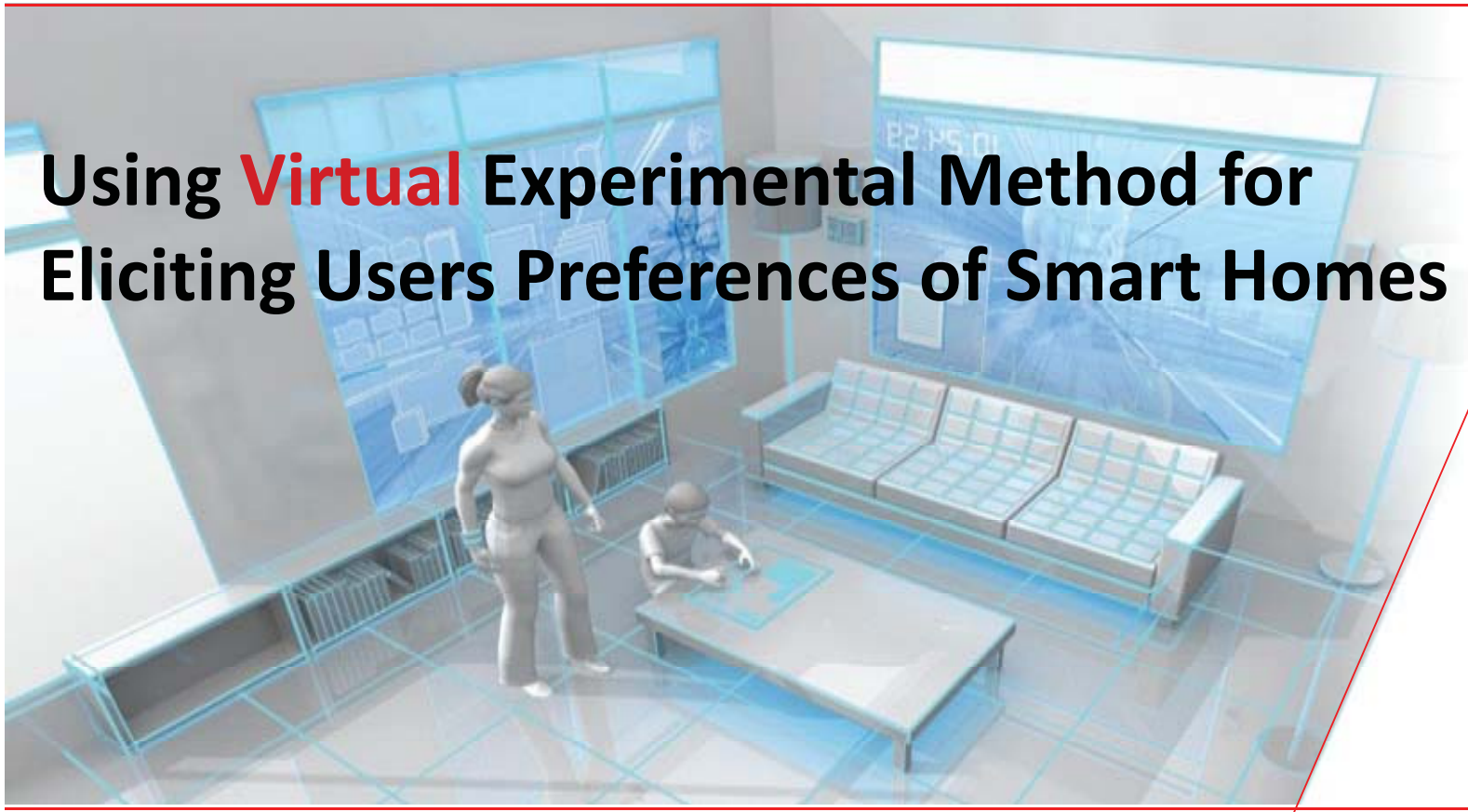
# Interactive application of a virtual smart home

# Using Virtual Experimental Method for Eliciting Users Preferences of Smart Homes



Erfaneh Allameh, Mohammadali Heidari, Bauke de Vries, Harry Timmermans

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# What are Smart Homes?

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# What are Smart Homes?

# What are Smart Homes?

Smart Floor

Smart Furniture

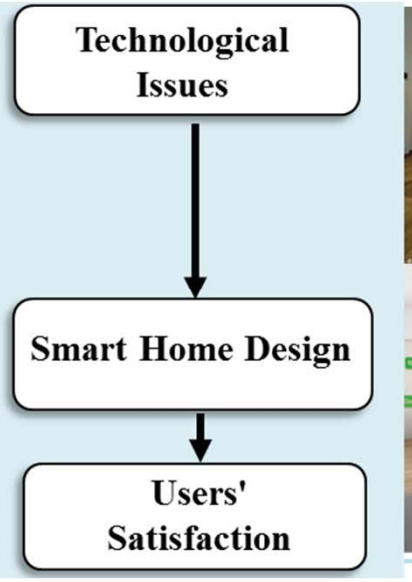
Smart Kitchen Table

Smart Furniture

Smart Wall

# Challenges in front of Smart Homes

- **Smart Homes are both predictable and achievable, but still not exist.**
  *This is too **luxury.***
  *This is **good only for lab not for real life.***
  *This is not **for them – their gender, age, income, background.***
  *This does not **fit into their values and daily routines.***
  *This **make their home complicated.***



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# Involving Users Preferences in Smart Home Design

- It is essential to involve users preferences in smart home design.
- Smart home should be a home and a place to live.

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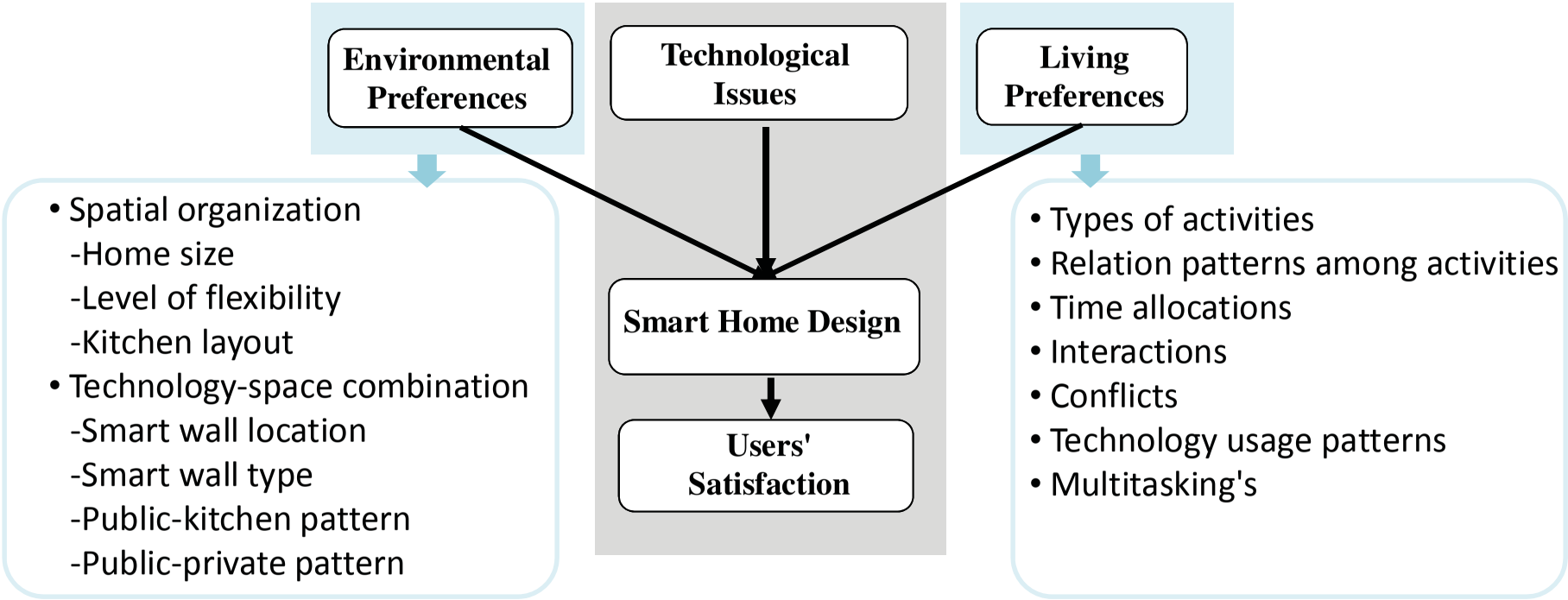
# Involving Users Preferences in Smart Home Design

- **We propose to consider different features of users' preferences together with technology installations during the process of smart home design.**



# How Can We Elicit Users Preferences?

- **To know users latent preferences, we need to:**

  -Let users **say** what they want.

