involved, reframing the problem in human-centric ways, creating multiple ideas, and adopting a bias-towards-action attitude in prototyping and testing.

The 5 steps of Design Thinking for our IoT project:

### **1- Empathise:**

We should begin by understanding people's experiences and motivations. We need to get out of our workspace, and immerse ourselves in our environment to get a deeper understanding of the issues involved. We have to interview and observe a variety of people. This is a divergent phase, so we need to gather lots of data and observations.

### **2- Define:**

After gathering insights around the humans and their context, it is time to boil these insights down to a statement about the problem that we are solving. A good problem statement should be human-centred, broad enough for creative freedom, and narrow enough to make it manageable. After identifying the right problem to solve, it is time to diverge and go broad again. By now, we know who the product is for, and what their needs and pain points are. We have analysed and synthesised our observations, and ended up with a human-centred problem statement. With this background, our team can start to 'think outside the box' to identify new solutions to the problem statement that we have defined.

### **3- Ideate:**

At this stage, it is time to stimulate free thinking, and to expand the problem space. It is important to get as many ideas or problem solutions as possible at the start of the ideation phase. We should not judge any idea yet — the more the better. We will later evaluate which ideas are worth prototyping, but first we need to come up with lots of ideas. Once we have come up with a bunch of ideas, we need to pick a few that our team thinks are the most promising to be prototyped and tested. Let's keep this idea in our back pocket. Since innovation is an iterative process, we might be returning to further explore some ideas that we decided to leave behind for now.

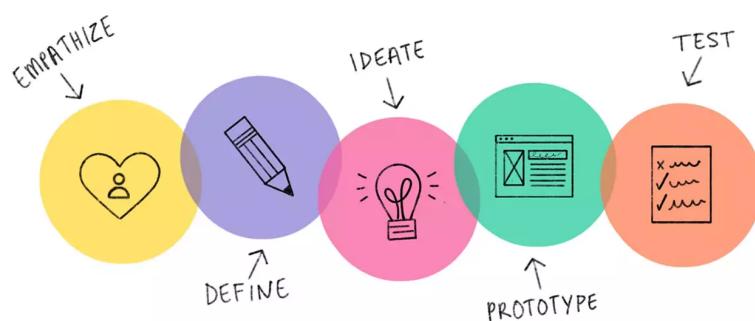
### **4- Prototype:**

Developing a product and bringing it to market is a very expensive and time-consuming endeavour. The main goal of prototyping is to make ideas tangible so that they can be understood and evaluated before committing them to lengthy development and testing. A prototype is a cheaper-than-making-the-real-thing way to understand and evaluate the viability of the solution. It is a key step in the Design Thinking methodology.

## 5- Test:

Finally, it's time to learn from the solution we decided to prototype. At this stage of our Design Thinking process, we will bring representative users to walk through a number of tasks using our prototype.

The results generated during the testing phase are often used to redefine one or more problems, and inform a better understanding of the users, the conditions of use, and how people think, behave, and feel. During this phase, alterations and refinements are made that gets us closer to a truly useful, innovative product.



## **Tackling the Issue-Steps in Design Thinking:**

Let's tackle the issue using the Design Thinking principles explained above. This section is the abstract view of our strategic plan to come up with a solution for the issue.

### **1. Empathise:**

- Preliminary: Exploratory and desk research. Strategic alignment meetings.
- Deep immersion: Crowdsourcing model and generative sessions

