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Executive Summary

RUGGEDISED is a smart city project funded under the European Union's Horizon 2020 programme. Several activities (solutions) are performed in the cities of Umeå, Glasgow and Rotterdam. This report describes the RUGGEDISED Smart solution WP3/ U4a in Umeå, which is focused on investigating whether it is possible to encourage tenants to change their habits and behavior with regard to sustainability and energy consumption, thereby reducing their combined environmental and climate impact.

In many projects seeking to optimise energy consumption, the general ideas have revolved around the actual supply chains and buildings. Solutions within these areas are becoming increasingly successful and efficient, thereby reducing the margin for improvement. As a consequence, there is an incentive to investigate other methods of impacting sustainable behavior and energy usage.

The objective of this project was thus to investigate alternative methods of impacting sustainability. In this case, the focus aimed to investigate whether it would be possible to engage inhabitants to be more sustainable with regards to energy usage as well as within other areas of their day-to-day life, thereby reducing their combined environmental and climate impact.

Method

For this action, a cooperation was formed with a local real estate company to use one of their buildings as a testing ground. The idea was to encourage the tenants to participate in a campaign intended to influence their habits and behavior with regards to sustainability and energy usage.

The method of choice was to use the concept of *Gamification*[1] - meaning creating game-like experiences to impact changes in behavioral patterns. Gamification naturally has its roots in the gaming industry, using methods of influence long established within this area. In short, Gamification means using game elements in a non-gaming context, that is, using drivers and mechanics found to be successful in games in a real-life context. Consequently, the project chose to produce an application intended for smart phones and other portable devices to use as a means of influence.

Figure 1: Visualisation of impact assessment

An impact assessment was performed together with stakeholders from Umeå Energi and the real estate company in order to focus and prioritise the desired impact, select appropriate target users and select an appropriate approach that prioritised impact, who to focus on, what to focus on, and how to get it done.

The next step in the process was performing a *Design Sprint.* The basic idea of a Design Sprint is to use a *Design thinking*[2] process, which contains different steps such as exploring, prototyping and learning.

Following this process, a test application intended for smart phones and other portable devices was produced. By providing information and the opportunity for continued feedback, the app encouraged and guided users on how to easily achieve more sustainable behavior in a range of different areas, in addition to reducing energy consumption.

Figure 2: design sprint

During the yearlong test period the application served as a tool to launch campaigns to influence the behaviors and habits of the test group regarding sustainability and energy usage.

Results of the testing were gathered from user interviews, feedback sessions and regular surveys with the test group throughout the test period.

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[1] https://en.wikipedia.org/wiki/Gamification

[2] https://www.interaction-design.org/literature/article/what-is-design-thinking-and-why-is-it-so-popular

Results
As the main objective of the project was to engage users in different activities aimed at reducing their climate footprint, the analysis of the quarterly surveys and user interviews focused on reviewing user activity and feedback during the test period. In summary the analysis showed the following:

- At the start of the test period the users had little or no perception of the application's impact. A few months into the test period their activity and knowledge increased, followed by a decrease in activity towards the end of the test period. Thus, user activity peaked in the middle of the period.
- User feedback shows that the main impact on behavior was within the areas of **consumption** and **household**, and less in travel and food provision.
- Users also requested improvements by choosing activities based on real-life situations and short- and long-term goals.
- Reminders, in the form of notifications, are essential to ensure continued usage of the application.
- One of the major challenges was to attract enough attention for the application to achieve the desired participation rate. Participation was less than expected; 13 of a total of 100 tenants (13%) participated.

Discussion and conclusion
Originally this project was meant to focus on energy consumption and investigating whether a change in behavior could be accomplished using methods of encouragement based on gamification. However, due to challenges and complexities regarding measurability of consumption data for individual tenants, and the number of impacting factors, a choice was made to widen the focus to sustainability in a broader sense looking at areas such as travel, consumption, food provisions and household management.

