



UiT The Arctic University of Norway

Faculty of Science and Technology
Department of Computer Science

Leveraging Mobile UX Principles for Nudges In Green Transportation

Mellet Solbakk

Master thesis in Computer Science ... June 2020



*Before you judge a man, walk a mile in his shoes. After that who cares?
He's a mile away and you've got his shoes!*

— *Billy Connolly*

“Nobody realizes that some people expend tremendous energy merely to be
normal.”
–Albert Camus

“I don’t believe in astrology; I’m a Sagittarius and we’re skeptical.”
–Arthur C. Clarke

Abstract

In 2008 Thaler and Sunstein published their book about Nudging. It has since become more and more relevant in both research and industry. Today we are facing issues like climate change and obesity in both young and grown adults. Therefore, there are strong incentives to try to get people to use more green transportation options in their lives and also to be more physical active by opting to choose more active transportation options such as walking, skiing and bicycling. In this context using Nudging in the field of computer science has become a big interest.

Smart nudging has a goal to try to nudge users, these nudges are personally tailored for their specific situation and needs. In this thesis we will combine knowledge from Nudging and principles from user interface design and user experience research to increase the likelihood of the smart nudges to be as effective as possible. A mobile application was created to show off how these smart nudges can be presented to the user through push notifications and recommendations for different types of transportation options that are available in the situation the user find themselves in.

Acknowledgements

I would like to thank my friends, family and class mates at the Open Distributed System group that have supported and motivated me while I have been writing this master thesis.

I would also like to thank my supervisor, Randi Karlsen, for excellent help supervising and reviewing my master thesis.

Contents

Abstract	iii
Acknowledgements	v
List of Figures	ix
1 Introduction	1
1.1 Background and motivation	2
1.2 Goal	2
1.3 Contribution	2
1.4 Limitations	2
1.5 Ethics and Transparency	3
2 Technical Background	5
2.1 Nudge	5
2.1.1 Smart Nudges	7
2.2 UX to Nudge Users	8
2.3 Modifying User Behaviour	9
2.3.1 Classifying Influence	10
2.4 Positive Reinforcement Through Gamification	11
2.5 Frameworks and Tools	12
2.5.1 Figma	12
2.5.2 React Native	12
2.5.3 Expo	13
3 Related Work	15
3.1 Entur	15
3.2 Mobility Choices	16
3.3 Our work	17
4 Methods and Methodologies	19
5 Design	21
5.1 User Acquisition Methods	21

5.1.1	Public Transportation Discounts	22
5.1.2	Lottery Points	22
5.1.3	Discounted City Bikes	22
5.1.4	Discounted Bikes	23
5.2	Profile Creation and Data Gathering	23
5.2.1	Profile Creation	23
5.2.2	Data gathering	24
5.3	UX Methods to Nudge Towards Good Choices	25
5.3.1	Push Notifications	25
5.3.2	Recommending Transportation Options	26
5.4	Transparency	27
5.5	Incentivising Usage to Change Habbits	28
5.5.1	Achievements to Motivate Nudge Completion	28
5.5.2	Leaderboards as Sosial Nudging	28
5.6	Types of Nudges	29
5.6.1	Daily Commute Nudge	29
5.6.2	Travel Smart Nudge	29
6	Implementation	31
6.1	Prototyping	31
6.2	Push Notifications	31
6.3	Dynamic Interface Templating	32
7	Evaluating and Testing the Effectiveness of Nudges	35
7.1	Passive collection	35
7.1.1	Notification CTR	36
7.1.2	Smart Nudge Display Duration	36
7.1.3	Routing Completion Data	36
7.2	Active collection	36
8	Discussion	37
8.1	Monetary incentives	37
8.2	Validating Nudge Completion	37
9	Conclusion	39
	Bibliography	41