  -Observe users what they **do** inside a smart home.

  -Let users **make** changes in the environment of a smart home.

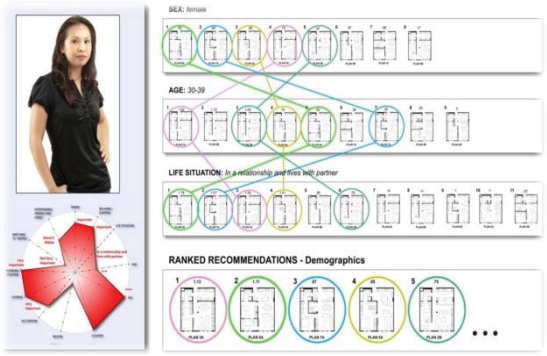
  **While making Flexible Living Lab with changeable settings is Cost-intensive &Time-consuming**

- **We apply virtual methods for eliciting users' preferences.**

Open Living Laboratory

# Related works for applying virtual methods

## Non-smart environments Spatial Preferences




**Home Genome Project**
(Larson & Smithwick, 2010)

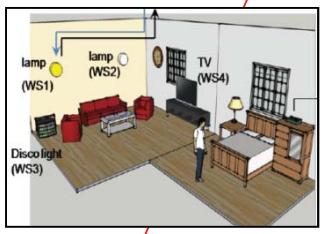
## Non-smart environments Living Preferences

**Tabak Activity Simulator**
(Tabak & de Vries,2010)

## Smart environments No User Preferences

**ISS**
(Van Nguyen et al. 2009)

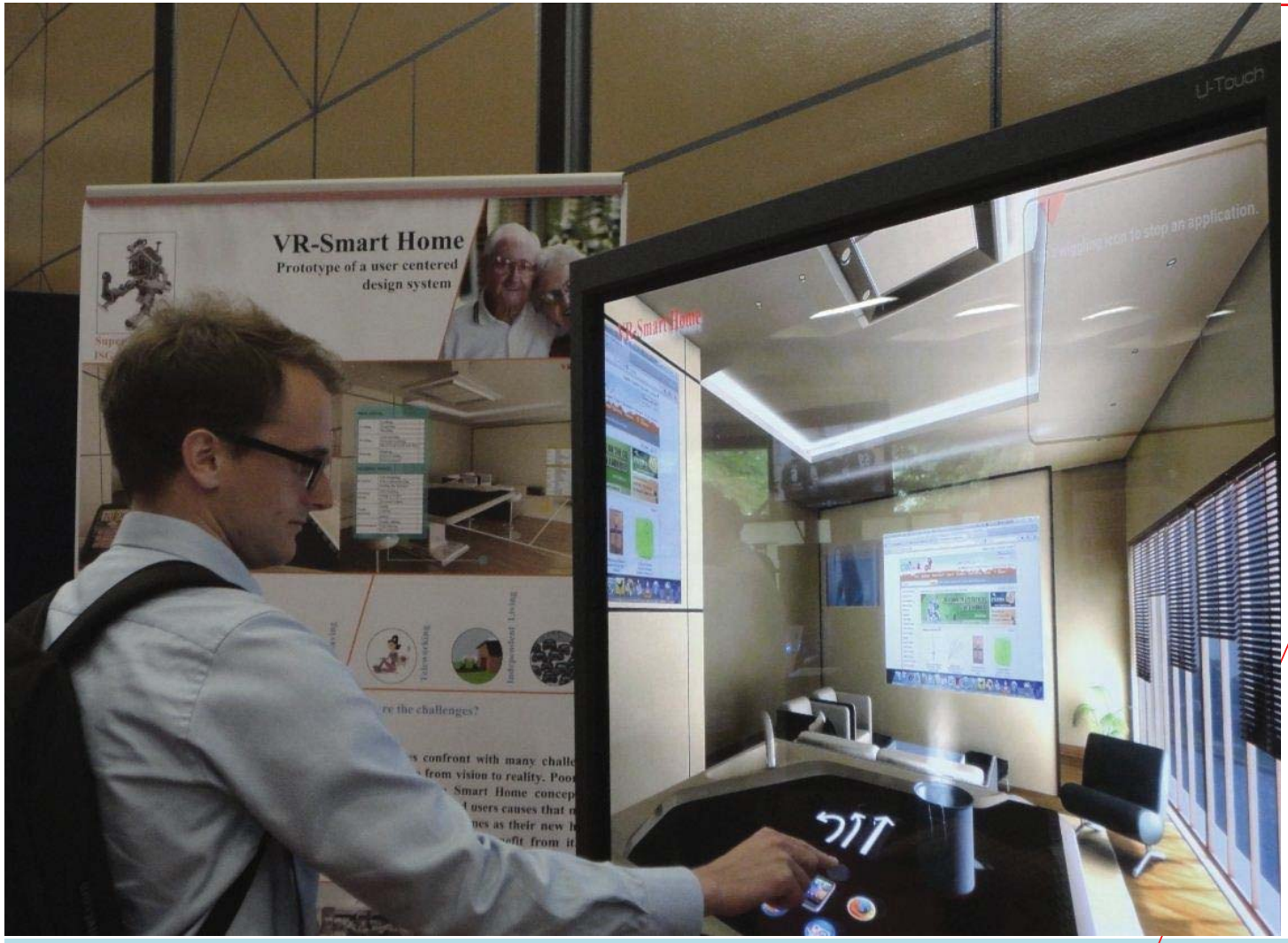
**CASS**
(Park et al. 2007)

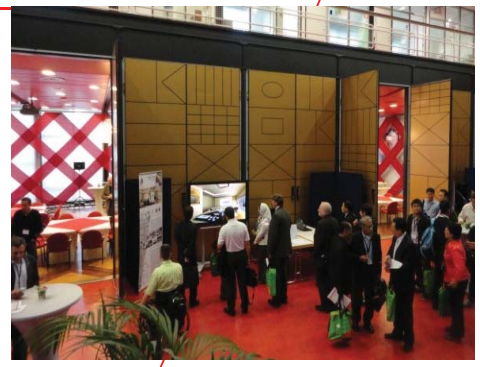



**ViSi/SM4All**
(Lazovik et al. 2009)

**V-PlaceSims**
(Lertlakkhanakul et al. 2008)

# The First Virtual Experiment



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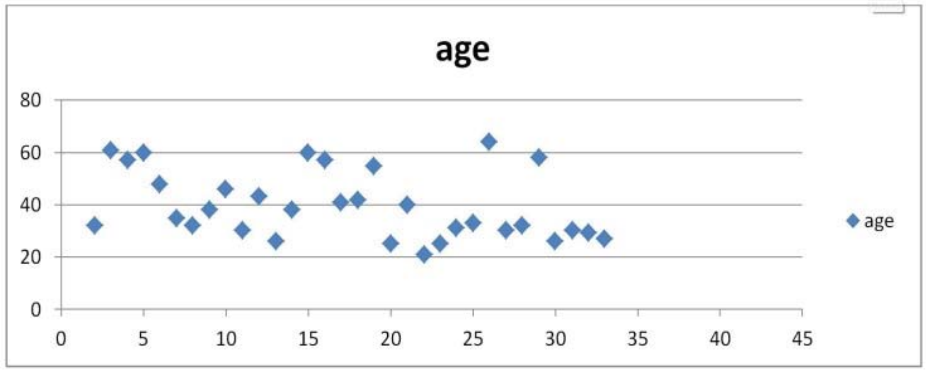
# Evaluation of the First Virtual Experiment

