

UNIVERSITEIT TWENTE.

SMART ENVIRONMENTS PROJECT

DOCUMENTATION REPORT

TEAM Light It Down

Bas van der Steenhoven

Daisy Baars

Jesse Boomkamp

Sungjune Lee

Veerle Mooren

Emiel Nagel

Luca Verschure

Table of Contents

CHAPTER 0: INTRODUCTION	3
CHAPTER 1: LITERATURE REVIEW	4
CHAPTER 2: IDENTIFICATION OF GENERAL PROBLEMS AND CHALLENGES	9
CHAPTER 3: IDENTIFICATION OF RELEVANT PROBLEMS	10
CHAPTER 4: PROBLEM SELECTION AND MOTIVATION	11
CHAPTER 5: POTENTIAL SOLUTIONS	12
RECOURSES	12
POSSIBLE SOLUTIONS	13
CHAPTER 6: SOLUTION SELECTION	15
CHAPTER 7: METHODOLOGY	16
BASIC.....	16
ADVANCED	17
TESTING	17
CHAPTER 8: RESULTS AND CONCLUSION	19
CHAPTER 9: RECOMMENDATION	21
APPENDIX A: GUIDE FOR THE ASSEMBLY OF A SMART LIGHTER	23
APPENDIX B: CODE FOR THE ARDUINO	24
APPENDIX C: CODE FOR THE APP	26

Chapter 0: Introduction

We are team Light It Down. Our team consists of the following members: Our team leader Bas van der Steenhoven, executive Veerle Mooren, innovator Jesse Boomkamp, innovator Emiel Nagel, executive Sungjune Lee, completer Daisy Baars and explorer Luca Verschure. The problem we are tackling is the fact that many people are addicted to smoking and it is difficult to get rid of this addiction.

Globally there are over 1.3 billion people addicted to tobacco. This means 1 out of 7 people is addicted to smoking. Most people do not know the risks involved by smoking tobacco and also the health-issues it gives non-smokers who are exposed to second-hand smoke. Yearly more than 8 million people die as a result of tobacco. This not only includes 7 million deaths of smokers, but also 1.2 million deaths of non-smokers who are exposed to the smoke.¹ The reason we chose this problem is that a smoking addiction is very unhealthy, even lethal. It is an addiction that is very hard to get rid of, affects bystanders and proves even more dangerous during the COVID-19 pandemic. The fact that a smoking addiction is very hard to get rid of and smokers receive almost no assistance when trying to quit, made us choose this disaster.²

An effective example for people who want to quit smoking is a nicotine patch. A nicotine patch is more effective than going cold turkey. This is because when stopping abruptly a smoker will encounter withdrawal symptoms and a craving for tobacco. When a smoker slowly reduces his tobacco consumption, these symptoms will be less severe, and a smoker will be more likely to quit.³ Therefore, we also want to implement a slow reduce of tobacco consumption in our solution.

To help smokers quit, we have proposed the following solution:

A smart electronic lighter that monitors how many times the user lights a cigarette per day and limits and slowly decreases the number of cigarettes the user can smoke each day in order to help them get rid of their addiction.

We chose this solution because we think it is a challenging but not too complicated way of supporting smokers trying to stop smoking. Our smart lighter solution consists of the lighter itself, the program for the lighter and the app that comes with the lighter. It therefore encompasses a lot of different techniques that we have learned during the study from programming to product design and physical building, which makes this an interesting project. There already exist lighters that count the amount of times the user has smoked a cigarette, but we have decided to take it a step further and actively support the smoker with this solution, and we think our solution will help solving the problem.

¹ World Health Organization, (2020, May 27). *Tobacco*. Retrieved January 20, 2020: <https://www.who.int/news-room/fact-sheets/detail/tobacco>

² Joanna E Cohen, M. M. (2020, November 1). *COVID-19 pandemic: an opportunity for tobacco use cessation*. Retrieved December 11, 2020, from The Lancet Public Health: [https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667\(20\)30236-X/fulltext](https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(20)30236-X/fulltext)

³ Fagerström, K.O., Schneider, N.G. & Lunell, E.(1993). *Effectiveness of nicotine patch and nicotine gum as individual versus combined treatments for tobacco withdrawal symptoms*. Retrieved January 20,2020 from Psychopharmacology: <https://doi.org/10.1007/BF02244941>

Chapter 1: Literature Review

In this first chapter, the 21 publications we found about disasters are described.

Poisoning in water

Lead corrosion in water has been the cause of multiple deaths. The water had not been tested and people thought it was drinkable. They think they should use data to predict the lead release in water. They want to predict the release with algorithms and make home testing kits on mobile phones. With artificial intelligence they want to predict the correlation between drinking water and pipe conditions. These ideas have not been tested yet, but people need to be more informed about the water status.

<https://www.sciencedaily.com/releases/2020/09/200918154522.htm>

Bushfires

There are special fire towers, high above the trees. In these towers, people will stay to watch the forest and detect smoke. This risk management is very old, and some people call it outdated. They are now experimenting with satellites detecting smoke from space. They are also using drones with cameras and machine learning algorithms to detect the smoke and fires. The earlier you detect the fire, the earlier firefighters can react to it. The problem now is that the detection of fires is still based on human processing of data, which is not fast enough. Even though they now use sensors to detect the fires, the humans who are in the fire towers are still better at detecting the fires.