### **2. Define:**

- ‘Personas’ creation
- Definition of problem statement

### **3. Ideate:**

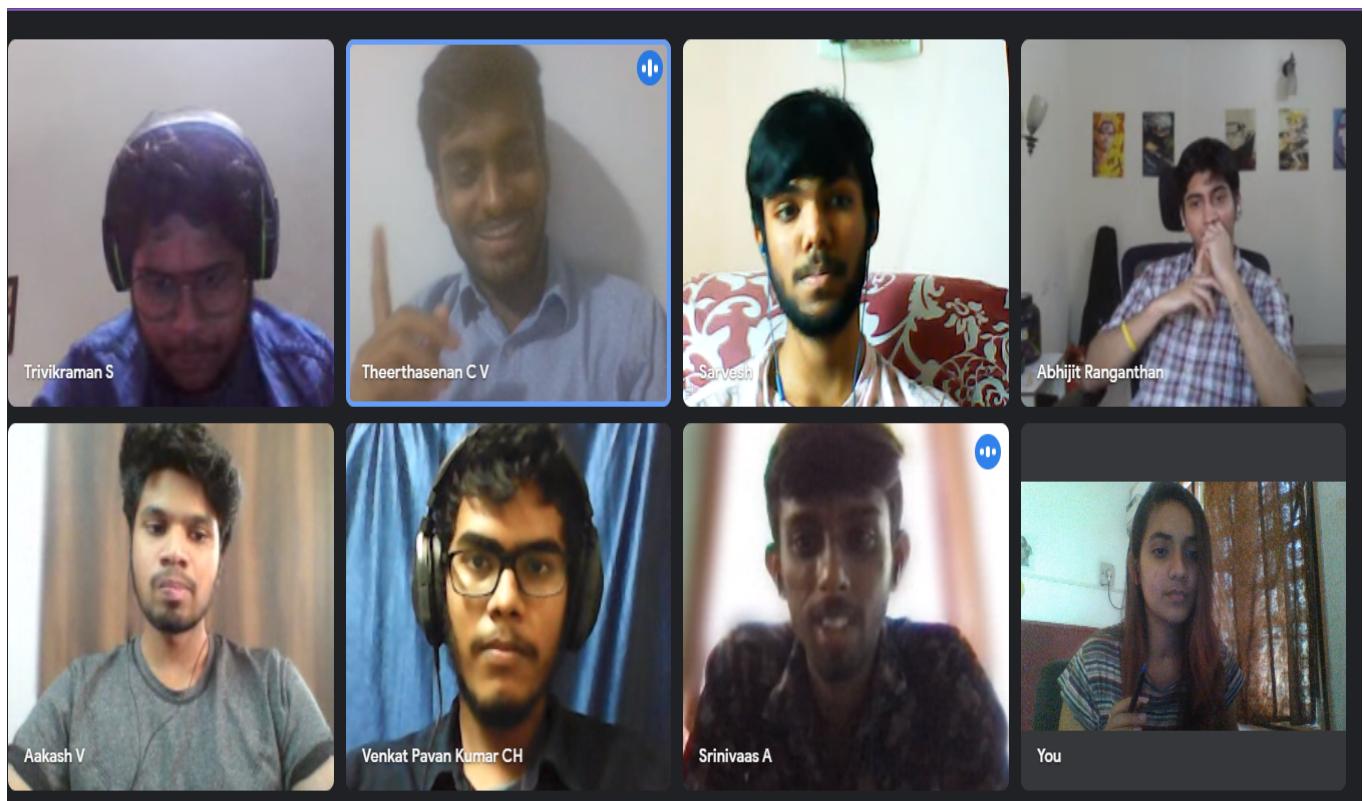
- Creating alternative smart home conceptions

### **4. Prototype and 5. Test:**

- Validation of the selected alternative
- Internal perspective: Design Thinking Project Team
- Contextual perspective: Stakeholders and target audiences