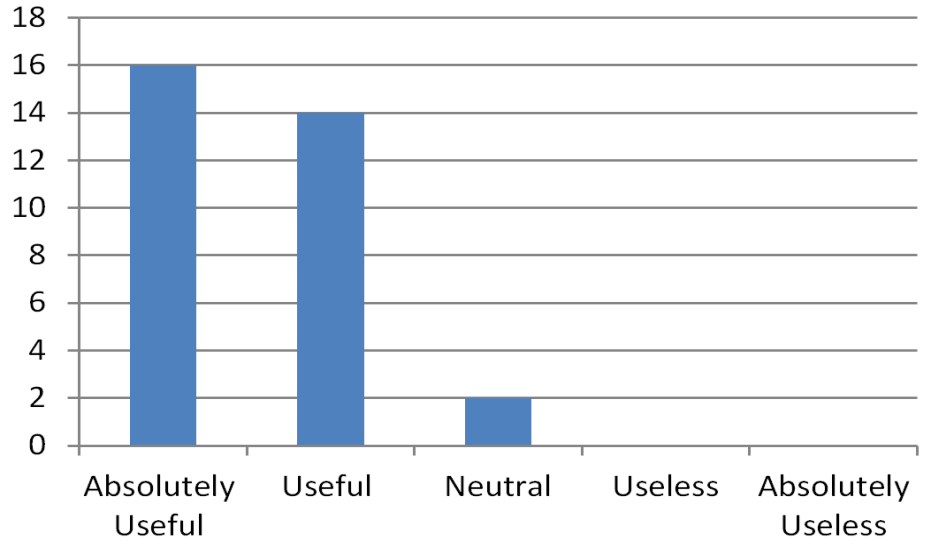
**32 Participants with**

- **Different ages of 20 to 65 years old**
- **Different countries such as,**
  Germany, Italy, Spain, Japan, America, England, Australia, Costa Rica, Albania, Iran and Netherlands




**The majority of participants find the VR prototype useful in improving their understanding of Smart Homes.**

**There are also relation among perceived usefulness of application and the smart home acceptance.**



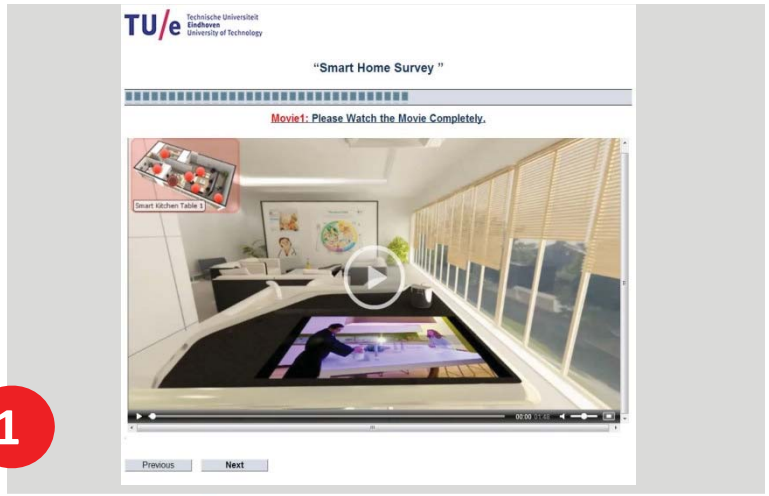
# Evaluation of the First Virtual Experiment

**Meaning that the amount of perceiving smart home usefulness and accepting it is related to the explorations of participants during the tasks.**

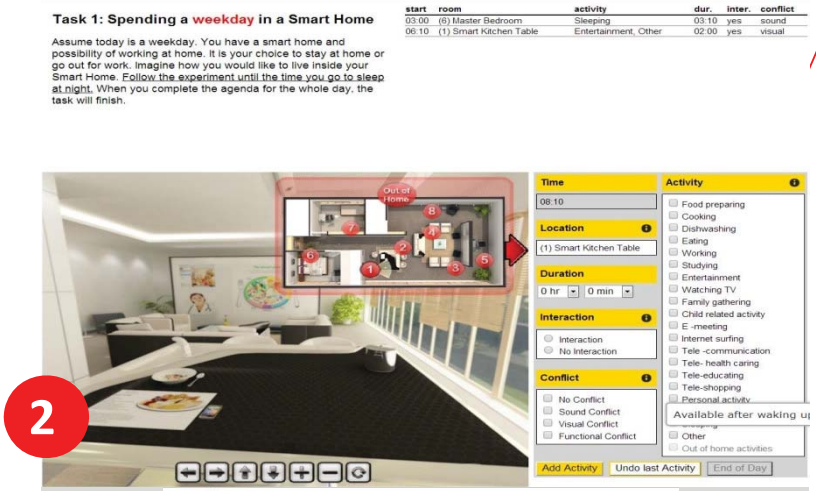
**Referring to these findings, we conclude that applying virtual methods in smart home design can increase users` understanding of smart homes.**

**The better users understand the smart home, the better they can express their preferences.**

# The Implemented Virtual Experimental Method




1

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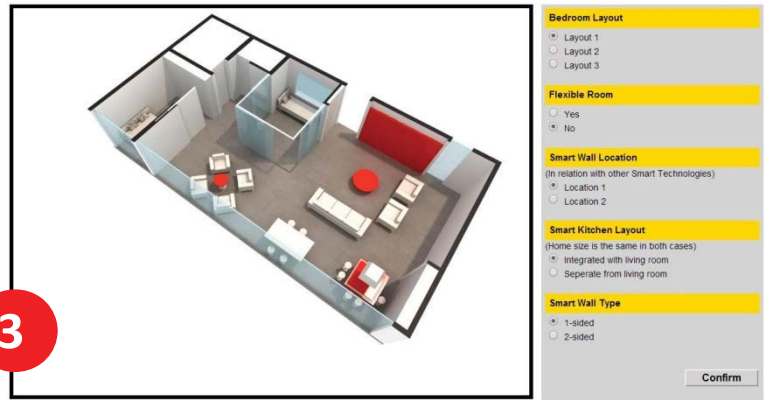


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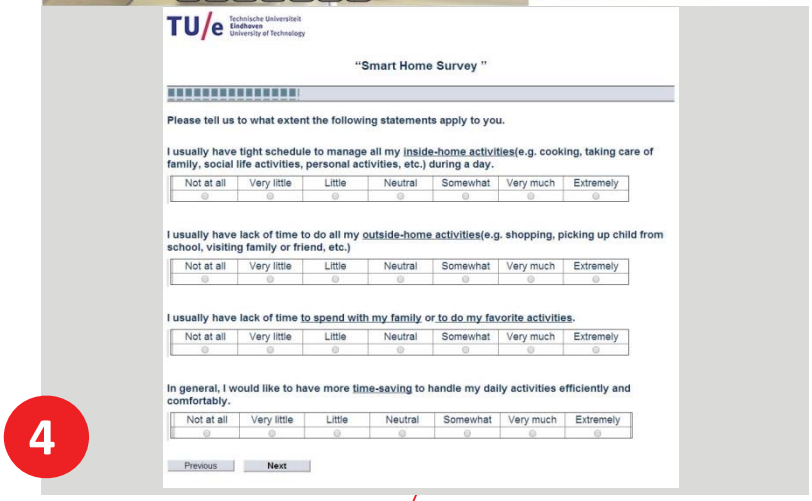