<https://www.theguardian.com/australia-news/2020/oct/25/early-warning-human-detectors-drones-and-the-race-to-control-australias-extreme-bushfires>

Power Outage

Power outages in business have a huge impact on different things. First, they lose customers, and their reputation is damaged. Besides that, they are not able to work as good as they would be when there is no power outage. The people from the IT department have to work harder to restore everything. Data stored to the computer will also be lost.

<https://fosterfuelsmissioncritical.com/power-outage-effects-businesses/#:~:text=If%20power%20outages%20occur%20frequently,when%20the%20power%20is%20restored.>

Power Outage

After a power outage you have to be careful with the food stored in your refrigerator and freezer. Food in the refrigerator will be okay up to 4 hours of power outage and food in the freezer can stay good up to 24 hours of power outage. To make sure the food stays good, keep the doors closed. If you do not trust if the food is good to eat, don't try it, just throw it out.

<https://okcfox.com/news/local/cdc-issues-food-safety-tips-for-power-outages>

Children exposed to disaster

A survey was conducted to determine PTSD symptoms in children after being exposed to disaster. Significant varying results were found in children across race, gender, and age groups. Females reported more symptoms associated with emotional processing and emotional reaction to the trauma. Males were more likely to report symptoms related to cognitive and behavioral factors. Younger children were more likely to report symptoms overall.

<https://www.sciencedirect.com/science/article/abs/pii/S0890856709641496>

UNIVERSITEIT TWENTE.

Evacuation models and disaster psychology

During disasters, psychological responses in humans are surprisingly consistent and transferable across kinds of disasters. Modelling these responses will enhance prediction of human behavior during evacuations. John Leach's Dynamic Disaster Model describes three phases and five stages: A Pre-impact phase (Threat Stage and Warning Stage), an Impact phase, and a Post-impact phase (Recoil Stage, Rescue Stage and Post-traumatic Stage). In each stage humans have a specific psychological response.

<https://www.sciencedirect.com/science/article/pii/S187770581000473X>

Mental health problem by the Covid19 situation

Being quarantined against covid19 situations, lots of people have to be in their home for the whole day or week so that they experience anxiety and depression. The anxiety and depression could lead the people to the warning signs, such as severe risk-taking behavior, significant weight loss, excessive use of drugs or alcohol, and changes in mood. Such warning signs are the result of the mental health problems that may be caused by people lost work by the corona situation or infected with the virus.

<https://www.nytimes.com/2020/11/12/health/covid-teenagers-mental-health.html>

Too many things have to be considered during the natural disaster and COVID-19

Even if a natural disaster happened, people need to consider that they are under the Covid19 situation. In other words, people need to consider everything for the disaster and the virus at the same time.

<https://eu.usatoday.com/in-depth/news/2020/03/21/coronavirus-how-safely-take-care-someone-sick-covid-19/2866984001/>

Suicide rates increase when natural disasters strikes

Disasters impact local communities, infrastructure, and the economy. so that people can have emotional distress and anxiety for those living in their paths.

<https://www.theweek.in/news/sci-tech/2020/11/13/suicide-rates-increase-when-natural-disasters-strike.html>

Nuclear war: What is a 'nuclear winter', and how likely is it?

Since the second world war 70 years ago nuclear weapons have not been used in warfare. That is not to say it might still happen in the future, since we have around 22.000 nuclear weapons lying around, ready for usage. What would a modern nuclear war look like?

The detonation has three main effects: a blast wave that can flatten cities, intense heat that can ignite fires and burn skin and radiation. Though the explosions on Hiroshima and Nagasaki were devastating, the modern bombs: hydrogen bombs, are many times more powerful and will lead to a lot more casualties. The USA does have a defense system to defend itself from such explosions, but it is unreliable and only works half the time. What is more dangerous is the nuclear winter that follows after a nuclear war has happened. Since the nuclear explosion will set a lot of places on fire, the smoke goes into the atmosphere, blocking the sunlight if enough explosions occur. This results in lower temperatures on earth and results in a nuclear winter, destroying crops and livestock and as a result creating even more casualties.

<https://eu.usatoday.com/story/news/world/2017/10/21/nuclear-war-what-nuclear-winter-and-how-likely-it/787175001/>

How to keep calm in a crisis

Panicking during a crisis will not help you manage the crisis, quite the contrary. Therefore, this reaction should and can be minimized. Before the crisis erupts, be prepared. Expect the worst that can happen, make a plan, get the right people in the right places, and trust them and above all yourself. When the crisis happens, it is important that you can cope during the crisis. Manage your feelings, put your plans into practice, support others and guard against negative behaviors. Be available and contribute to the immediate needs. This will help you cope with crises as best as possible, should one occur.

<https://www.mindtools.com/pages/article/calm-in-crisis.htm>

Drought and climate change in US

Climate change increases the possibility of worsening drought in the US and the rest of the world. Due to the increase in temperature, evaporation from the ground is sped up, resulting in a dry soil. The higher temperatures can also change the atmospheric rivers, resulting in irregular rainfall in different areas, disrupting the farmlands. Scientists are certain that through climate change, wet places will get more wet and dry places will get drier. The United States is historically very susceptible to droughts. Droughts can have an effect on livestock and crops, resulting in decreases in those and making the food market unreliable. Also, transportation will be affected by drought, since rivers will either dry up or get wetter making it harder to move by boat. Also, roads can take damage from drought. Through droughts wildfires will become more frequent and more of a problem. And finally, droughts will have an effect on the reliability of energy production since hydroelectric energy and biomass energy will possibly become unavailable.