List of Figures

2.1	Designing a smart nudge	8
2.2	Classifying Influence	10
3.1	Profile Screen for Mobility Choices Application	17
5.1	Profile Creation, Transportation Options	24
5.2	Example of Notifications using emojis for higher CTR.	26
5.3	Smart Nudge: Transportation Choice	27
5.4	Smart Nudge: Transparency View	28
6.1	Expo Notification Service Overview	32



Introduction

The concept of Nudging was coined by Thaler and Sunstein in 2008 when they published their book *NUDGE: Improving Decisions About Health, Wealth, and Happiness*.^[1] Since then there has been an interest in the subject from both politicians and from academia. The term Nudge describes the theory for influencing behaviour and decisions using mainly non-coercive techniques such as suggestions and positive reinforcement to get the subject to make changes that will benefit themselves and society as a whole.

From the book they describe a nudge as; “To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandating. Putting the fruit at eye level counts as a nudge. Banning junk food does not.”

Nudges distinguish themselves from other recommendation systems by not only recommending behaviour that is in the user’s current interest but tries to get them to acquire new habits that will improve society and the individual long term. As nudges try to influence the individual to alter their behaviour there are ethical aspects that need to be addressed.

1.1 Background and motivation

Today the world is facing many challenges. Pollution from over usage of fossile fuels are contributing to climate change and in many countries obisity is big problem in the population. Some ways countries try to mitigate these two issues is by building out better public transportation options, better bike lanes and more walk-able areas.

Even tho the options might be there, lack of motivation or perhaps just ignorance of the options that are available might not be enough. Developing a system for Nudging people to use greener transportation options like walking, biking, skiing or using public transportation instead of driving your car alone to work every day could be beneficial to both the individual and society as a whole.

1.2 Goal

The work of this thesis will be to build a mobile application that uses digital nudging in the transportation sector. The goal of the application will be to combine techniques from nudging theory and UX principles to guide the user into making greener transportation options like walking, biking, skiing or public transportation.

How can smart nudges effectiveness be improved by using user experience and design principles that guide the user into making better choices in green transportation?

1.3 Contribution

This theses contributes the ODS group and anyone interested in in how to leverage user experience and user interface to display personalized digital nudges.

1.4 Limitations

The work on digital nudging of the ODS group at UiT is a work in progress and there are multiple others working on other aspects of the system. Such as looking at options for data gathering to serve personalized nudges and creating

the actual micro services that deliver the data required to display nudges to users on the client. This thesis will make some generalisation and assumptions about what data might be possible to get to display digital nudges and also what services are available in the system. The data used will be assumed to be limited to Norway for simplicity.

1.5 Ethics and Transparency

One criticism of nudging is that it is a form of manipulation and that it changes people's behaviour without their knowledge. To address this the application can increase the transparency in the application, explaining to the user why a certain nudge was shown and what kind of data gathered from the user was used to form the nudge.



Technical Background

2.1 Nudge

The term Nudge was first coined in the book NUDGE: Improving Decisions About Health, Wealth, and Happiness[1]. To nudge is to influence behaviour and decisions in a predictable way using positive reinforcement, suggestions and other non-coercive methods without forbidding other options or significantly changing their economic incentives. From [1], Thaler and Sunstein define the term as:

“A nudge, as we will use the term, is any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting fruit at eye level counts as a nudge. Banning junk food does not.”

In the case of transportation, the Nudge would try to influence the individual to make more environmentally friendlier options and options that could have economic advantages for the individual. The goal of the nudge would be to both improve the individual but also a common good where more people use environmentally better transportation options.

As an example of Nudges delivered through a mobile application[2], these would be considered as digital nudges. The choices the user makes are not only affected by the content of the nudge but also by the way the nudge is

presented as the user interface.

There are many different methods to affect the users choices through nudging. In *Nudging: A very short guide*[3], Cass R. Sunstein goes through the most 10 most important nudges.

Let's look at some of them that are most relevant in the context of nudging for better choices in green transportation.