Based on the feedback sessions and surveys, the result shows that the main impact seems to bewithin the areas of household management and consumption and less in other focused areas. In addition, the test shows that it is indeed possible to make an impact on tenants' habits and behavior with regards to sustainability, thereby reducing their combined environmental and climate impact. It is also very important to actively manage a campaign to attract and maintain user interest over time. Nevertheless, changes in behavior do not come overnight, it is a process that takes time and requires continued engagement.

A challenge is, of course, to develop this into a commercial product on par with today's demands and standards. The project came to the conclusion that it cannot compete with other social media applications in the long run, and therefore chose to terminate the application after the test run.

Continued work
However, the data collected in this project may serve as a basis to further developother areas of engaging end users by providing information, encouragement and joint participation. In addition, the application is possible to develop further alongside other urban systems, e.g. monitoring and controlling energy and electricity.

Contents

1. Introduction

1.1 Background

RUGGEDISED is a smart city project funded under the European Union's Horizon 2020 research and innovation program. It brings together three lighthouse cities: Rotterdam, Glasgow and Umeå and three follower cities: Brno, Gdansk and Parma to test, implement and accelerate smart city solutions across Europe.

The three overall aims of RUGGEDISED are:
1. **Improving citizens' quality of life,** by offering citizens a clean, safe, attractive, inclusive and affordable living environment.
2. **Reducing the environmental impacts of activities**, including by achieving a significant reduction of CO2 emissions, a major increase in the investment and usage of renewable energy sources and an increase in the deployment of electric vehicles, not only to reduce emissions, but also to enable smart grid balancing.
3. **Creating a stimulating environment for sustainable economic development,** by generating more sustainable jobs, stimulating community involvement in smart solutions and encouraging start-up and existing companies to exploit the opportunities of the green digital economy and Internet of Things.

To achieve these aims, all three RUGGEDISED lighthouse cities will demonstrate combinations of integrated smart solutions for energy and e-mobility and appropriate business models with the right incentives for stakeholders to invest and participate in a smart society. This report describes the work done in one of the nine smart solution sub-projects implemented in Umeå: U4a.

1.2 Objective

This report describes the RUGGEDISED smart city solution U4a, which is focused on sustainability and energy consumption habits and behavior and the possibility of influencing change within these areas, thereby reducing their combined environmental and climate impact. The objective of this project was therefore to investigate alternative methods of impacting sustainability and, in this case, the focus aimed to investigate whether it would be possible to engage residents to behave more sustainablywith regards to energy usage as well as within other areas of their day-to-day lives. This was addressed in part by trying to answer an number of questions such as:

- To what extent would people get engaged in reducing their climate impact?
- To what extent, if any, would they actually change their behavior and energy consumption?
- Would this have any actual effect on their climate impact?

Furthermore, the goal of the project was to evaluate the impact of different campaigns, provide insight into what strategies actually succeed in engaging tenants and feed the findings into further business and city development projects.

1.3 Actions

Activities included in the smart solutions WP3/ U4a were:

- Deploy an impact assessment – set goals for change
- Conduct a Design Sprint for a mock-up user collaboration tool
- Prototyping and development of the user collaboration tool
- Testing and evaluation of the constructed tool
- Evaluation of testing period
  - Impact of methodology used
  - Conclusions

2. Methods and results

2.1 Impact assessment

The first action on the agenda was to conduct an impact assessment session together with stakeholders from Umeå Energi and the real estate company. The purpose of doing an impact assessment is to define and focus on the effects the project is aiming to achieve; that means identifying the needs of users to achieve these effects and finding what drives them to take action and remain engaged, while finding indicators to support the desired impact and ensure measurability.

This was done in two separate sessions. The first was used to get a wider understanding of the area and what the project wanted to achieve, whereas the second focused on refining, complementing and prioritising the findings of the first session. The decision was made to focus the project according to the following:

Figure 3: visualisation of impact assessment

- Impact goals:
    - More sustainable energy consumption
        - Consume at appropriate times of the day
        - Reduce electricity usage
        - Reduce indoor temperature
        - Reduce water consumption
- Who: Focus on the tenants (as opposed to the landlord)
- What:
    - Getting a better understanding of connections between usage and climate impact
    - Understanding sustainable usage
    - Better knowledge of user energy consumption
    - Pedagogical platform to encourge younger persons to not take energy for granted
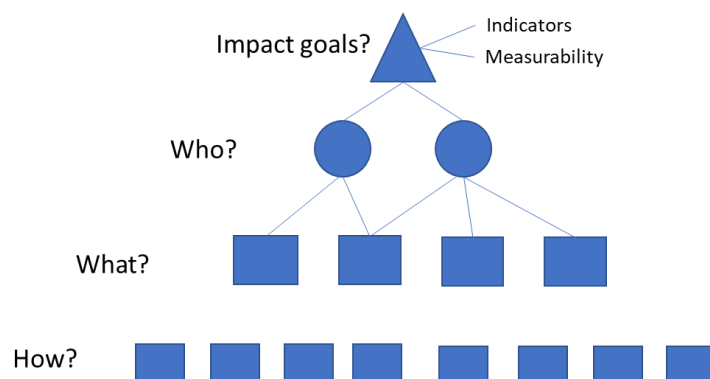- How: Create a mobile application to promote desired outcome

2.2 Design Sprint

Following the impact assessment, a Design Sprint was conducted. The idea of a Design Sprint is to create a testable solution in a very short time, i.e. moving from ideas to solution to testing in the course of a week. Thus, with a basis provided by the findings of the impact assessment, participants from all stakeholder groups, including software developers, spent a week refining the original ideas and produced a mock-up solution, which was tested on external users. The results and feedback of the test group was then used to define the basic design of the application.

Below is a brief summary of activities during each day of the Design Sprint:

- Day 1: Map out the question that needs to be answered during the sprint, including collecting input from subject matter experts from the energy company. End with creating flow chart of the user journey based on key success factors (see Flow Chart under section 2.3)
- Day 2: Sketching ideas in groups, performing quick demos and reviewing them together, rejecting and keeping ideas in quick succession.
- Day 3: Choosing ideas to take further into prototyping and choosing areas to focus on for the sprint (not time to cover all).
- Day 4: Creating a test table prototype and test manuscript for Day 5.
- Day 5: Target user testing with external users, including filming test subjects with live review from the team to get insights on what works, and what doesn't, according to the user & get futher ideas to build on.
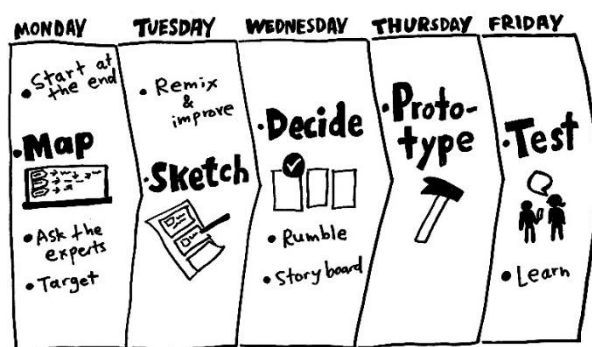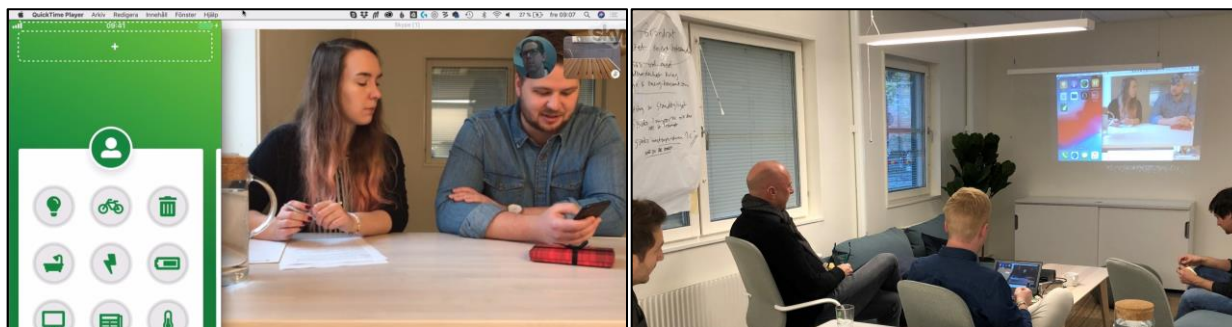