<https://www.c2es.org/content/drought-and-climate-change/>

Flooding Best Practices

The most effective flood prevention and protection are river basins. Storage dams in large headwaters also considerably contribute to the reduction of risk of flood damage. Flood forecasting is an important part of flood prevention if used in combination with other measures, like water retention and structural measures. Structural measures also include storage of excess water. Flood prevention downstream may lead to an increased risk upstream.

https://ec.europa.eu/environment/water/flood_risk/pdf/flooding_bestpractice.pdf

Levees increase flooding

Building levees on the side of rivers against flooding increase the severity of floods. A flood does not happen less frequently, but when a flood happens, the water level is about 1 meter higher than without levees. Levees also increase the water height levels upstream negatively. Downstream, the water levels are lower. A possible solution is setback levees. These are levies that are placed not directly on the side of rivers but allow a small area to be flooded.

<https://projects.propublica.org/graphics/levees>

Global warming increases the frequency of river floods in Europe

On average, in Europe, flood peaks will double in frequency in the next 30 years for floods that have a return period of over 100 years.

https://www.researchgate.net/profile/Lorenzo_Alfieri2/publication/307738024_Global_warming_increases_the_frequency_of_river_floods_in_Europe/links/57d6863808ae601b39abae41.pdf

Epidemics after natural disasters

The risk for outbreaks of diseases is often presumed to be very high in the chaos after a natural disaster. A fear that likely comes from a perceived relation between dead bodies and epidemics, but this is far from true. Usually, the risk of an epidemic isn't that high, and it is dependent on a variety of factors. The most important one being population displacement, which only happens in extreme cases. Other factors include the availability of safe water, the degree of crowding, the underlying health status, and the availability of health care services. This all indicates that some areas are more prone to an epidemic than other more developed areas, but also that there is an unfair perceived relation between dead bodies and an epidemic.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2725828/>

Tweedr: Mining twitter to inform disaster response

Tweedr is a twitter mining tool that consists of three main parts designed to help disaster relief workers. In the first phase classification methods are used to identify useful tweets. In the second phase filters are used to merge similar tweets. The third phase is the phase where specific information is extracted that can be presented to the workers that need it.

<http://amulyayadav.com/spring19/pdf/asht.pdf>

Mental health during the COVID-19 pandemic: Effects of stay-at-home policies, social distancing behavior and social resources

Social distancing and the stay-at-home policies were separately linked to increased decline in mental health. As the policies and rules extended the mental health declined more. A subsample of participants in a study, had already participated in a similar study a month before. A significant difference could be seen between earlier in the pandemic and a month later when the stay-at-home policies and social distancing were implemented. In some cases, the symptoms are so high that it goes beyond the protective effects of social resources.

<https://www.sciencedirect.com/science/article/pii/S0165178120315419>

Physical and mental health shortly after a disaster: first results from the Enschede firework disaster study

On the 13th of May of 2000, a disaster involving three massive firework explosions occurred in Enschede. This disaster destroyed around 500 houses and killed 22 people. Shortly after this occurrence the Dutch government decided to run a health survey focusing on the short-term and long-term physical and psychological effects of disasters on humans and their physiology. The results were that at least 30% of the people affected by this disaster suffered from physical symptoms such as fatigue, muscle pain, dizziness and gastric troubles and psychological symptoms such as anxiety, depression, avoidance, and intrusion in the 2 or 3 weeks after the incident.

<https://academic.oup.com/eurpub/article/16/3/252/469827>

UNIVERSITEIT TWENTE.

Coronavirus in Spain: Fear of 'Official' Fake News Boosts WhatsApp and Alternative Sources
Spain now has to deal with a second disaster on top of the COVID-19 epidemic. Spain is a country which has engraved into its roots a deep oppression and neglecting towards science. This started in the 17th and 18th century with a very despotic inquisition, and after this considered science to be a threat to religion and the State. Nowadays they are dealing with a government which runs most of the scientific organizations and taking into account the vast amount of mistrust there is between citizens and their government already, by adding this underlying obstructive issue, they create a huge distancing between the government and the people. The disaster which has come out of this, is a huge influx and magnification of fake news through channels such as WhatsApp and Instagram, which are adding to a dangerous and increasing instability in the country. This led to violent demonstrations and harsh ideological clashes between members of Spanish society which are extremely detrimental in times of an epidemic.

<https://www.cogitatiopress.com/mediaandcommunication/article/view/3217/3217>

Social Media in Disaster Risk Reduction and Crisis Management

Social media is a tool which has various different functions, from chatting with your friends to marketing your new company, but in this case, the usage of social media is related to saving lives and making an impact on society. In these fields, social media is used for things such as, listening to public debate, extending emergency response and management, crowdsourcing and creating social cohesion, in between many other uses. Social media can be a great tool in these situations, but we have to acknowledge its negative side, which could be using social media to disseminate rumors, undermine authority or promote terrorist acts.

<https://link.springer.com/article/10.1007/s11948-013-9502-z>

Chapter 2: Identification of General Problems and Challenges

After reading and analyzing the publications, several general challenges and problems were found to explore.

1. Increase in mental health problems, but no suitable response yet.
2. Social media, good or bad for Disaster Risk Reduction and Crisis Management in relation to mental health.
3. When risk reduction works for a certain area, it could be making the risk bigger for another area.
4. The effect of climate change on natural disasters nowadays
5. The effect of disasters in people's daily life
6. Preventing disasters insufficiently
7. Technology, does it aid us or hinder us in disaster risk reduction and crisis management.
8. Insufficient ways to prevent the aftermath of a disaster

Chapter 3: Identification of Relevant Problems

This chapter contains the most relevant and accurate problems and solutions in the world that our group found.