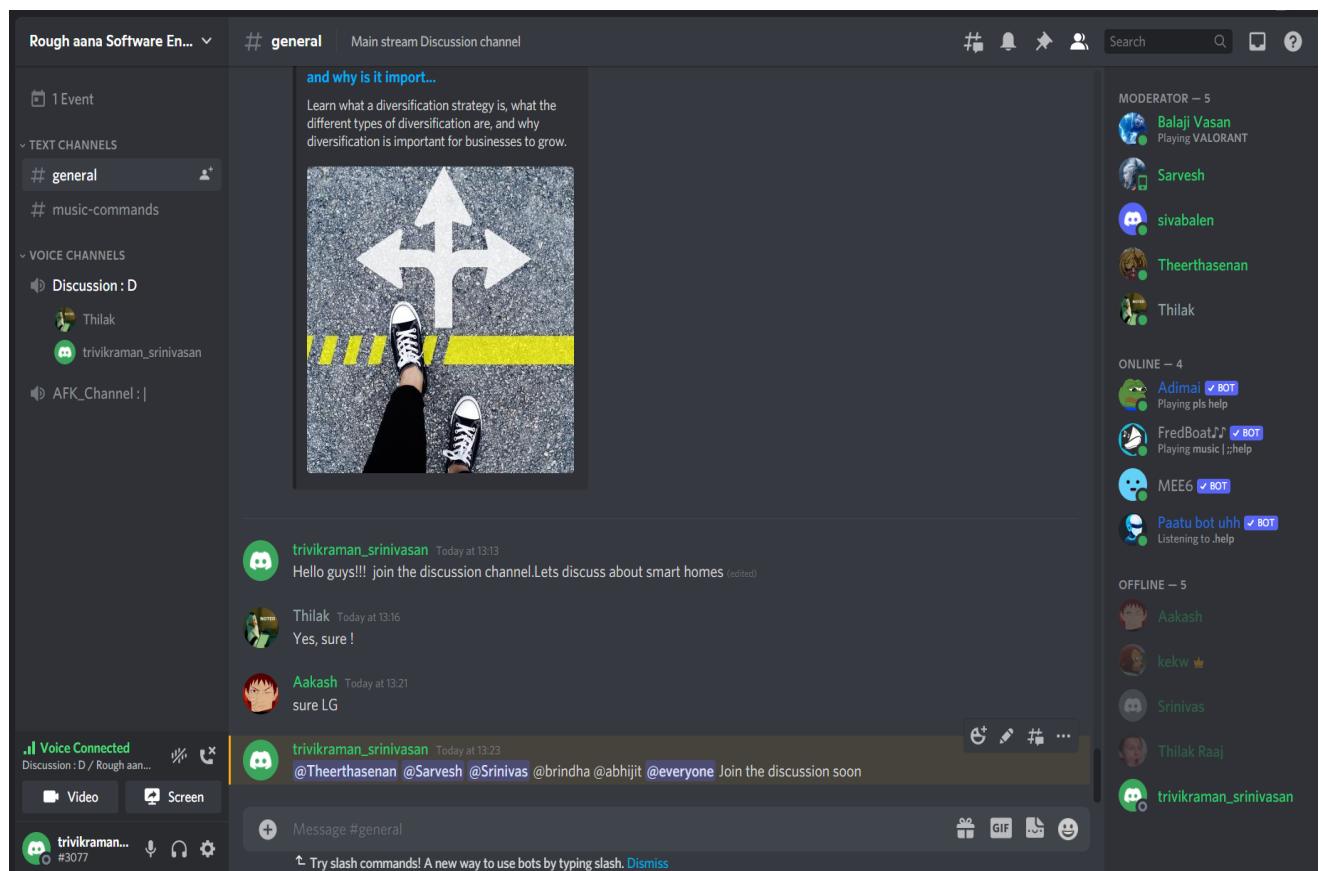
## **Brainstorming:**

During the brainstorming session, we reviewed the scientific literature and carried out an analysis on existing smart home models and projects around the world. Strategic alignment meetings were held involving the whole team, to find the problem and to reframe it with different perspectives of the project stakeholders. Concerning this, we tried to present a general picture of the future smart homes' service categories and respective functions associated with each service. We found that not many people are adopting the services of smart homes in our country, and there are a lot of reasons for this.



## Immersion Activity:

When members of the Design Thinking team have immersed themselves, and have experienced an abstract emotion of what the customer needs, their insights are sharper. On a digital collaboration platform, all those people who were interested in discussing topics related to the smart home projects can register and post their needs, expectations, and ideas about what a smart home should look like. This method consists of a model of collaboration and problem-solving, which took place online through web platforms - Discord and Reddit.



## **Empathising:**

We conducted Focus Group discussions to gain future residents' perceptions.

Eventually, this helped us build customer empathy.