Figure 4: Design sprint

Figure 5: Day 5 User testing

2.3 Method of change - Gamification

Since the aim of this project was to investigate whether it would be possible to bring about a change in tenants' sustainability habits and behavior, a method of trying to introduce change had to be chosen. The project chose to use the concept of *Gamification.* As the name suggests, the method has its roots in the gaming industry and the idea is to use techniques based on human psychology to steer users towards desired goals.
 A basic description could be summarised as follows:
- It can be a game, but not necessarily
- It means enhancing the effect of an existing product or service experience   by using motivational techniques that:
  - Inspire and challenge targets
  - Promote and encourage
  - Provide information to inspire

There are four different stages of gamification that need to be managed correctly in order for the project to be successful:
- A Discovery phase
  - How to make the user aware of it?
  - How to arouse curiosity
- Onboarding phase
  - How do you learn?
  - What are the rules?
  - How to attract the user?
- Scaffolding/Building habits
  - How to start building habits?
  - How to keep users at it?
  - Become proficient
- End-Game
  - Become a master
  - Be an ambassador

Below is the flow chart of the user's journey, as developed during the first day of the Design Sprint described earlier, including key factors/actions that need to take place for each phase to be successful (according to gamification ideas).
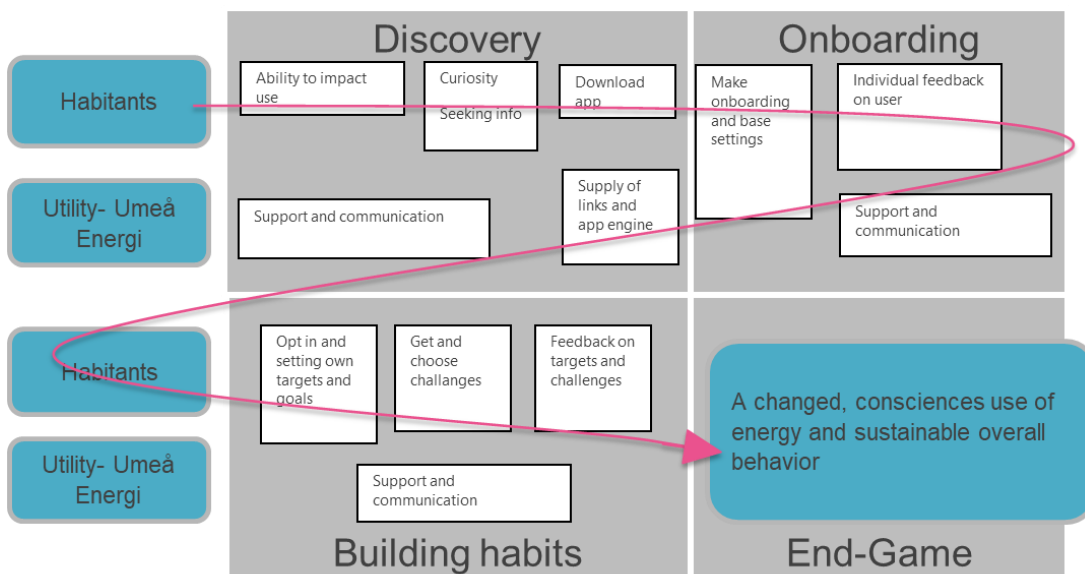

Figure 6: Gamification process and key success factors for the user journey

- Discovery
  - Habitants
    - Get information on their ability to impact their energy consumption
    - Curiosity aroused, seeking information
    - Downloading the application
  - Utility – Umeå Energi
    - Provide support and communicate
    - Supply links and app engine
- Onboarding
  - Habitants
    - Go through onboarding flow & base configuration
    - Individual feedback in user choices
  - Utility – Umeå Energi
    - Provide support and communicate
- Building habits
  - Habitants
    - Opt in and set personal goals and targets
    - Receive and choose challenges
    - Feedback on targets and challenges
  - Utility – Umeå Energi
    - Provide support and communicate
- End-Game
  - A changed, conscious use of energy and sustainable behavior; user makes regular and active choices regarding climate and energy consumption.