1. Technology, does it aid us or hinder us in disaster risk reduction and crisis management, more focused on mental health.
2. The increase of severity of addiction and the risk of getting an addiction during a disaster and it affecting mental health.
3. Not being prepared for a disaster, especially for damages to personal properties and being stranded in your house.
4. Home automation that helps in the preparation of a disaster.
5. Phosphorus ends up in the ocean which eventually will leave us with a shortage.
6. The loneliness of students during a disaster.

Chapter 4: Problem Selection and Motivation

In this chapter we describe our chosen problem and why we think it is an accurate problem to work on.

The problem that we chose is: the increase of the severity of addiction and the risk of getting an addiction during a disaster and it affecting mental health.

We chose to base our project on the topic of Addiction and how we are more susceptible to entering or recurring an addiction after experiencing trauma. Trauma which can be caused by disasters such as the current pandemic or any other form of natural or non-natural disaster.

We chose this topic for various reasons, its direct impact on our daily lives, the underlying seriousness of addictions which seem less dangerous, such as porn addictions or social media addictions, and ultimately because of the reduced amount of attention this topic is getting in current times. Smoking is also a world wide problem with serious effects on a person's health, as shown in Chapter 0.

The psychological state in which we are before, during and after the disaster is one of the main factors leading to a dependency. A study from 2010 carried out by the "Mental Illness Research, Education, and Clinical Center (MIRECC)" et al., shows how "Veterans who screened positive for PTSD or depression were two times more likely to report alcohol misuse relative to Veterans who did not screen positive for these disorders."

Addiction is something which society has been dealing with since the beginning of times, from the stoned ape theory, which claims that psychoactive substances were the main reason for the cognitive leap experienced by humans over 200.000 years, to the usage of *amanita muscaria*, commonly known as the fly agaric or fly amanita, in religious ceremonies in the medieval times to social media addictions in the 21st century.

Society needs to change the image it has on addiction and treat it as a disease, and not as a criminal act as it is considered nowadays. And it is our task now to combat addiction and change the perception of people on this topic.

Chapter 5: Potential Solutions

We first searched for resources with possible solutions. We searched for existing solutions to improve or develop further, as well as theoretical solutions. We combined parts of these resources into five possible solutions that we find interesting to work on and that would also be able to help combat addiction. We found the following resources.

Recourses

Urge surfing

Urge surfing can help people who suffer from an addiction disorder. Most people feel helpless when they feel an urge coming and feel like they have to fight against it. Urge surfing helps them cope with the urge and also understand where the urge came from. If people do this a lot, instead of acting upon the urge, they will see patterns in which they feel more likely to relapse. This can be for example in social situations or when they are under a lot of stress. Identifying the urge through urge surfing, will not make the urges stop, but it will help understanding and coping with the urges.

<https://portlandpsychotherapy.com/2011/11/riding-wave-using-mindfulness-help-cope-urges/>

<https://www.recovery.org/pro/articles/riding-the-wave-how-to-manage-your-cravings/>

<https://psycnet.apa.org/doiLanding?doi=10.1037%2Fa0017127&errorCode=invalidAccess>

The marigold app

The marigold app is an app for peer support for opioid addicts. It is based on machine learning, which detects when somebody texts something that might lead to relapse (such as: 'I had a rough week') With this program moderators can easily detect these messages and react only on them, which means they don't have to read everything.

https://jpbs.hapres.com/UpLoad/PdfFile/JPBS_1183.pdf

<https://www.marigoldhealth.com/about>

Dealing with cravings

When addicts feel the need to use again and may think about relapsing, there are several things they can do to minimize the urge. They can use distraction, while doing things they enjoy, the urge to relapse will become less intense. Besides that, they have to remember why they are clean (for example; I am clean, if I use I will lose custody over my child). They also can talk to somebody about it, which also helps. And urge surfing can also help people.

<http://www.drug-rehabs.com/addiction/dealing-cravings/>

Dopamine fasting

By reducing the brain's feel-good chemical known as dopamine, Dopamine fasters believe that they can "reset" the brain to be more effective and appreciate simple things more easily.

The rds that initiate the wanting for the rewards in the first place. In other words, doing Dopamine-fasting is to reduce our exposure to the triggers associated with the rewatter routine by changing the environment around you.

<https://theconversation.com/dopamine-fasting-an-expert-reviews-the-latest-craze-in-silicon-valley-127646>

Neuroplasticity

Neuroplasticity in the brain's reward system following repeated drug use leads to more habitual and more compulsive drug use. Thus, repeated exposure to drugs of abuse creates experience-dependent learning and related changes. Also, our brain's plastic nature

UNIVERSITEIT TWENTE.

suggested that we can change our behaviors throughout our lives by learning new skills and habits. This approach is based on operant conditioning theory, a form of learning, where behavior that is positively reinforced tends to be repeated.

<https://www.health.harvard.edu/blog/brain-plasticity-in-drug-addiction-burden-and-benefit-2020062620479>

Transferring addiction and to prevent it

Since with an addiction you are not addicted to the substance but to the dopamine that's being released when you consume that substance, one addiction can easily be replaced by another. This often happens when a patient is trying to recover from their addiction, when they're done with one addiction they'll simply get addicted to something else. To prevent trading addictions, you have to be very thorough in your daily habits and closely watch what you're doing. Also see a therapist since he can help you with finding the psychological root cause and remove it.