Default rules: most people when they register for a new service will not change their settings. Therefore giving them default options that are intended to nudge them to affect their behaviour is one method.

Ease and convenience: When creating new habits a big barrier to overcome is that it can feel hard or not understandable. Making decisions easy by having clear information and simple visuals can help overcome these barriers.

Simplification: having overly complex systems can confuse users. Making systems and tasks as simple and easy to complete can be beneficial to nudge users.

Social norms: Humans are flock animals, so we mimic other people around us. An example of how to leverage this is by telling you that all your neighbours are using less energy in their household. Nudging you towards reducing your electricity consumption in this situation.

Disclosure: When people are making choices it's important for them to know as much information as possible. Whoever is trying to Nudge you needs to be transparent about how data was collected and why you are being nudged in a particular direction.

Reminders: People are forgetful and tend to procrastinate. There are a bunch of people going to the gym in January. But by February the gym is almost empty. Often a simple reminder that you should probably take a trip to the gym can be all that is needed. One factor that is very important for reminders is timing them correctly. If you get a notification that you should go to the gym right after you had a big meal and laying on the sofa watching netflix, it might not be the most effective.

Inform about consequences of past choices: Giving a user information about what happens with their choices can be a good way of nudging them. For example telling them how much money they are saving by choosing to walk to work instead of driving.

2.1.1 Smart Nudges

Not every user is created equal. There are many ways to nudge a user, and the method used on one user can be very effective while on someone else it can be ineffective. Creating personalized nudges that are tailor made for you is important to increase the likelihood of it being as effective as it can. Some people might like frequent reminders, while others get annoyed by them. One person can be very visual while other get more out of more text heavy nudges.

Smart nudges are defined as *digital nudging, where the guidance of user behaviour is tailored to be relevant to the current situation of each user*[4]. Creating different experiences for different user can be achieved in many ways. Asking the user for their preferences is one method, but it is often combined with collecting data about them.

In *Recommendation with Nudges* by R. Karlsen et al. they illustrate the steps needed to design smart nudges. In figure 2.1 these steps are visualized.

1. **Define goal:** To create a nudge first a goal for the nudge must be selected. In the case of transportation, the goal of the nudge would be to get the user to choose a more environmental transportation option than then usually might have selected.
2. **Understand the user:** To understand the user we need to both look at the psychology of users in general but also gather information about the specific user to create nudges that are personalized for them. These steps are taken when the user creates a profile and also learned over time by observing how impactful a given nudge was on them.
3. **Understand the situation:** For the nudge the context is very important. Information like time of day, weather, road conditions, and other factors that affect transportation need to be taken into effect to make the nudge effective. If on a given day it's sunny outside, perhaps a nudge to get the user to walk to work is a great option. However if it's raining outside it is likely a bigger chance of the nudge getting completed if we instead suggest taking the bus instead of walking that day.
4. **Select target activity:** Based on the information we know about the user, and the context, an activity for the nudge can be selected. Like walking, bicycling or taking the bus.
5. **Select relevant information:** To get the user from point A to B we need to gather information like bus routes, walking routes, location where to