2.4 Application development and testing

Following the completion of the earlier phases of the project a first prototype, *The Green Coach,* was built and tested on a small group of users over the period of a couple of months. Feedback and findings from the initial test were included as corrections and featured requests based on the prototype testing.

The prototype was then further developed into a test application intended for smart phones and other portable devices. By providing information and continued feedback, the application encouraged and guided users on how to easily achieve   more sustainable behavior in a range of different areas, in addition to reducing energy consumption. The application centres around 'challenges' that reflect everyday actions and can be performed

easily, such as turning off unnecessary lights, not heating up living quarters more than needed, using less tap water and using public transportation instead of cars when possible.
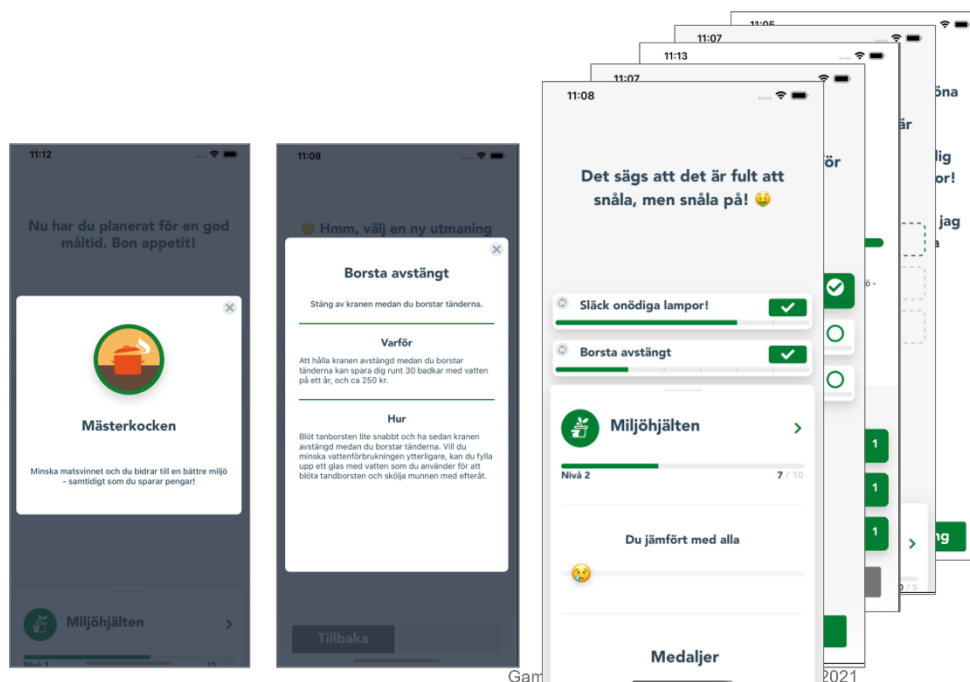

Figure 7: Screen shot of application

The finished application was tested over a year, using tenants of a building provided by the real estate company. The test period was then set up and managed in collaboration with representatives from the real estate company responsible for the selected building. The test group consisted of volunteers living in the chosen building and during the test period the application served as a tool to influence their sustainability and energy usage behavior and habits.

An introduction and initial information session were conducted with the test group and support and service was in place during the entire test period to ensure the test group did not feel unattended. Results were collected by performing user interviews, feedback sessions and regular surveys with the test group throughout the test period.

Due to the challenges and complexities related to the measurability of consumption data for individual tenants and the number of impacting factors, a choice was made to widen the focus to sustainability in a broader sense looking at areas such as travel, consumption, food provisions and household management.

With that in mind, the surveys focused on looking at the impact of the application in four areas, instead of actual energy consumption:
- Travel
- Food provision
- Household
- Consumption

2.5 Results

As the main objective of the project was to engage users in different activities aimed at reducing their climate footprint, the first factor to look at was participation rate:
- The participation rate was unfortunately only 13%; a lot less than anticipated and hoped for.

However, the analysis of the quarterly surveys and user interviews still went ahead and focused on reviewing user activity and feedback during the test period.