<https://www.springboardrecovery.com/understanding-addiction-transfer/>

<https://www.recoveryways.com/rehab-blog/how-to-avoid-transfer-addictions/>

<https://dualdiagnosis.org/addiction-treatment/transferring/>

Home Automation and IoT to Prevent Addiction (smart intervention)

There is not much to find about home automation, but a lot more about IoT connected devices. An example is a "smart" lighter, called Quitbit. The lighter could slowly lower the amount of times you can use it to light a cigarette, based on your goals and the data can be shared with others, like your doctor or friends.

Another example of this is the NSS@-Bridge, which has four electrodes to deliver small, targeted currents to nerves around your ear to reduce the symptoms of opioid withdrawal. Smart fitness trackers are common, but smart belts can perform most of the same functions. This is mostly helpful for eating addictions. Another option is small shocks as negative reinforcement.

<http://www.quitbitlighter.com/>

<https://www.masimo.com/bridge>

<https://www.weltcorp.com/>

<https://www.bloomberg.com/news/articles/2018-01-25/best-apps-for-breaking-bad-habits-pavlok-motivaider-ksafe>

Possible Solutions

After combining the sources above, we came up with the following five possible solutions that we want to work on.

VR Setting

A possible solution to addiction is using a VR environment to trick your brain. After finding out what is triggering your urges, you can show pictures of those triggers and replace them or combine them with images that do not trigger your brain. This would theoretically reduce the number of triggers to the addiction.

Gamification

Using gamification is another way to reduce addiction. This works the best for addictions that lead to gaining weight and less exercise or game addictions. Addicts could play games that encourage activity. Tracking these activities using a phone or a fitness tracker would give the option to reward players with rewards in game. Players will be stimulated to get rewards and

UNIVERSITEIT TWENTE.

walk outside, as long as walking outside or other activities are more rewarding than in game actions.

Smart Lighter

A possible solution for smoking addiction is a smart lighter. This lighter can track the amount of times a smoker used it to light cigarettes. This data can be insightful for the addict and for their doctor. Other features could include changing the number of times it can be used every day. By limiting the amount of times, the lighter can be used, you can control a smoking addiction. First, you measure a baseline use, and after that, the number of times the lighter can be used can slowly be toned down. This will help smokers overcome their addiction. This solution can also work for other addictions that have an item that is needed, like a smart fridge that limits the amount of times the beer compartment can be opened or smart cigarettes that can restrict the amount of nicotine that is released.

Using Smart Accessories for Rewards

A solution using smart devices like mentioned above, is to give users rewards for their use. If they use their lighter less, they get coupons for cinema tickets or discounts at stores. This could be done separately or in combination with the solution above.

Using Electrodes for Stimulation

It is possible to suppress the effects of withdrawal for opioids using electrodes around the ear. Theoretically, it could also be possible to give the same rush that addicts experience, but with artificial stimulation. The human body slowly needs more stimulation to reach the same rush, because it gets a higher tolerance for dopamine and other stimuli.

First, you would give a bit more stimulation, so the addict needs less of a substance or dopamine creating activity for the same rush. This way, unhealthy products or habits can be replaced by these artificial stimuli. After that, you can slowly reduce the amount of stimulation to decrease the need for dopamine.

Chapter 6: Solution Selection

In this chapter we describe our solution and motivate why we have chosen it.

The solution that will be turned into a prototype is the smart lighter. This decision was made because of several reasons. First of all, it is a solution that would be feasible in the amount of time we have. Second, for smoking, quitting completely at once or slowly does not change the chances of quitting. Furthermore, it is also a problem that can be tested. Still a lot of people can be found in our surroundings that smoke and some of them are struggling with quitting. This is the perfect opportunity to test our prototype. Other than that, it is also a solution which can be implemented into other addictions. Think about a fridge with a smart lock that can only be opened a number of times. All these things can be linked to the same app, where you can keep track of your progress. This solution is divided into the following modules and certain team members will work on these modules.

Hardware	Veerle, Daisy
Lighter software	Daisy, Emiel, Jesse
App software	Jesse, Luca, Sungjune
Team Leading, Management, Coordination	Bas
Presentation, Feedback	Bas
Hardware purchase	Bas
Support where necessary	Bas
Documentation and research	Veerle

Chapter 7: Methodology

Basic

The smart lighter will be made in several steps. All steps and parts of the smart lighter will be discussed below.

Hardware

The smart lighter itself will consist of various parts.

- Arduino. The Arduino keeps track of all data from the sensor and connects to the application over Wi-Fi or Bluetooth. All calculations are done by the Arduino and it sends the relevant data to the application.
- Button. This button will activate the lighter, so that the user can light up their cigarette.
- Electrical heating element. This will light the cigarette. For testing purposes, a LED will be used.
- Battery for power.
- Timer. This timer will keep track of time, so quick uses, i.e., for friends, do not count towards your limit. The timer is built into the Arduino.
- A Bluetooth module for communication between the Arduino and the app.
- Case to encapsulate the lighter and protect it from the elements and damage.

All hardware will be linked to the Arduino and the Arduino will communicate with an application.

Software

We need multiple different software solutions. First, we need software to upload to the Arduino. This software will allow the Arduino to communicate with the application and will make sure the data collected by the Arduino is stored and sent to that application. It also ensures that data sent to the Arduino will be interpreted correctly. This software will be written in C++, as it will allow for efficient operation of the Arduino and we have the knowledge to code in C++.

The requirements for this software are:

- Read the data from the sensor to keep track of use
- Store the data
- Connect to an application
- Receive data
- Analyze data
- Perform simple calculations based on the received and collected data
- Keep track of time
- Limit use based on data and calculations

We also need an application that can connect to the smart lighter. This application can perform more difficult calculations, as it will run on higher performance technology like a phone or a computer. The application can be written in multiple languages. For now, we are planning to build it in Java because the application engineers in our team know Java the best.