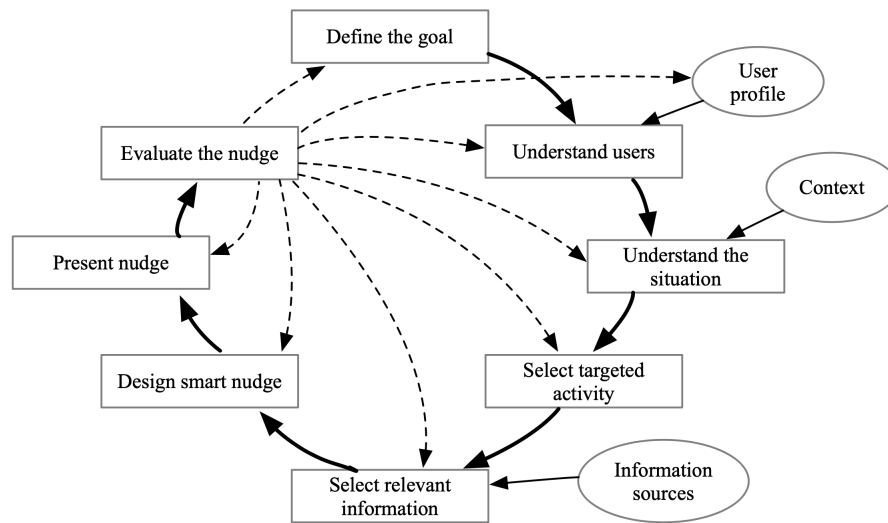


Figure 2.1: Designing a smart nudge

buy bus tickets, app for buying tickets etc. This information is then used to create an informative nudge for the user.

6. **Design nudge:** Once all of the steps above is completed, it can all be combined into a nudge.
7. **Present nudge:** When the nudge has been created it's time to present it to the user. In a mobile application this would be as a push notification where the user then would be presented with the choices and practical information on how to complete the nudge.
8. **Evaluate nudge:** Once the user has received the nudge it's time to evaluate it. For a given nudge some success factors need to be set up. An example of such a success factor could be that the user chose to take the environmentally friendly option and completed it. A mobile application would implement some analytics that would inform the system of the success or failure of a nudge and adjustments could be made for the specific user or a group of users.

2.2 UX to Nudge Users

From the paper Digital Nudging: Guiding Online User Choices Through Interface Design by Schneider et al. they explain that not only does the content of a

nudge have an effect on the user decisions, but also how it is presented in the user interface. There are particularly three heuristics that were looked at for nudging users in a particular direction. These were the decoy effect, scarcity effect and the middle-option bias.

Status Que Bias, Default Settings

One way to Nudge a user is to have defaults that are designed to change their behaviour for the better. In the context of this application these default would most naturally be during profile creation.

Decoy Effect

Increases an options attractiveness by presenting a option next to an unattractive option no one would want to choose. Schneider

Scarcity Effect

People tend to perceive scarce items as more attractive and desirable.

Middle-Option bias

When presented with three or more options tend to select the middle option. Even irrespective of scale of the commitment between the options the researchers could nudge the users into selecting a higher pledge.

2.3 Modifying User Behaviour

In 2003 Fogg termed the goal of changing a users behaviour as persuasive technology[5]. Since then there have been a wide range of studies in this topic. When trying to alter a users behaviour Tromp et al. try to categorize methods of altering a users behaviour in their paper *Design for Socially Responsive Behaviour: A Classification of Influence Based on Intended User experience*[6].

Trying to influence the choice of an individual can be a tricky task. In some circumstances the individuals and societies concerns will be in line and other times they will collide. If someone is trying to go on a diet to be more healthy, their individual change in behaviour is in line with the collective. Trying to stop someone from using public transportation without buying a ticket is an example of a situation where the individuals and the collective concern might not be in line. The individual might not have enough money to buy a ticket or they might enjoy the adrenaline rush of breaking the rules.

Knowing that the individual and society's concerns can be different can help us figure out what type of strategy to deploy to try and change behaviour. In essence what we are trying to do is to discourage the bad behaviour and