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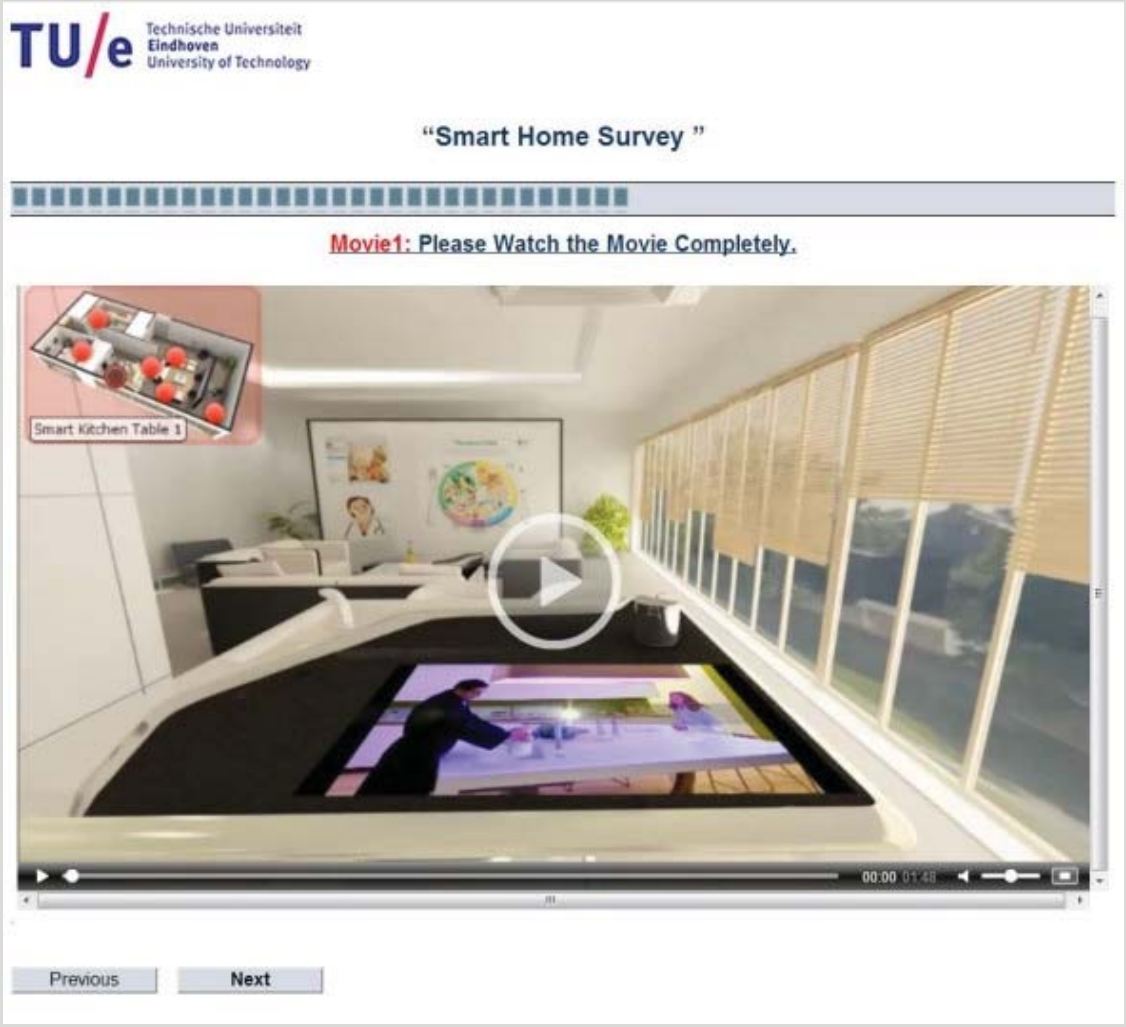
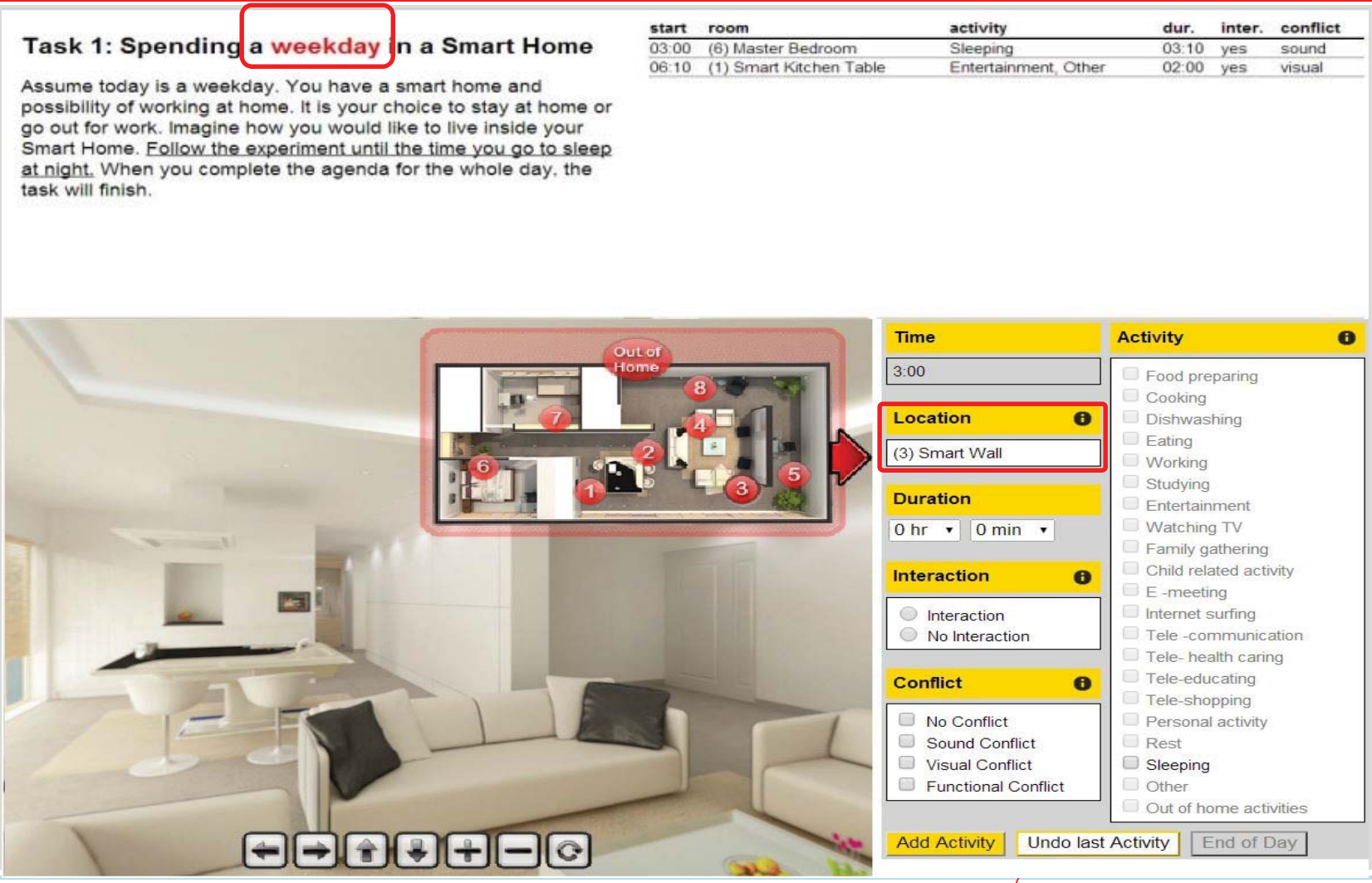
# Part1: A Virtual Tour Through The Smart Home



# Part2: Activity Arrangement

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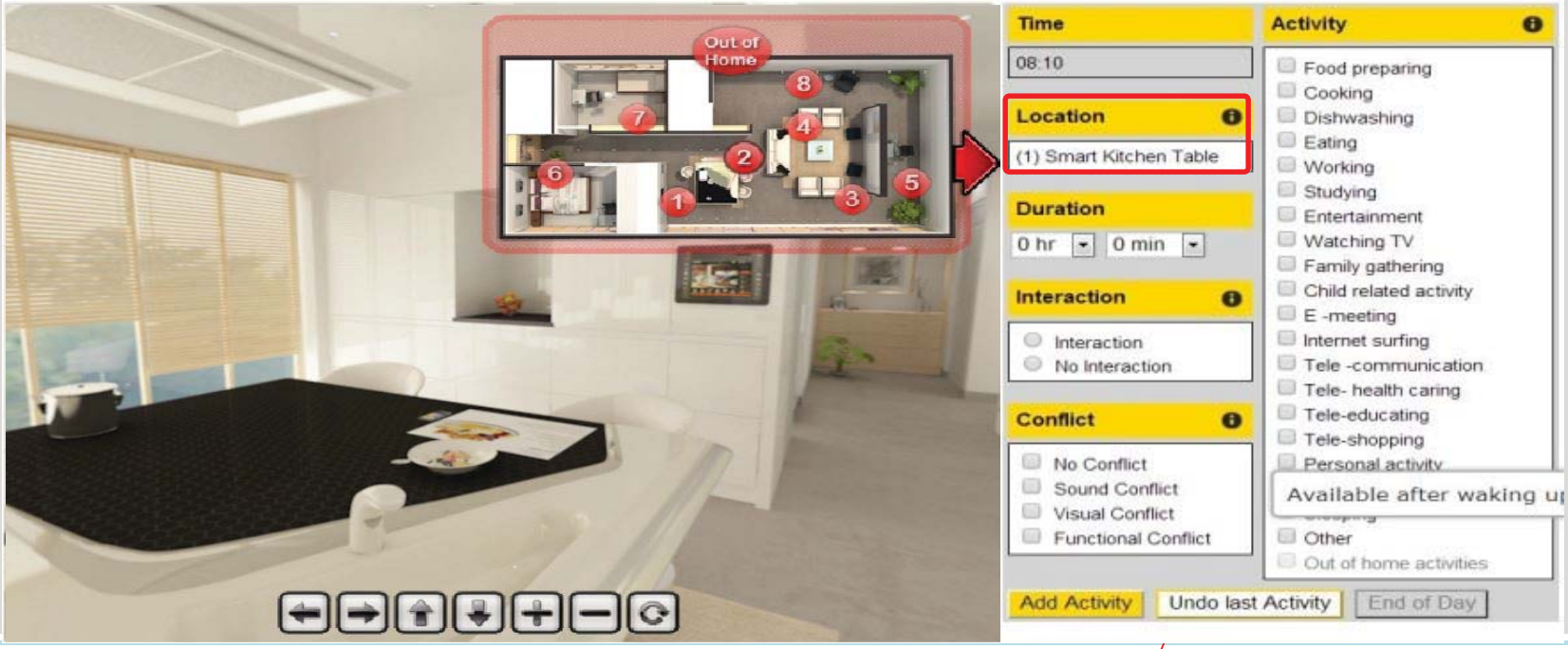
# Part2: Activity Arrangement