The requirements for the app are:

- Connect to the smart lighter
- Receive data
- Send data
- Analyze data
- Perform difficult calculations

UNIVERSITEIT TWENTE.

- Synchronize data with the lighter
- Show data to the user
- Send notifications to the user.
- Let the user change settings and send the settings to the lighter

Data can be analyzed both on the Arduino and in the application, based on the amount of computing power necessary. The Arduino will control the lighter, to make sure that the lighter can be used while the application is not connected. The lighter can be used without the application, but features are probably limited. The features that are available without connection depend on the Arduino that will be used.

Advanced

When the basic features are working, we will extend the feature set of the lighter and the application.

We will build a web server so that users can see their data from anywhere. This will also allow users to combine multiple lighters.

Another extension we are planning is calibration. Users might not know exactly how much cigarettes they are smoking each day. The calibration option will count the daily use of the lighter for a week. After that, the amount of uses each day can be determined and a strategy for quitting can be made and personalized. This could increase the effectiveness of the smart lighter.

For the basic version, there will only be 1 program for quitting with a set difficulty. For the advanced version, we will work on a setting to adapt this difficulty. Users can take longer or shorter amounts of time to quit.

A hardware feature we want to add is a small screen on the lighter. This could show statistics and other data to the user, like battery level and the number of uses left for that day.

Testing

For testing, we used one of our own group members and her significant other to test the product. This choice was made because of a few reasons. First of all, it is relatively easy to get the product to them in a safe way during the lockdown. They are both over 18 and know they won't be compensated and must buy their own cigarettes. Since there's only one working prototype this allows us to test it on multiple people and therefore get more feedback. When it comes to results, they will both write something separately and someone else will look at these results. This way they can influence each other the least.

If time and circumstances allowed it, a different approach would be better. In that case the following approach would be used.

For testing, the current plans are subject to change, based on the feedback and approval of the Ethics Board.

Participants should smoke and be willing to stop smoking. This is necessary to test the use of our products. Participants should be at least 18 years old, as that is the legal age before people can buy cigarettes. Participants are not compensated for participating and need to buy their own cigarettes.

UNIVERSITEIT TWENTE.

Participants will be given the smart lighter and will have a video call to explain how it works and what it does. Participants will need to manually report their data using an anonymous form. Using automatic reporting from the application or web server could lead to participants being connected to their data. Data collected include the number of times the lighter is used, the current maximum uses and questions about the ease of use and the ways participants use their smart lighter.

Participants will sign a consent form and will be able to withdraw their consent at any time. Data will be anonymized. Participants will be given a unique identifying number. One member of the group will have a key to connect participants with their identifying number. This group member will not have access to the data of the trail. All group members that have access to the data will not have access to the key that connects participants to their identifying number. The identifying number is necessary to delete the data after participants withdraw their consent.

Chapter 8: Results and Conclusion

The current capabilities and properties of the smart lighter are:

- Setting a starting amount of uses per day.
- Declining the amount of uses by 1 less per day.
- Connecting it via Bluetooth to an app on your phone
- This app can receive and display the number of uses left for the day and draw a graph of the amount over multiple days.

Things to add/improve:

- Calibrating the decline of uses better to make it more doable.
- Letting the user choose how quickly they want to stop smoking.
- Having a calibration period instead of needing to set a starting amount.
- A battery percentage indicator
- Displaying heartrate with a heartrate sensor, so that users notice how smoking impacts the heart rate.

Basic vs Advanced scenario:

Earlier we set goals for the basic and the advanced scenario which our product should qualify for. The lighter itself qualifies for everything from the basic scenario, except that the lighter does not have a case. The app does not do complicated calculations, is not able to send notifications to the user and the user cannot change the settings of the lighter via the app as well. Apart from that it qualifies for the basic scenario.

For the advanced level we were able to connect a 4-digit screen that shows the user the amount of uses left. We were not able to set up a server for user data, calibrate to give advice to the user about their best program and make multiple programs to give the users a choice how fast they want to quit smoking.

Test reviews:

“For me this wasn’t as successful as I hoped it would be. This is because of several reasons, but first I will take you through the process. Since we had to start very last minute, we only had about 3 days to try it out. Not knowing how much I smoke the first day was spent calibrating. I ended up smoking 9 cigarettes that day. Since there had to be a decline to see what it does, I gave myself 7 cigarettes the next day and 5 on the final day. I have been able to keep to it, but only because I knew that it would be over after this. Overall, this would have been a way better experience if it were over a longer period of time. This would have allowed for a longer calibration period, which would result in a better start. I noticed that the calibration day was actually one of the days where I smoked less than usual, and this made it very hard the rest of the days. This could have been prevented if there was the possibility for a longer calibration period. Besides this the decline was way too fast, but unfortunately again due to time issues this could not be more gradual. If that were the case it wouldn’t be as noticeable and probably easier. Now it was very noticeable which made it hard to keep to it. Then there is also the fact that if this would work it would probably not be a product for me. I have quit once before for over a year and did this cold turkey. I am aware that cold turkey is not an option for a lot of people, so I do think this has the possibility to help them.”

UNIVERSITEIT TWENTE.