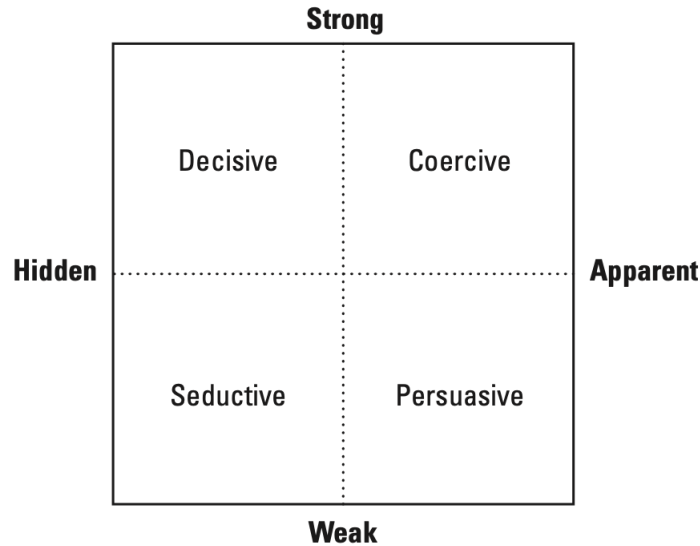


Figure 2.2: Classifying Influence

encourage the good behaviour.

2.3.1 Classifying Influence

When trying to classify influence strategies Tromp et al. see that individual and collective concerns can easily collide. Therefore they chose to classify different strategies to alter behaviour in the situation where the individual has little or no motivation to change.

To classify the different strategies they see that the design can differ in force, either trying to strongly influence the individual or weakly. The design of a product or design can also vary where it's more explicit or implicit. Using these dimensions they pinpoint four different ways of influencing a user choice. Decisive, coercive, seductive and persuasive as seen in figure 2.2.

Coercive

Coercive strategies are very easy to spot and they strongly try to modify a users behaviour. A example of this is when park benches have spikes in between seats to deter homeless people from using them to sleep on.

Decisive

If you just moved into a apartment complex with many floors and there is no elevator, this could be a decisive strategy deployed to encourage the residents

to use the stairs to get them to get some extra exercise. Such a strategy might not be as apparent to the residents, and might not even be intentional but still has the behaviour altering effect.

Persuasive

Persuasive strategies are similar to coercive but the behaviour altering is not as strong. Giving the person suggestions on how to behave, such as a sign in the bathroom to wash your hands.

Seductive

Students at a University might only hang out with their closes peers but if the University want to get them to socialize with other groups of people a way to do this could be to have a shared kitchen for two or more fields of study. Giving them a natural place where they can bump into new people and get into conversation.

From the above classification and what we know about nudges we can see that nudges fit in with weak influence but does not necessarily care if they are hidden or apparent. Nudges can therefor fit into the seductive and persuasive categories, but are often more on the hidden side in the spectrum.

2.4 Positive Reinforcement Through Gamification

To keep users engaged and coming back to using a product gamification can be used as positive reinforcement. Gamification is when a product integrates game mechanics into their service to increase user engagement and alter their behaviour. The product does not necessarily need to be a game itself but can still use the same engagement mechanics that games often use to get their users to come back to the game.

There are many mechanics that can be borrowed from games, adding leaderboards allows the user to compare themselves against their peers, giving the user motivation to use the service more to climb the leaderboard. Very closely related to leaderboards are experience points, where the user gains points for using the service. Another very often borrowed technique is the use of achievements as users complete goals or gain experience points.

Gamification is used to motivate the user through psychology principles and there have been many studies to find out if implementing gamification into a service actually has any effects. Hamari et al.[7] has done a meta study

looking at multiple previous studies to see what effects, if any, gamification has. They compared 24 previous studies on gamification and saw that there was a positive effect when implementing gamification into a service. They also saw that pure utility services might not have a positive effect on users' engagement overall.

2.5 Frameworks and Tools

2.5.1 Figma

Figma¹ is a prototyping tool used to create either low fidelity or high fidelity prototypes of websites and mobile applications. It allows you to create the visual elements of a mobile application and also attach simple actions to buttons that takes you to new screens. It is often used in the early stages before implementing a application to get the feel of how the application will work and allows you to quickly iterate without writing any code.

Figma also allows you to get code snippets for the different elements that are created that can be sent to a engineer who is implementing the solution.