**Task 1: Spending a weekday in a Smart Home**

Assume today is a weekday. You have a smart home and possibility of working at home. It is your choice to stay at home or go out for work. Imagine how you would like to live inside your Smart Home. Follow the experiment until the time you go to sleep at night. When you complete the agenda for the whole day, the task will finish.

| start | room | activity | dur. | inter. | conflict |
|---|---|---|---|---|---|
| 03:00 | (6) Master Bedroom | Sleeping | 03:10 | yes | sound |
| 06:10 | (1) Smart Kitchen Table | Entertainment, Other | 02:00 | yes | visual |



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|---|---|---|---|---|---|
| 03:00 | (6) Master Bedroom | Sleeping | 03:10 | yes | sound |
| 06:10 | (1) Smart Kitchen Table | Entertainment, Other | 02:00 | yes | visual |


**Time**
08:10

**Location**
(1) Smart Kitchen Table

**Duration**
0 hr 0 min

**Interaction**
- Interaction
- No Interaction

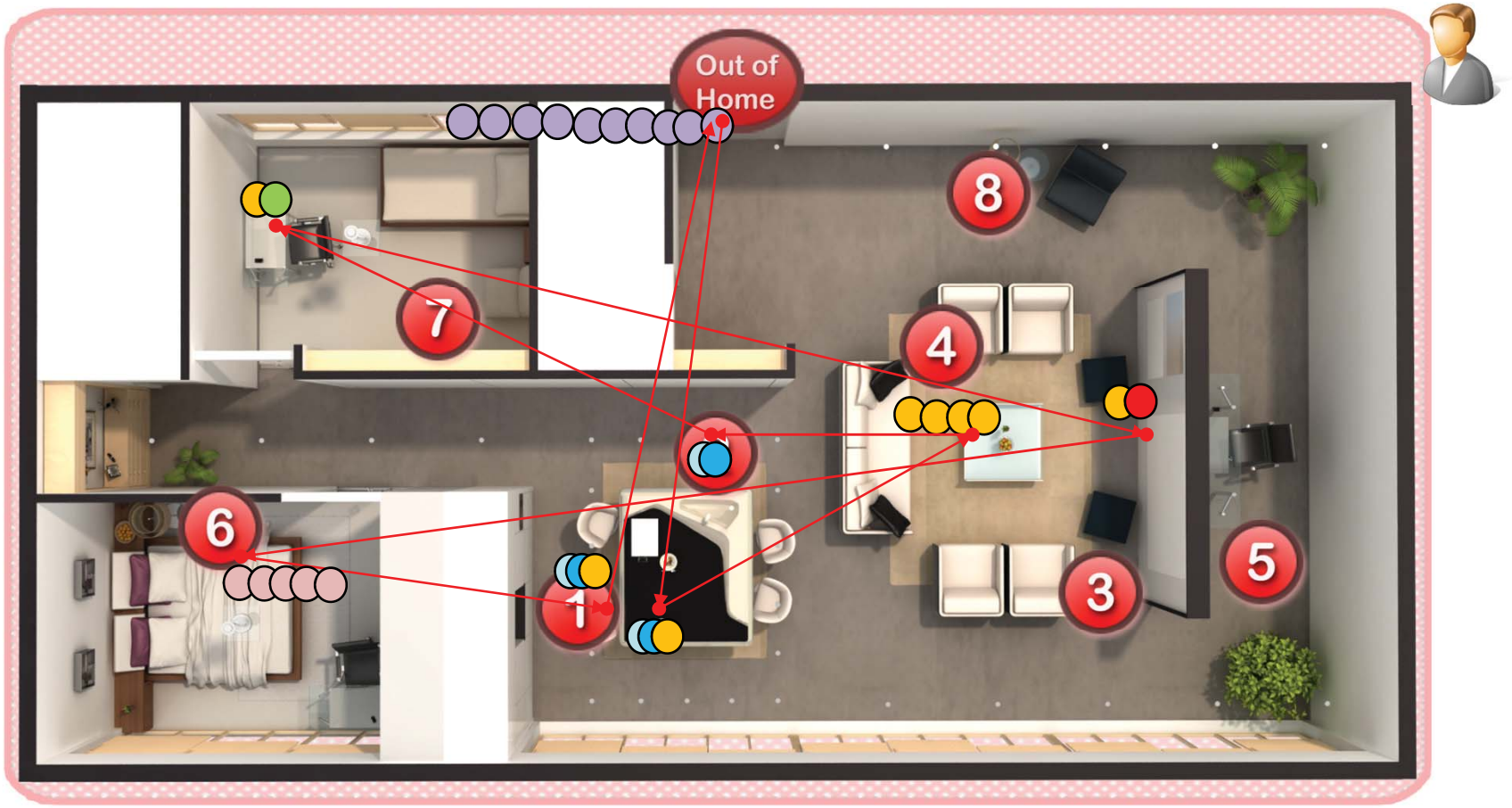
**Conflict**
- No Conflict
- Sound Conflict
- Visual Conflict
- Functional Conflict

**Activity**
- Food preparing
- Cooking
- Dishwashing
- Eating
- Working
- Studying
- Entertainment
- Watching TV
- Family gathering
- Child related activity
- E -meeting
- Internet surfing
- Tele -communication
- Tele- health caring
- Tele-educating
- Tele-shopping
- Personal activity