Unfortunately, cold turkey is the way for me though and that makes this a very hard way to quit.” - Veerle

“I started with a calibration day in which I smoked 10 cigarettes. I know that on another day I would smoke more, but since there was not much time, I started with 10 cigarettes as my starting point. I choose to try a decline of 2 cigarettes a day, again because of the little amount of time. The second day started off a bit rough. I noticed I wanted to smoke more than 8 because of the heavy decline in the number of cigarettes. The third day I broke. I was only allowed to smoke 6 but I had an exam and was very stressed out.

I never tried to stop smoking before and I reckon a technique like this would help if there was a longer period of time between the decline or if the decline were less drastic. I am a stress smoker, and this design doesn't incorporate such things, maybe something to look at in the future.” – Marvin

From other research, we can conclude that solution is not worse than normal solutions but can be an alternative for people looking for another option. At worst, it has the same effectiveness, but it can give better results due to instant feedback and by creating motivation for users (<https://doi.org/10.1002/14651858.CD013183.pub2>). Research also shows that smart lighters have a moderate to high satisfaction score for use (<https://doi.org/10.1016/j.addbeh.2019.106052>).

Conclusion:

In the current state, our product is capable of all the functions that we proposed at the beginning of this project, however lots of finetuning is necessary in order to make it effective, there was not enough time to do testing to find out how quickly the number of times the lighter can be used in order to make the decline unnoticeable and easy to manage. A team member did test it, but quickly concluded that with current settings it is hard to manage the pace of declining. However due to the little time left, the results are compromised as she had to increase the pace of declining to notice anything, therefore her experience unfortunately does not resemble how a real user would experience it. With more time more extensive testing would have been possible.

Chapter 9: Recommendation

As with most projects the first try is always faulted. There are some aspects in the design we didn't get to and testing could have been done better. We would like to discuss these aspects so follow-up research could be done by us or other people interested in this subject.

Most of the advanced features sadly couldn't be implemented, but some basic things also couldn't be realized. The app does not send notification to the user and you can't change the settings of the app or the lighter. These took more time to implement and were more difficult than expected. Luckily these don't prevent the lighter from working. We planned on giving the lighter a good look and a small form factor for ease of use. Due to time-constraints and costs, this was not feasible. This could not be realized. Everything luckily works, but it does not have a casing as we speak and is therefore very hard to carry around.

We did not implement user-specific programs. We do not have the knowledge to give advice to users and did not have the resources to research this further for this project. We do think this can be an important aspect of quitting smoking. A study by Lipkus et al. (<https://academic.oup.com/ntr/article-abstract/1/1/77/1018477>) shows that tailored programs work better than non-tailored programs. This confirms that user-specific programs are a helpful addition for future projects, although there are also studies showing no or a very small *increase in efficacy* (<https://doi.org/10.1002/14651858.CD001118.pub2>). *We do recommend users to get professional help, as professional help.*

Then there is testing. A lot of things could be improved here. Since it took a while to build the product and there were some slight hiccups along the way, the testing started way too late. This caused the testing period to be limited to 3 days. Of those 3 days a calibration day was needed because the participants had no idea how many cigarettes they smoked each day. After that, a daily decline of 2 cigarettes has been used, because a decline of one cigarette a day would result in 2 cigarettes decline total, which is not as significant. First, the calibration period was needed, but it was way too short. If the participant were having a day where they smoked less than usual, the starting point is way off, and this would make the decline in the next couple of days even harder to keep up with. Only having 2 days left the decline was way too fast, but if chosen 1 cigarette daily it would not improve either. That is because there were only 2 days to test, and 2 cigarettes decline in 2 days and nothing after that is rather insignificant for a smoker. Overall, the true mistake that was made is that the period left for testing was too short. Every way we went with the time we had would not give any better results. If the decline was less than the difference was not significant and it would make it seem like quitting is easy, which it isn't. The way used now had too big of a decline, which made it hard to keep up.

UNIVERSITEIT TWENTE.

There were 2 other things mentioned by participants that would be nice for a follow-up research. One said that this is not their way of quitting and this could be looked at. Maybe this could work better for certain people and not at all for others. Another thing would be looking at different kinds of smokers since some people's smoking increases if they are stressed. If this is the case maybe a feature could be implemented that lets you consider stressful days and maybe allows you to smoke one cigarette more that day. This could be nice because some people feel like failing if they cannot keep up, which can demotivate them.

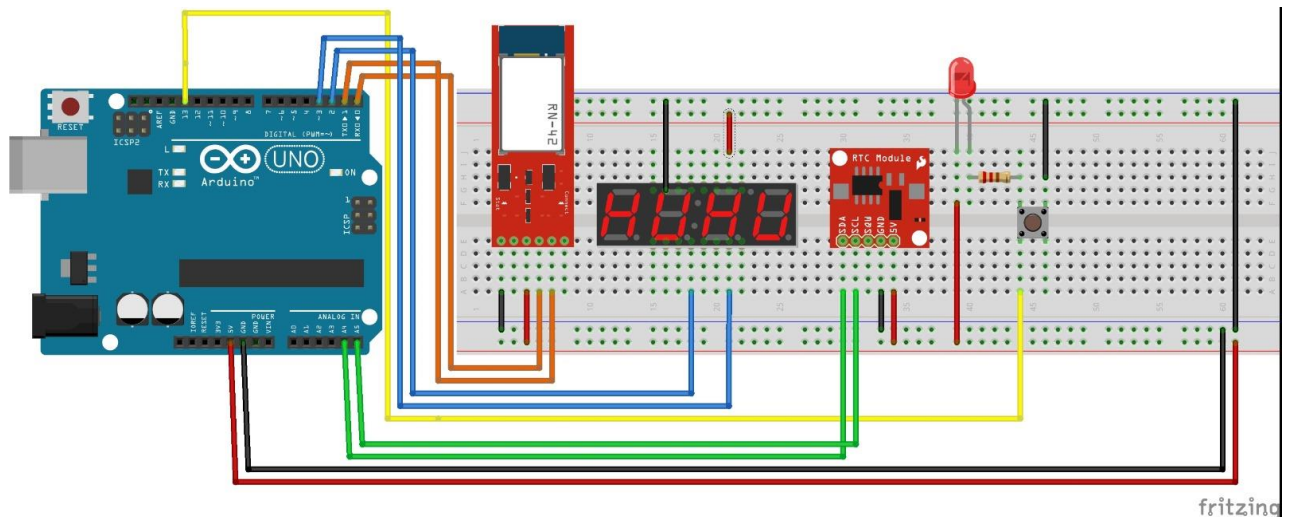
Appendix A: Guide for the assembly of a smart lighter