2.5.2 React Native

Today we have two primary platforms where you can publish mobile applications. The *App Store* by Apple for iOS applications and the Google Play store for android applications. When these two where first launched businesses often had to have developer teams for each platform. React Native tries to make this easier by being a framework where you can write one implementation that works on both platforms.

React Native² uses Javascript or Typescript as a common language instead of writing one application in Swift/Objective-C for iOS and Java/Kotlin for android application. React Native also allows you to include native code in the platforms native languages if the need for highly niche or high performing code is required.

1. <https://www.figma.com/>

2. <https://reactnative.dev/>

2.5.3 Expo

React Native can be tricky to set up correctly, and it was often required to write native code when a good solution is not possible to write in Javascript. The team at Expo³ took this as an opportunity to create a tool-chain that makes life easier when developing, testing and deploying your application. They have written a bunch of native plugins that many people need in their applications, such as making push notification easier, making in app purchases easy to set up and a bunch of sensor data from the different platforms.

One of the major contributions Expo has done is making it very easy to share your application with others for testing by allowing you to download their Expo app from the App Store and scan a QR code. You can then test it out on a real device or send it to a friend to have them test it without sending them any code.

3. <https://expo.io/>

/ 3

Related Work

In today's market there are many other apps that are designed to influence a users behaviour. Some apps try to get you to stay fit by giving you workout plans and reminding you to keep you going to the gym regularly. There are also apps designed to track what you eat and recommend diets. In the transporation space there are also a couple of apps available. Let's look at a few and see what they offer to the user.

3.1 Entur

*Entur*¹ is a application developed in Norway that aims to make travel with collective transportation in the country as seamless as possible. The goal of their application is to combine all the different collective transportation companies into a single application, making is extremely simple to select a start and end location and get the recommended mode of travel between these two places. Their goal is also to make it very convenient to have a single application to buy a ticket in situations where you might be taking bus, train and a boat to reach your final destination.

The app does not give you any recommendations by trying to influence you directly in any way. But one thing is for certain, reducing the complexity of

1. <https://www.entur.org/>

figuring out how to get from A to B with public transportation is a Nudge in itself. It can often be a hassle especially if you have to switch between different types of transportation to get further distances, and laziness could make you take a airplane instead.

A nice feature of the app is also that they allow others to use their APIs in other apps and services.

3.2 Mobility Choices

In Germany a mobile application called *Mobility Choices*² has been developed. Their goal of their application is to *make a significant contribution to strengthening sustainable and "gentle" mobility in the area by empirically investigating which measures actually bring about behavioral changes*. Their app relies on looking at traffic flow in the area and uses the users personal preferences and tries to give the user personalized feedback to improve in green transportation.

To give the users feedback they use and analyze data from transportation services that are available in their are and calculate different routes depending on congestion and traffic flow. The app tries to give the user recommendations to use these routes for public transportation as an alternative to using their personal car.

Another aspect for data gathering they use is through the user profile they have for every user. The user can choose what transportation options they have available and the maximum distance they are willing to travel with each option. An example of this could be that a user is only willing to travel 2km by bike. In figure 3.1 there are options to choose your modes of travel and your goals.

Mobility Choices uses both data from public transportation and from the users own preferences to give them nudges to use more green transportation.

2. <http://www.mobility-choices.org/>

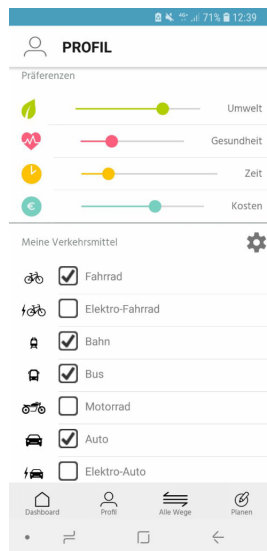


Figure 3.1: Profile Screen for Mobility Choices Application

3.3 Our work

The work of this thesis is in the same spirit of the two above mentioned applications. The work of the ODS group regarding Nudging is to increase the scope of possible options for data gathering to create even richer Nudges and for multiple different categories. Specifically is this thesis looking into principles from User Interface(UI) and User Experience(UX) research that can be combined with previous work to improve the rate at which a individual can change their behaviour for the better.