In summary, the analysis showed the following:

- At the start of the test period the users had little or no perception regarding the impact of the application. A few months into the test period their activity and opinions increased and then decreased again closer to the end of the period. Most likely user activity peaked in the middle of the period.
- User feedback shows that the main impact on behavior was within the **consumption** and **household** areas and less in travel and food provision.
- Users also requested improvements by choosing activities based on real life situations and short- and long-term goals.
- Reminders in the form of notifications are essential to ensure continued usage of the application.
- One of the major challenges was to attract attention for the application to get a better participation rate. Participation turned out to be less than expected.

Each survey stated two questions for each of the four areas: Travel, Food provision, Household and Consumption:
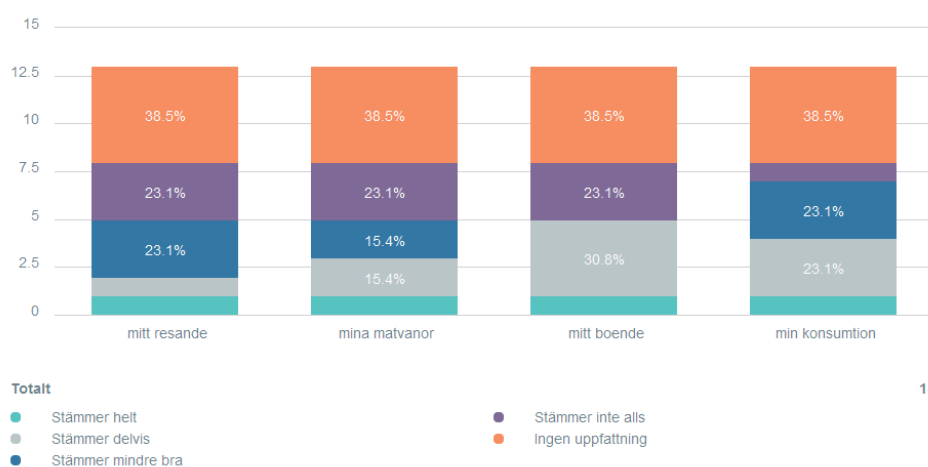
- I believe the *Green Coach* stimulates a more sustainable life style regarding
- I believe the *Green Coach* impacts my sustainable behaviors around

Below is a summary of each survey based on the four areas: Travel, Food provision, Household and Consumption.

Legend - Orange: No opinion | Purple: Strongly Disagree | Blue: Disagree | Grey: Agree | Turquoise: Strongly agree
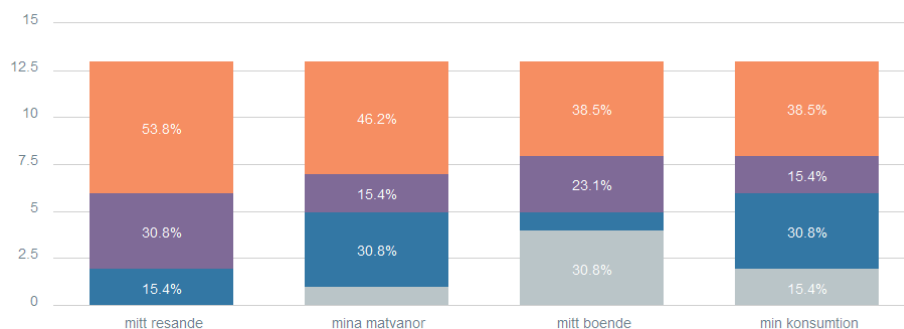
Survey 1 – Main impact on Household and Consumption

I believe the *Green Coach* stimulates a more sustainable lifestyle regarding:

Legend- Orange colour: No opinion | Purple colour: Strongly Disagree | Blue colour: Disagree | Grey colour: Agree | Turquoise colour: Strongly agree