Our team confronted numerous demanding situations at this stage. Participant identity and invitation was the most crucial step, for the reason that this approach was essentially based on organisation dynamics and synergistic relationships amongst individuals to generate data. Another essential challenge was the variety of respondents to be invited for the discussion sessions.

Finally, we discussed with various stakeholders through Google Forms. We ordinarily classified their challenges into four classes namely Cultural, Functional, Commercial and Perceptual and constructed a quadrant primarily based on the data they provided as:

The Empathy Quadrant

<p style="text-align: center;"><u>Cultural</u></p> <ul style="list-style-type: none"><li>• Service centric</li><li>• Joint families</li><li>• Varied literacy ratios</li><li>• Diversity of culture</li></ul>	<p style="text-align: center;"><u>Functional</u></p> <ul style="list-style-type: none"><li>• Elders and helps cannot operate</li><li>• Lack of technical expertise</li><li>• The click of the manual switch is reassuring</li></ul>
<p style="text-align: center;"><u>Commercial</u></p> <ul style="list-style-type: none"><li>• Price sensitive</li><li>• Not top of mind</li></ul>	<p style="text-align: center;"><u>Perceptual</u></p> <ul style="list-style-type: none"><li>• It's still a switch for on/off</li><li>• Will make me more lazy</li><li>• Technology is a friction</li><li>• Will increase my EB bill</li></ul>

## Google Form Template:

Our team conducted a survey to understand the background and specific perspectives of the users.



### SMART HOMES-SURVEY

This is a survey conducted to understand the public opinion on smart homes in order to develop a solution that addresses all/most of the requirements of an average customer.

 123018111@sastra.ac.in (not shared) 

\* Required

Name \*

Your answer

Email \*

Your answer

Favorite tech related activities \* 1 point

Your answer

Tell us about yourself (optional) 1 point

Your answer

Views and suggestions on smart homes \*

Your answer

<b>Age *</b>					
Your answer					
<b>Occupation *</b>					
Your answer					
<b>Orientation towards technology *</b>					1 point
1      2      3      4      5 <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>					
<b>Interests and Hobbies *</b>					
Your answer					

### Focus Group Interaction:

Our team members interacted with a focus group to understand their requirements.



Note: We use the data collected from these interactions and surveys to create the persona.

## Persona Creation:

### Persona 1:

General (Name, Age, Location)	<ul style="list-style-type: none"> <li>• Balaji Kumaresan</li> <li>• 32 years</li> <li>• Chennai</li> </ul>
Family Situation	<ul style="list-style-type: none"> <li>• Family of two ( himself and wife).</li> <li>• Mrs.Balaji is a dentist.</li> <li>• Financial burden shared between the two equally.</li> </ul>
Key interests or hobbies	<ul style="list-style-type: none"> <li>• Learning new technology</li> <li>• Gaming</li> <li>• Coding</li> <li>• Reviewing new gadgets in the market.</li> </ul>
Occupation	<ul style="list-style-type: none"> <li>• Software Developer</li> </ul>
Key Values/ motivations	<ul style="list-style-type: none"> <li>• Dedicated to his job</li> <li>• Coding is his passion</li> <li>• Tech Critique- finds faults in technology quickly as he is highly updated on latest technology</li> </ul>
Attitude to technology	<ul style="list-style-type: none"> <li>• Does not prefer investing in high capex or complex solutions.</li> <li>• Demands service backed products.</li> <li>• Prefers easy to deploy solutions that do not require any change in wirings or electrical.</li> </ul>
Favourite activities	<ul style="list-style-type: none"> <li>• Reviewing technology and gadgets .</li> <li>• Adopting technology that makes daily life easier and efficient .</li> </ul>
Pain Points	<ul style="list-style-type: none"> <li>• Wasting time in slow work .</li> <li>• Every minute counts with technology, time spent is lesser.</li> <li>• Frustrated with using normal switch wants to adopt smart switches and Smart Home Technology .</li> </ul>
Any other observation	<ul style="list-style-type: none"> <li>• Tries to develop new technology and makes people around him also adopt these technologies to make efficient use of time and for quality of life .</li> </ul>