/4

Methods and Methodologies

In this theses we are trying to look at different methods used in design and user experience that fit well into the theory of nudging. Combining the theory from all three disciplines to create a mobile application that is more effective at nudging the user to alter their behaviour regarding green transportation options.

In her paper *Portal of Research Methods and Methodologies for Research Projects and Degree Projects*[8], Anne Håkansson created a portal that can help people choose research methods when conducting research and writing degree projects. Using the portal will lead to you making more structured research and choose the correct methods and eliminate any method that does not fit the thesis goal and research subject.

For this thesis *qualitative research* has the best fit, as we are looking into changing users behaviour through nudging. As we are looking for information from different disciplines this thesis uses *exploratory research*.

Once the ODS group has a micro service architecture to serve the data needed to present digital nudges through the mobile application a more *analytical research* approach can be used it future work to explore and analyse different iterations for nudges, both in how they are presented and the data they contain.

/5

Design

In the design chapter we will be going through a users journey from before they install the application until they start receiving smart digital nudges that attempt to modify the users behaviour to use greener transportation options.

The goal of the application is to create a easy to use application that serves the user digital nudges with suggestions for alternative transportation options. The user will set up a profile and based on the context of the user, their preferences, location and other data points we will be serving personalized nudges as timely notifications with data rich recommendations for the user.

5.1 User Acquisition Methods

One of the hardest challenges when creating a new service or an application is user acquisition. For the app to be able to try to use Nudging to alter the users behaviour the user must first install the application and create a profile. Highly motivated users whose goals are in line with the behaviour the app is trying to improve can likely see the value of using the app. However more reluctant users goals might not be in line with the goal of the nudge or they are apathetic to trying to change their behaviour.

For the second category of users they would need some additional incentive to

install the app on their phone and use it. In a perfect world these incentives would also be in line with the goal of the nudge. In this case it is to get the user to use greener transportation options like using the bus instead of driving a car, or walking and biking when possible.

In the next couple sections many of the incentivizing options are monetary. In the definition of a Nudge it says that Nudges should not significantly change the users economic incentive. If these incentives are too coercive or do indeed significantly change their economic incentive will be discussed later in the discussion chapter.

The possibilities for incentivizing users to install the app are endless, but let's look at a couple of options where the incentives align with the goals of the nudge.

5.1.1 Public Transportation Discounts

One option for incentivising the user is to give them a flat rate on public transportation if they have the app installed. This option has some drawbacks as it only would require the user to have the app installed and not actually complete the nudges. They would still get the discount which could make them choose using the public transportation more frequently than they already do.

5.1.2 Lottery Points

Another option would be to give the users points that act as lottery tickets as they complete nudges and make good choices. These points would automatically add them into a raffle where they could win prizes.

5.1.3 Discounted City Bikes

In some cities there is also the option for people to use city bikes that can either be rented for a one time use or through a subscription. Giving people who have the app installed either a flat rate discount or a free bike ride when they have completed multiple nudge recommendations is another option to get them to use greener transportation options.

5.1.4 Discounted Bikes

Not everyone owns a bike, so driving short distances might be their only option. Here is another opportunity where after completing recommendations through the app they would be eligible to buy a bike for themselves at a local sporting goods store for a discounted price.

All these incentives align up with the goal of the nudge but they do require some cooperation with local transportation services to give the users these perks. Doing this can also be a positive for the businesses as they can increase their user acquisition as a side effect of giving these perks through the nudge app.