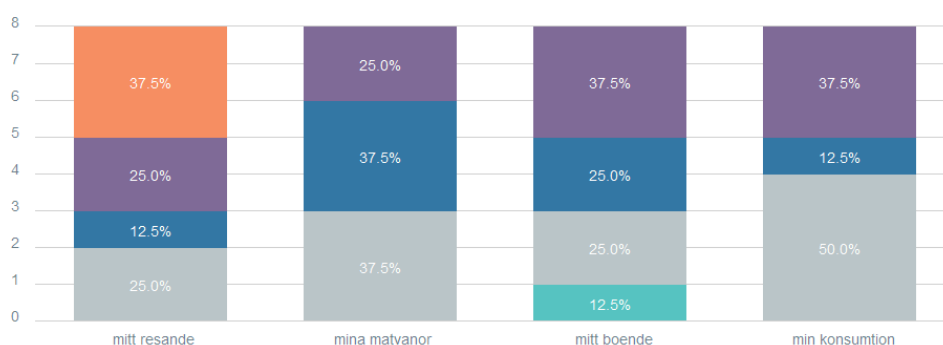**I believe the *Green Coach* promotes my sustainable behaviors around:**

Legend- Orange colour: No opinion | Purple colour: Strongly Disagree | Blue colour: Disagree | Grey colour: Agree | Turquoise colour: Strongly agree

Survey 2 – Main impact on Household and Consumption
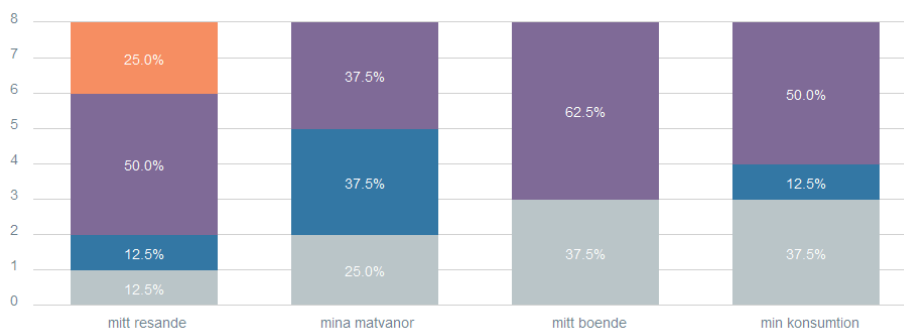**I believe the *Green Coach* stimulates a more sustainable lifestyle regarding:**

Legend- Orange colour: No opinion | Purple colour: Strongly Disagree | Blue colour: Disagree | Grey colour: Agree | Turquoise colour: Strongly agree

I believe the *Green Coach* promotes my sustainable behaviors around:

Legend- Orange colour: No opinion | Purple colour: Strongly Disagree | Blue colour: Disagree | Grey colour: Agree | Turquoise colour: Strongly agree

Survey 3 – Main impact on Household and Consumption

I believe the *Green Coach* stimulates a more sustainable lifestyle regarding:

Legend- Orange colour: No opinion | Purple colour: Strongly Disagree | Blue colour: Disagree | Grey colour: Agree | Turquoise colour: Strongly agree

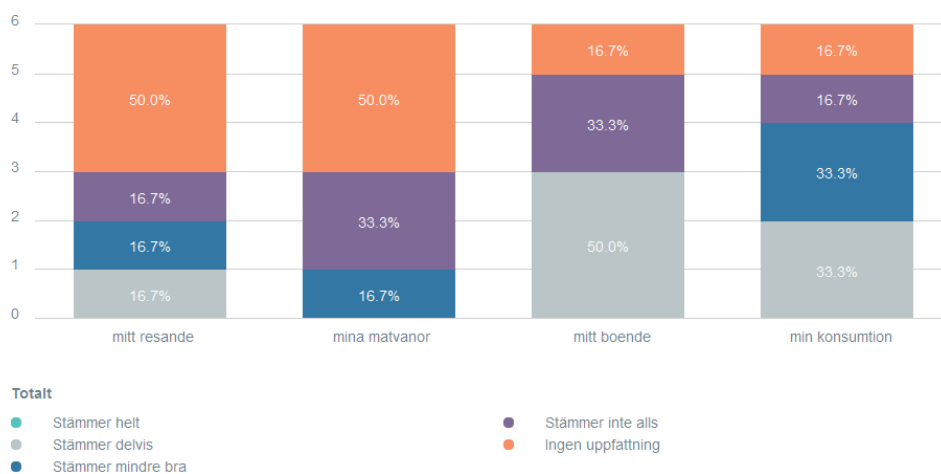**I believe the *Green Coach* promotes my sustainable behaviors around:**