Available after waking

- Other
- Out of home activities

Add Activity | Undo last Activity | End of Day




Kitchen related activities

Eating

Secondary

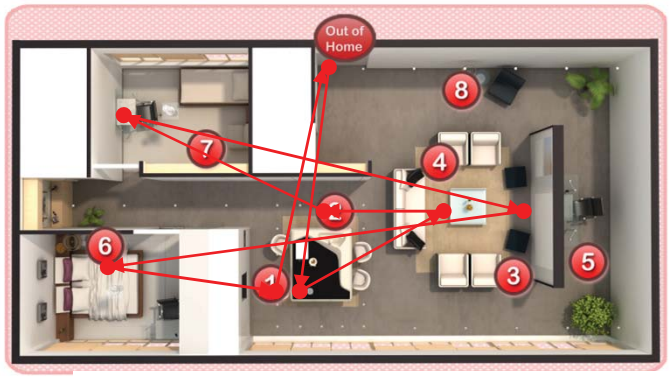
Work

Out of home

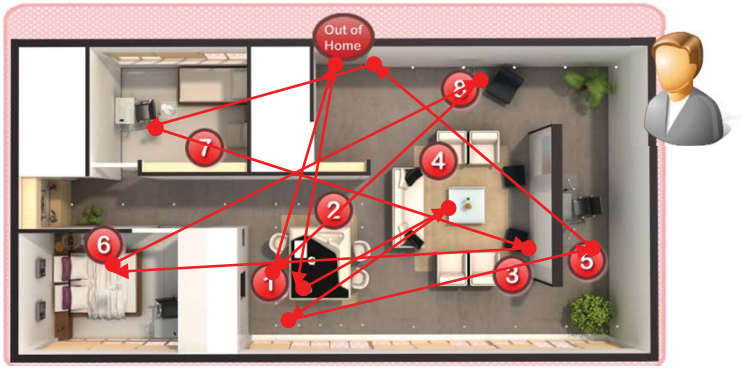
Tele activities

Sleeping

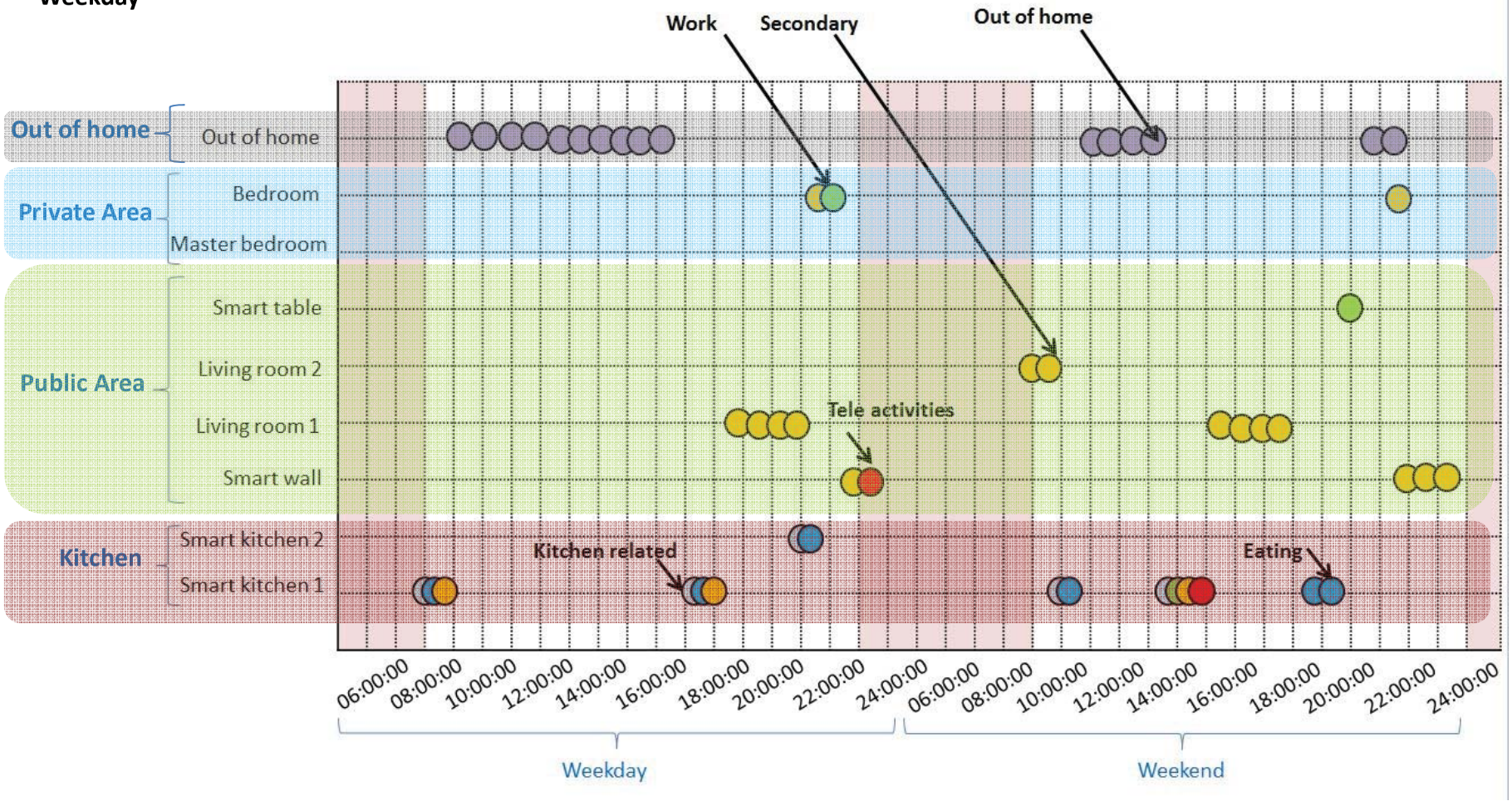
## Weekday




Weekday



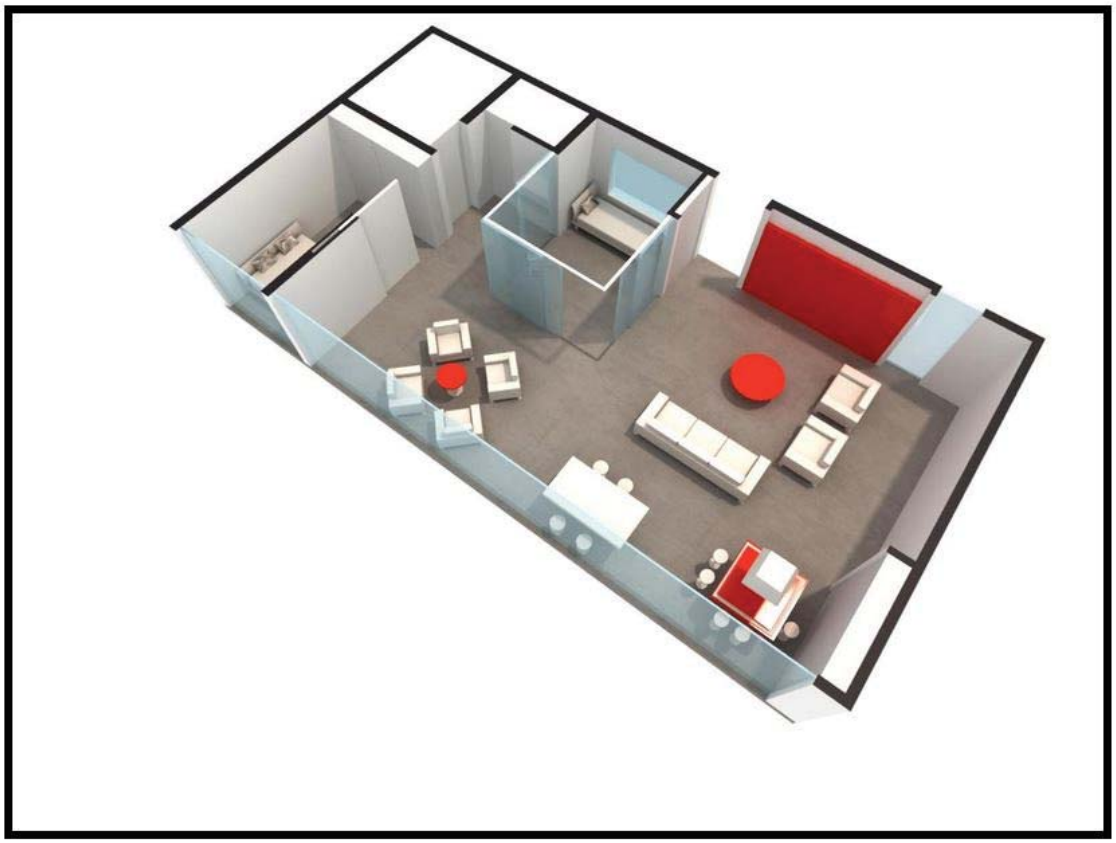

Weekend



# Part3: Environment Arrangement

**Task 1: Make your favorite 125 m² Smart Home**

Using the toolbars, you can see multiple alternatives for each part. By selecting the alternative you like the most for each part, you can make your favorite layout. Be sure that you explore **all the possible combinations** of the presented Smart Home. When you reach into a final decision, click on the confirm button to continue the experiment. (The Red Objects show Smart technologies inside home).