Persona 2:

General	<ul style="list-style-type: none"> <li>● Rahul Raaj</li> <li>● 23 years</li> <li>● Bengaluru</li> </ul>
Family situation	<ul style="list-style-type: none"> <li>● Family of three (father, mother and himself)</li> </ul>
key interest/ hobbies	<ul style="list-style-type: none"> <li>● Watching sports matches and movies,</li> <li>● Building small electrical appliances for friends and family</li> </ul>
Occupation	<ul style="list-style-type: none"> <li>● Electrician</li> </ul>
Key values/ motivation	<ul style="list-style-type: none"> <li>● Interested in new gadgets and devices</li> <li>● Wishes to develop himself in his career though he is not from a well educated background.</li> </ul>
Attitude to technology	<ul style="list-style-type: none"> <li>● Not skilled for any complex technical job like programming.</li> <li>● Attends simple calls of households electrical Fittings or faults.</li> <li>● Finds installing Smart Home Technology into homes easy but tough to repair.</li> </ul>
Favourite activities	<ul style="list-style-type: none"> <li>● Repairing any electrical device</li> <li>● Building small products on his own.</li> </ul>
Pain points	<ul style="list-style-type: none"> <li>● Smart Home Technology requires complex repairing techniques which he is unaware of.</li> <li>● Repair services of smart home systems are beyond his scope.</li> </ul>
Any other observation	<ul style="list-style-type: none"> <li>● Not very educated .</li> <li>● Serves mostly in a particular locality.</li> <li>● Learn work from practice and experience.</li> </ul>

Persona 3:

General	<ul style="list-style-type: none"> <li>• Latha Kamarajan</li> <li>• 65 years old</li> <li>• Thanjavur</li> </ul>
Family Situation	<ul style="list-style-type: none"> <li>• Lives alone in her ancestral home.</li> <li>• 2 sons - married and settled in Chennai and Bangalore.</li> <li>• 2 granddaughters and a grandson.</li> </ul>
Key interests or hobbies	<ul style="list-style-type: none"> <li>• Farming</li> <li>• Animal husbandry</li> <li>• Cooking</li> </ul>
Occupation	<ul style="list-style-type: none"> <li>• Homebound</li> <li>• Manages agriculture business.</li> </ul>
Key Values/ motivations	<ul style="list-style-type: none"> <li>• Spiritual person.</li> <li>• Likes to keep the environment clean</li> <li>• Mostly homebound.</li> </ul>
Attitude to technology	<ul style="list-style-type: none"> <li>• Technically non- rational</li> <li>• Mostly homebound</li> <li>• Emergency help needed at times</li> <li>• Prefer ease of use / assisted use / health friendly.</li> <li>• Conventional thoughts towards use of technology</li> <li>• Restricts from adopting smart home technology though it is very helpful.</li> </ul>
Favourite activities	<ul style="list-style-type: none"> <li>• Watching news and TV serials on television.</li> </ul>
Pain Points	<ul style="list-style-type: none"> <li>• Lack of simplicity in usage in day to day activities.</li> <li>• Conservative thoughts towards use of technology.</li> <li>• Emergency help needed at times, prefer ease of use or assistance.</li> </ul>
Any other observation	<ul style="list-style-type: none"> <li>• Restricted movements and forgetful.</li> <li>• Health conscious.</li> <li>• Insecure of smart home systems getting hacked which might lead to security issues.</li> </ul>

Persona 4:

General	<ul style="list-style-type: none"> <li>• Vaijayanthi. R,</li> <li>• 35 years.</li> <li>• Chennai.</li> </ul>
Family Situation	<ul style="list-style-type: none"> <li>• Family of four (herself, husband and two children)</li> <li>• Belongs to a lower high income group.</li> </ul>
Key interests or hobbies	<ul style="list-style-type: none"> <li>• Checking out new technology for home applications</li> <li>• Home management.</li> </ul>
Occupation	<ul style="list-style-type: none"> <li>• Homemaker</li> </ul>
Key Values/ motivations	<ul style="list-style-type: none"> <li>• Wants children to grow up and be well settled</li> <li>• Wants family to be happy</li> <li>• Needs home to be managed efficiently</li> <li>• Emphasises on safety and security of her children.</li> </ul>
Attitude to technology	<ul style="list-style-type: none"> <li>• Does not actively follow innovations in technology, but is able to adapt to new changes quickly.</li> </ul>
Favourite activities	<ul style="list-style-type: none"> <li>• Cooking</li> <li>• Home activities</li> <li>• Television shows,</li> <li>• Spending time with family.</li> </ul>
Pain Points	<ul style="list-style-type: none"> <li>• Inefficient work at home.</li> <li>• Finds it frustrating to have different controls for different appliances at home.</li> <li>• Family behaving ignorant about budget planning and security.</li> </ul>
Any other observation	<ul style="list-style-type: none"> <li>• Saves money regularly for children's education.</li> <li>• A budget strategist considering adopting smart home systems for efficiency.</li> </ul>

## **Defining the Problem and Drafting the Problem Statement:**

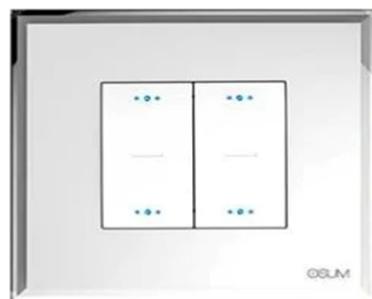
After a chain of discussions, our Design Thinking team found out the expectations of the customers in this regard. The customers wanted it to be:

1. Easy to plan and install
2. Service backed
3. Modular
4. Suitable for Indian environment
5. Valuable for the cost
6. A single solution
7. Flexible
8. Easy to maintain and service
9. Robust
10. Future ready and backward compatible
11. Customisable to individual's needs
12. Easily Scalable
13. Easy to use by everyone in the household
14. Functional and aesthetically pleasing
15. Secure



## **Ideation:**

The main purpose of the ideation phase is to create alternative smart home conceptions, which come to meet the selection criteria and persona's aspirations that were defined in the previous phase. We came up with the idea of a smart switch . Only requirement from the customer end is a mobile phone with our application installed in it. All the other devices are integrated thereby making this smart switch as a control for everything in the house - A one stop solution.



### Features of our smart switch:

#### 1. Lighting Automation:

As our smart switch is controlled by an android application, it is programmable. It can be used to control lighting in the room. It is also designed in such a way that it can automatically change lighting based on past data and moods of the user

#### 2. Climate Control:

We can control the Air Conditioner temperature and program it in such a way that it needs to be maintained at a particular temperature for a certain period of time.

**3. Curtain Control:**

With the help of sensors it can control movements of curtains i.e. it opens the curtains when the sun rises.

**4. IR Control:**

It can replace the IR remote control, a wireless device used to operate audio, video and other electronic equipment within a room using light signals in the Infrared (IR) range.

**5. AV Control:**

It can replace the Audio Video control system as we can control them with the help of our phone in the app.

**6. Security Integration:**

It also has certain sensors used for home security purposes. Fire in the house can be detected and emergency messages are sent accordingly

**7. Switch Level Protection:**

It has an inbuilt fuse and zero cross over protection.

**8. Voice Recognition:**

We can switch on devices around with voice commands through the app.

**9. 3rd Party Integration:**

We can integrate anything we want with the switch. For example, Uber can also be integrated with it. Switching off all lights, fans before Uber arrival.

**10. Touch On/Off:**

Apart from the mobile app we can also use the touch interface of the switch.

## **Prototyping:**

In this phase, we expanded the concept space which resulted in the ideas materialising associated with the smart home concept in order to represent the captured reality and provide the validation of all detained contents. Prototyping is carried out according to: (i) the internal perspective (Design Thinking project team); and (ii) the context perspective (project stakeholders and users). After the internal validation of the selected smart home concept, we validated the smart home concept with the representatives of future resident profiles and project stakeholders. In this phase we planned for an architectural pre-design in which much of the work does not really involve the production of the project document per se. In this pre-design phase, the technical team worked closely with us to define and clarify the basic ideas. The outcome of this phase is a virtual tour video of the selected smart home concept.