Legend- Orange colour: No opinion | Purple colour: Strongly Disagree | Blue colour: Disagree | Grey colour: Agree | Turquoise colour: Strongly agree
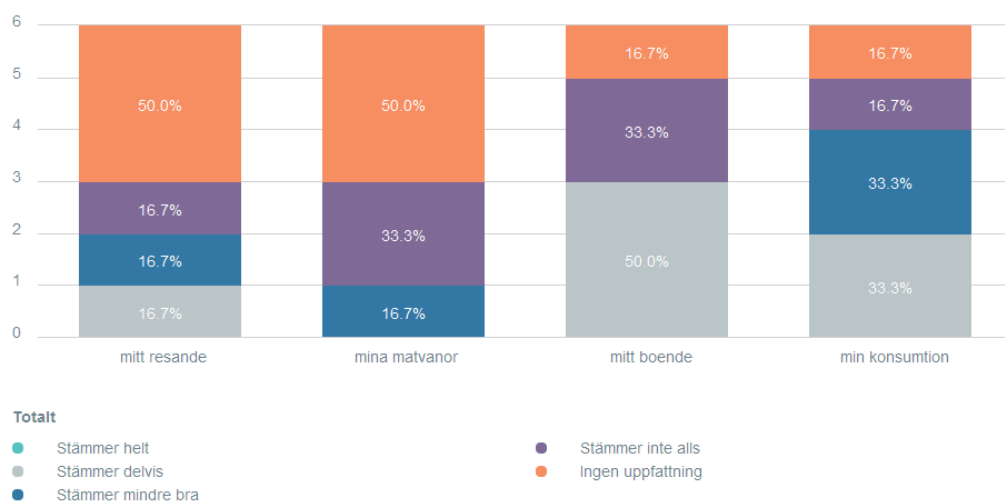
3. Conclusions and Discussion

At the start of this project the idea was to focus on the energy consumption of buildings and whether a change in tenants' behavior could have an impact on this energy consumption, and if this could be accomplished using methods of encouragement based on the concept of gamification. However, due to challenges and complexities regarding the measurability of consumption data for individual tenants and the number of impacting factors, a choice was made to widen the focus to sustainability in a broader sense, looking at areas such as travel, consumption, food provisions and household management.

Based on the feedback sessions and surveys, the results show that the main impact was within the areas of household management and consumption, and less in the other focus areas. The results also show that it is possible to make a slight impact on tenants' sustainability habits and behavior. Whether this perceived impact actually led to any energy savings is impossible to detect because the impact was too small, and not time stamped, to be detectable in the building's energy consumption data.

During the course of the project, it also became apparent that in the "noise" of today's society with many competing applications, it is very difficult to attract and maintain the attention of the user community. To be successful over time, it is crucial to actively manage campaigns to attract and maintain user interest. Change in behavior does not come overnight, it is a process that takes time and requires continued engagement.

It is also quite expensive to develop features and campaigns that are of low commercial value. The decision was therefore made to terminate the application after the test run period.

4. Recommendations

Due to the difficulties in attracting and maintaining the users' attention, and doing so in a cost effective way, it is hard to justify a further development of the application at this point. The data collected can serve as a basis for further development within the area of engaging end users to impactsustainable behavior. In addition, it might be possible to develop the application further by connecting it to other urban systems for monitoring and controlling energy and electricity.

5. Risk Register

Table 3. Risk register

Risk	What is the risk	Level of risk[3]	Solutions to overcome the risk
Software malfunction	Bugs, hackers, malwares, etc., impedes or disrupts function of the application	3	The application is running in an isolated test environment; no way in to live systems.
Data privacy	Data related to individual persons are compromised	3	No saving of personal data in application. Tracking behaviors are not connected to specific individuals.

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3 Risk level: 1 = high risk, 2 = medium risk, 3 = Low risk