**Bedroom Layout**
- (•) Layout 1
- ( ) Layout 2
- ( ) Layout 3

**Flexible Room**
- ( ) Yes
- (•) No

**Smart Wall Location**
(In relation with other Smart Technologies)
- (•) Location 1
- ( ) Location 2

**Smart Kitchen Layout**
(Home size is the same in both cases)
- (•) Integrated with living room
- ( ) Seperate from living room

**Smart Wall Type**
- (•) 1-sided
- ( ) 2-sided

Confirm

# Part3: Environment Arrangement

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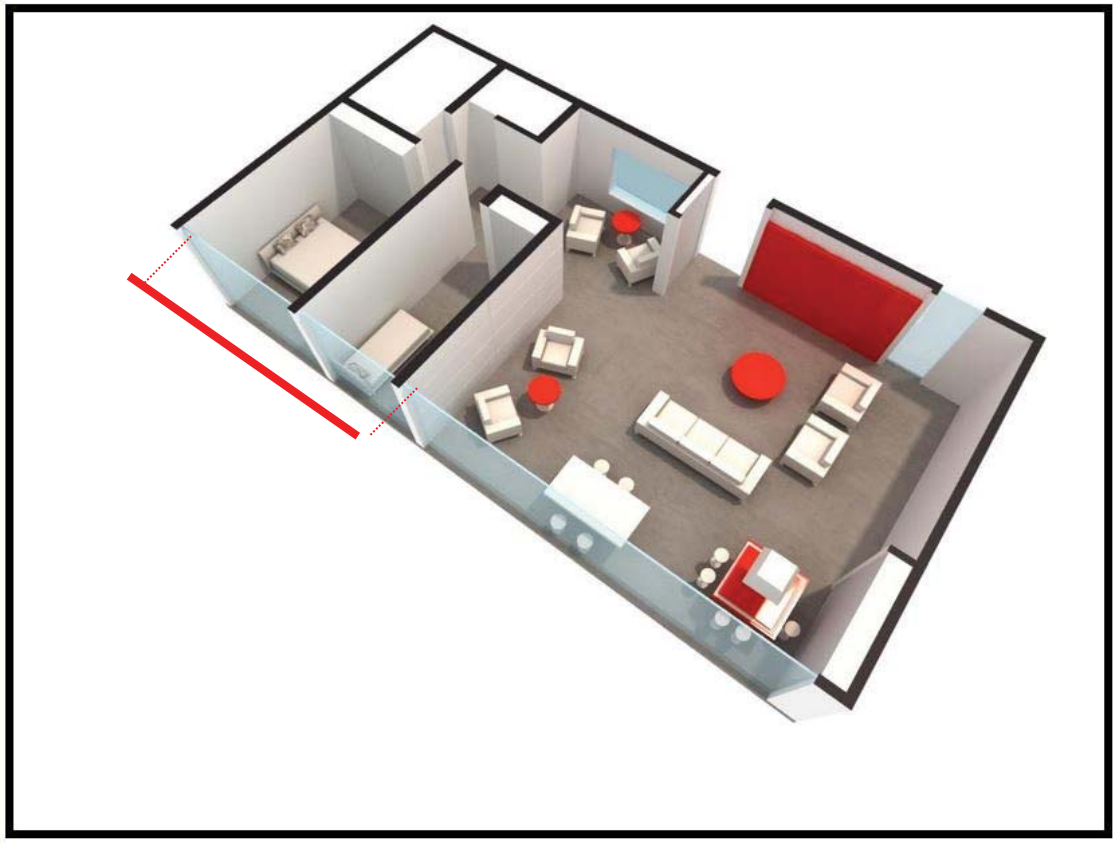

**Bedroom Layout**

- ○ Layout 1
- ◉ Layout 2
- ○ Layout 3

**Flexible Room**

- ○ Yes
- ◉ No

**Smart Wall Location**

(In relation with other Smart Technologies)

- ◉ Location 1
- ○ Location 2

**Smart Kitchen Layout**

(Home size is the same in both cases)

- ◉ Integrated with living room
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**Smart Wall Type**

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Confirm

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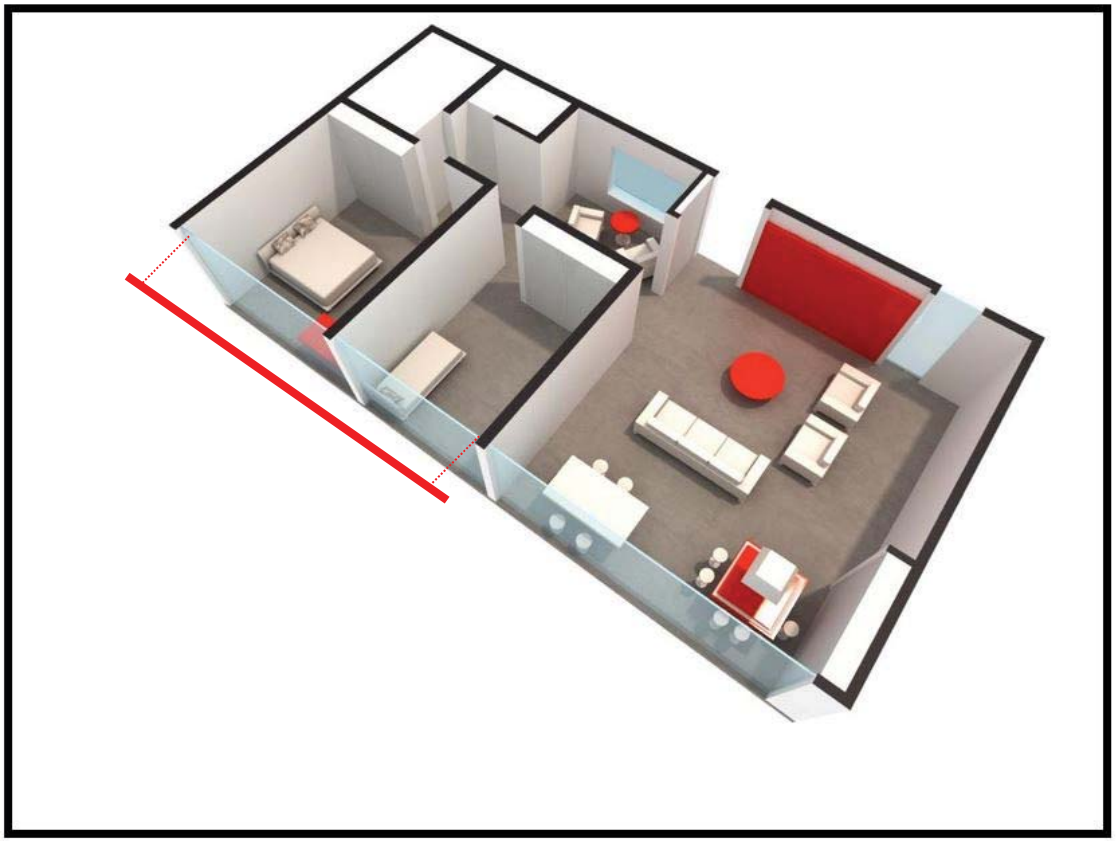

**Bedroom Layout**

- ○ Layout 1
- ○ Layout 2
- ◉ Layout 3

**Flexible Room**

- ○ Yes
- ◉ No

Flexible room is not compatible with Layout 3

**Smart Wall Location**

(In relation with other Smart Technologies)

- ◉ Location 1
- ○ Location 2

**Smart Kitchen Layout**

(Home size is the same in both cases)