To make this smart lighter some materials are needed. After acquiring these the lighter can be made following the schematic provided.

Materials:

- 1 Arduino uno
- 1 breadboard
- 1 RTC DS3231 real time clock
- 1 AZDelivery 3x4 bit digital tube LED display module I2C
- 1 Bluetooth module HC-OH-05
- 18 wires
- 1 LED
- 1 resistor ...Ohm
- 1 button

Schematic:



Appendix B: Code for the Arduino

```
1. #include <DS3231.h>
2. #include <Arduino.h>
3. #include <TM1637Display.h>
4. //include libraries for rtc, 4-digit display
5.
6. #define CLK 2
7. #define DIO 3
8. //define pins 2 and 3 as CLK and DIO for display
9.
10. TM1637Display display(CLK, DIO);
11. //initializes display
12.
13. DS3231 rtc(SDA, SCL);
14.
15. int count = 0;
16. int maxCount = 5;
17. int countDown = 1;
18. String rtcPrevDate = "1.1.2014";
19. int state = 0;
20. int prevButton;
21. int prevButton2;
22. int state2 = 0;
23. int timeThen, timeNow;
24.
25.
26. void setup() {
27.     Serial.begin(9600);
28.     pinMode(12, OUTPUT);
29.
30.     rtc.begin();
31.     rtc.setDOW(WEDNESDAY); // Set Day-of-Week
32.     rtc.setTime(12, 0, 0); // Set the time to 12:00:00 (24hr
format)
33.     rtc.setDate(1, 1, 2014); // Set the date to January 1st, 2014
34. }
35.
36.
37. void loop() {
38.
39.     /*if(digitalRead(11) == 0){
40.         prevButton2 = digitalRead(11);
41.     }
42.
43.     if(prevButton2 != digitalRead(11) && digitalRead(11) == 1){
44.         maxCount = maxCount - countDown;
45.         count = maxCount;
46.     }*/
47.
48.     //if date changes then max sigarettes each day goes down by
countDown
49.     if (rtcPrevDate != rtc.getDateStr()) {
50.         rtcPrevDate = rtc.getDateStr();
51.         maxCount = maxCount - countDown;
52.         count = maxCount;
53.     }
54.
55.     timeNow = rtc.getUnixTime(rtc.getTime());
```



```
56.
57.   if (digitalRead(13) == 0 && count > 0) {
58.       digitalWrite(12, HIGH);
59.       state = 1;
60.   } else {
61.       digitalWrite(12, LOW);
62.   }
63.
64.   if (prevButton != digitalRead(13) && prevButton != 0 && state2 ==
    0) {
65.       state2 = 1;
66.       timeThen = timeNow;
67.   }
68.
69.   if (digitalRead(13) == 1 && state == 1 && timeNow - timeThen >=
    60) {
70.       count--;
71.       state = 0;
72.       state2 = 0;
73.       uint8_t blank[] = { 0x00, 0x00, 0x00, 0x00 };
74.       //initializes variable blank to clear the display
75.       display.setSegments(blank);
76.       //clears display
77.   }
78.
79.   prevButton = digitalRead(13);
80.
81.   display.setBrightness(0x0f);
82.   //sets brightness of display
83.   display.showNumberDec(count, false);
84.   //displays maxCount from left to right without extra 0 digit in
    front
85. }
86.
87. /*****Bluetooth*****/
88.
89. byte count2 = count;
    Serial.write(count2);
    delay(500);
```

Appendix C: Code for the App

```
when Screen1 . BackPressed
do close screen

when BluetoothList . BeforePicking
do set BluetoothList . Elements to BluetoothClient1 . AddressesAndNames

when BluetoothList . AfterPicking
do set BluetoothList . Selection to call BluetoothClient1 . Connect
address BluetoothList . Selection
set Connection . Text to "Connected"
set Connection . TextColor to green

initialize global X to 0
initialize global X_before to 0
initialize global Y to 0
initialize global Y_before to 0

when Clock1 . Timer
do if BluetoothClient1 . IsConnected
then if call BluetoothClient1 . BytesAvailableToReceive > 0
then set global X_before to get global X
set global Y_before to get global Y
set global X to get global X + 1
set global Y to call BluetoothClient1 . ReceiveUnsigned1ByteNumber
set Count . Text to get global Y

call Canvas1 . DrawLine
x1 get global X_before
y1 Canvas1 . Height - 0
x2 get global X
y2 Canvas1 . Height - get global Y * 50

if get global X ≥ Canvas1 . Width
then call Canvas1 . Clear
set global X_before to 0
set global X to 0
```