Link:<https://www.youtube.com/watch?v=ShTn-HMw7rU>

In this video, we have demonstrated a prototype with normal two-way switch instead of smart switch mentioned in ideation phase. It is not economically feasible for us to create a smart switch so here we have pointed out one of the important add on features of smart switch i.e voice recognition with the two way switch using Alexa.

## **Testing:**

When designing for a classical screen-based interface, there are several heuristics (or usability principles) that are often used to evaluate the problems associated with the design of the interface such as Nielsen's heuristics. Some of them can also be applied to an IoT-based system and we believe that several new heuristics specific to IoT will arise with the spread of the field. We aim to identify such evaluation indicators by the end of this research project. Another way to evaluate a prototype is the use of usability testing methods. There are various methods that can be used, such as the "thinking aloud", where the tester is asked to talk aloud his thoughts while using the system. The process of a usability test is basically the same for every method. You first pick representative users to test your system, then you select a typical and well described scenario that the user will be performing in the test, and finally you report the results. Moreover, if high-fidelity prototypes were developed in the previous phase, quantitative usage data logged by the systems may be analysed in this phase as a useful complement to the data obtained from qualitative testing methods.

Since there are various guidelines and methods described in the literature about usability testing and we are only at the stage of prototyping in our use-case, we will not explain this step in further detail.

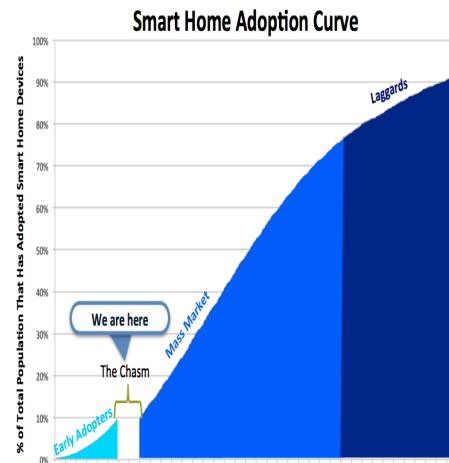
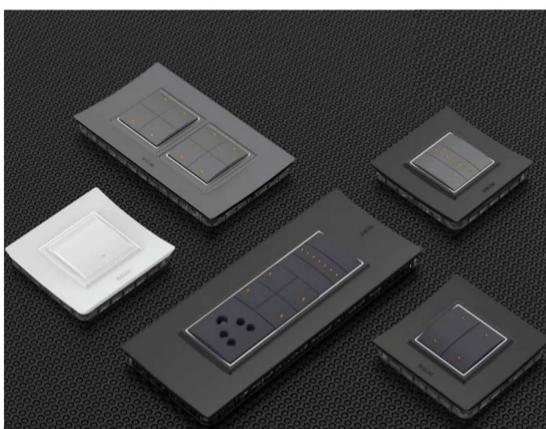
## **Retracing and Re-defining:**

At the end of the evaluating phase, test results are reported. It is in this “Refine” phase that the results of these tests are handled and transformed into new adjustments for the next cycle of the product in the iterative loop of the methodology. As we are adopting prototyping SDLC model for our product development, a basic prototype is distributed to a small community of users and their feedback is used for further tuning. After receiving feedback regarding technical aspects and feasibility of the product idea, the whole process is again repeated for further enhancement. As our product is in prototype stage we are yet to present our product as an alpha version to users and stakeholders.



## Conclusion:

The move from technology-driven research towards an user-centric approach has enabled researchers and designers to explore the potential development of a broader scope of services to fulfil more user segments and encompass all the potential benefits of adoption of this technology. After going through the various stages of Design Thinking our team came to a conclusion that making people adopt smart switches boosts the rate of adopting Smart Home Technology. We have also demonstrated the advantages of a smart switch with a prototype. To conclude, we would say that since in India the adoption of Smart Home Technology is very less because of various reasons pointed out above in the document, adopting smart switches would be a start to the users.



**References:**