- ◉ Integrated with living room
- ○ Seperate from living room

**Smart Wall Type**

- ◉ 1-sided
- ○ 2-sided

Confirm

# Part3: Environment Arrangement

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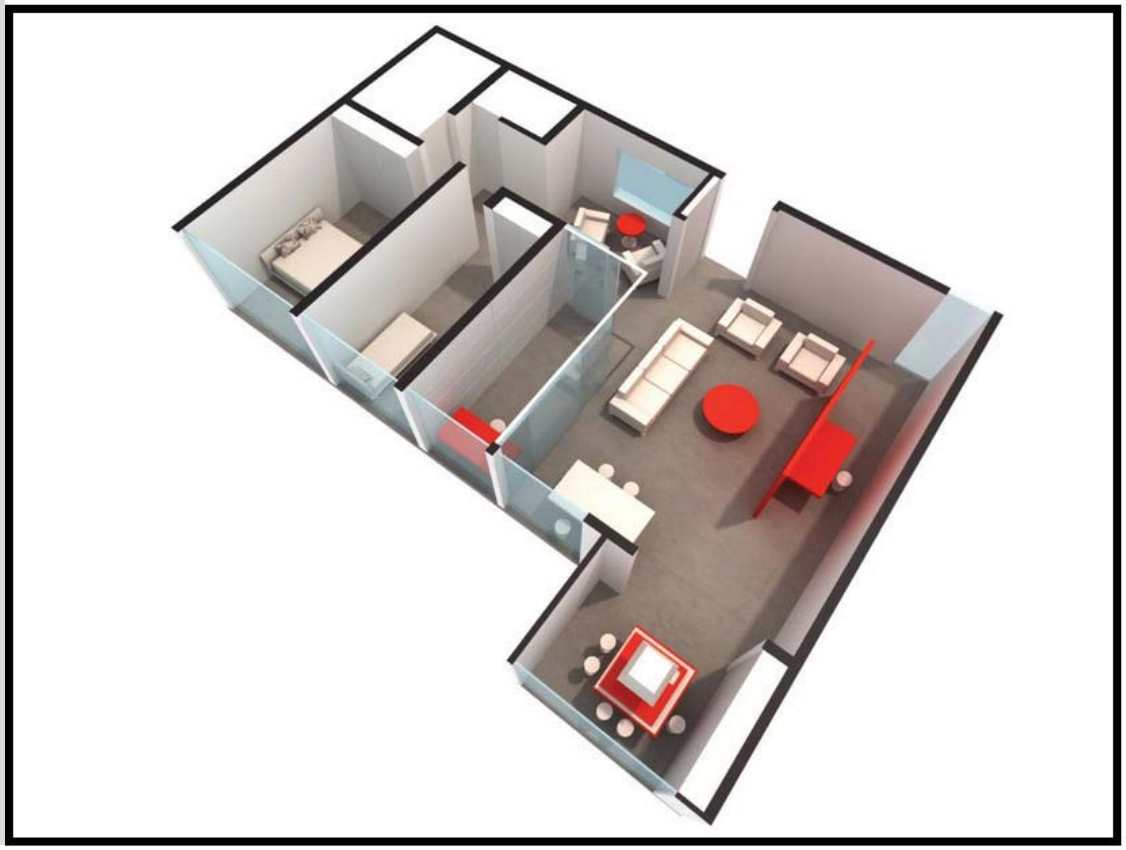

**Bedroom Layout**

- ○ Layout 1
- ◉ Layout 2
- ○ Layout 3

**Flexible Room**

- ◉ Yes
- ○ No

**Smart Wall Location**

(In relation with other Smart Technologies)

- ○ Location 1
- ◉ Location 2

**Smart Kitchen Layout**

(Home size is the same in both cases)

- ○ Integrated with living room
- ◉ Seperate from living room

**Smart Wall Type**

- ○ 1-sided
- ◉ 2-sided

Confirm

# Part4: Complementary questionnaire

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"Smart Home Survey "

Please tell us to what extent the following statements apply to you.

I usually have tight schedule to manage all my inside-home activities(e.g. cooking, taking care of family, social life activities, personal activities, etc.) during a day.

| Not at all | Very little | Little | Neutral | Somewhat | Very much | Extremely |
|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

I usually have lack of time to do all my outside-home activities(e.g. shopping, picking up child from school, visiting family or friend, etc.)

| Not at all | Very little | Little | Neutral | Somewhat | Very much | Extremely |
|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

I usually have lack of time to spend with my family or to do my favorite activities.

| Not at all | Very little | Little | Neutral | Somewhat | Very much | Extremely |
|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

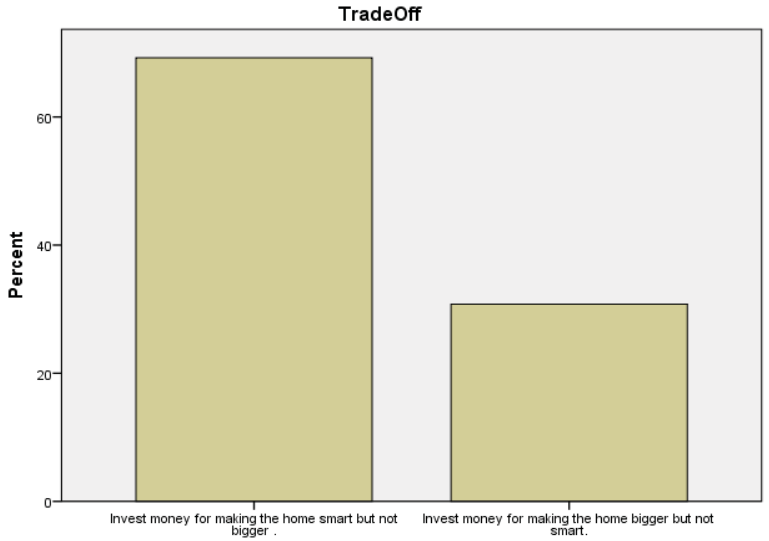
In general, I would like to have more time-saving to handle my daily activities efficiently and comfortably.

| Not at all | Very little | Little | Neutral | Somewhat | Very much | Extremely |
|---|---|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ | ○ | ○ |

Previous Next

# Outcomes

**If you have limited budget, would you like to invest money for making your home smart or bigger?**

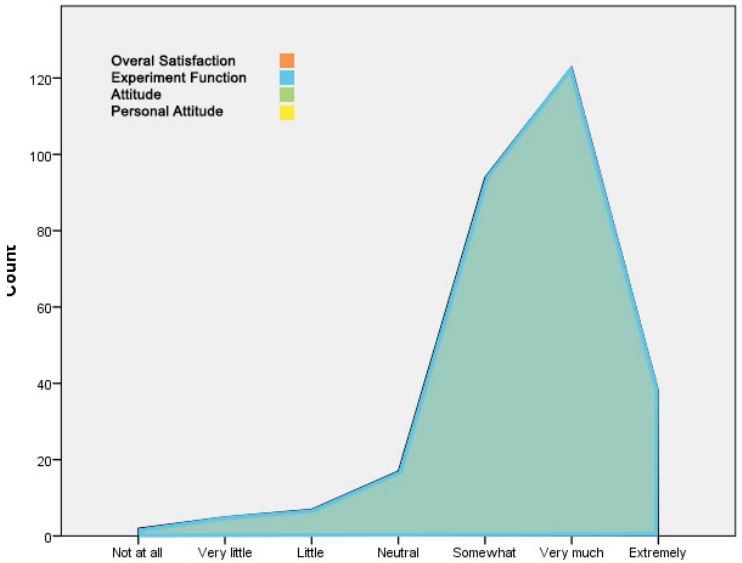



**TradeOff**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Invest money for making the home smart but not bigger . | 198 | 63.7 | 69.2 | 69.2 |
| | Invest money for making the home bigger but not smart. | 88 | 28.3 | 30.8 | 100.0 |
| | Total | 286 | 92.0 | 100.0 | |
| Missing | System | 25 | 8.0 | | |
| Total | | 311 | 100.0 | | |

# Outcomes

**To what extent do you think the virtual experiments you performed in this questionnaire improve your understanding of a smart home?**




| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Not at all | 2 | .6 | .7 | .7 |
| | Very little | 5 | 1.6 | 1.7 | 2.4 |
| | Little | 7 | 2.3 | 2.4 | 4.9 |
| | Neutral | 17 | 5.5 | 5.9 | 10.8 |
| | Somewhat | 94 | 30.2 | 32.9 | 43.7 |
| | Very much | 123 | 39.5 | 43.0 | 86.7 |
| | Extremely | 38 | 12.2 | 13.3 | 100.0 |
| | Total | 286 | 92.0 | 100.0 | |
| Missing | System | 25 | 8.0 | | |
| Total | | 311 | 100.0 | | |

# Discussion

## Benefits

**Virtual methods can be applied in smart home designs. They can be considered as virtual living labs:**

- **For evaluating design alternatives**
- **For testing the functionalities of smart technologies**
- **For eliciting users preferences**
- **For training users**

## Drawbacks

- **Users should be able to interact with the computers, iPad or any other touch screens.**
- **It seems that the real living labs can not be replaced by virtual labs for analyzing the real users behavior inside a smart space but they can be complemented by virtual methods.**

**Thank You Very Much for Your Attention.**

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