5.2 Profile Creation and Data Gathering

5.2.1 Profile Creation

After a user has installed the app on their phone their first contact will be to create a user profile. During profile creation the user will provide the application with information about what transportation options the user has access to at the present time. This includes personal car, bicycle, city bikes, electric scooters, or any other form of transportation that fits the region the user is living in. Another important data point to create informative nudges are points of interest, these include the users workplace, school and their home address. These locations are places the user will need to use some form of transportation to travel between.

The goal of the nudges are to get the user to go outside their comfort zone. Depending on the user their comfort zone can be vastly different. One user might already be using public transportation, so we might try to give them a nudge for them to walk or cycle to work. Another user might be driving his own car to work every day, so to avoid stretching their comfort zone too hard we can nudge them to take the bus to start with. Then at a later point once they have been taking the bus for a while we can try nudging them to walk or bicycle to work.

Using these constraints the nudges created for the user will have a higher probability of being completed. Later in the analytics, chapter 7, we will see how these constraints can be modified as we learn insights about the users behaviour.

In section 2.1.1 we explained that to create a nudge we must understand the

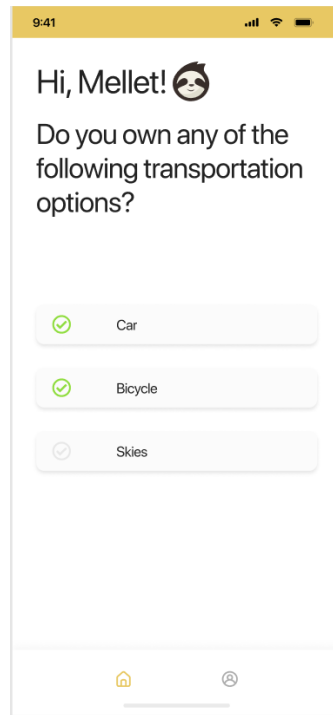


Figure 5.1: Profile Creation, Transportation Options

user. To make the nudges more effective a personalized user interface for presenting the nudge is desirable. To make the nudges more personalized we require access to some personal information about the user. These facts about the user can be acquired in different phases of their usage of the application. First during profile creation and then during their use of the application.

5.2.2 Data gathering

To accomplish the goal of having personalized nudges one of the steps of creating a smart nudge is to understand the users situation, such as where they are located at this moment, points of interest, weather conditions and more.

For the system to be able to know such things the user either needs to explicitly tell us this information, or some information can be gathered by sensors and other data sources available on smart phones.

Data gathering is not the primary focus of this thesis, but is a important part about building the context around the user to generate personalized nudges. So we will quickly go over some options where it's natural to get information

about the user on the client that can be ingested and understood by the nudge generating services that support the client.

Geo Location

To serve the user timely smart nudges one important data point the mobile application will be responsible for providing is the users current location. Sending a user a nudge prompting them to walk to work today would be unnecessary if they for some reason decided to not stick to their normal schedule and decided to go to work earlier than expected.

The Geo Location data can also be used to figure out if the user is stationary, cycling or in a vehicle based on the speed. Using this data can be used to validate if the nudge recommendation is being performed or if the user decided to take a more convenient option.

Calendar events

To get a understand of what points of interest are important for the user calendar events can be a major data point to understand the situation of the user. Many users have their schedule on their phone calendar. As an example a user might have a meeting at a office that required them to travel a certain distance. Based on this data a smart nudge can be served to them with options for walking, biking or the best bus route to take depending on other conditions such as weather and the users own preferences.

5.3 UX Methods to Nudge Towards Good Choices

Getting a user to complete the smart nudges we are serving them can be a hard task. Standing out from all the other notifications the user is receiving and also making them want to choose a more green option are all challenging. Let's look at some UX principles that can be used to increase the likelihood of nudging the user.

5.3.1 Push Notifications

The first contact the user has with a smart nudge is through a push notification that is sent to them. The push notification is our way of getting the user to see the smart nudge, so having something eye catching will be important.

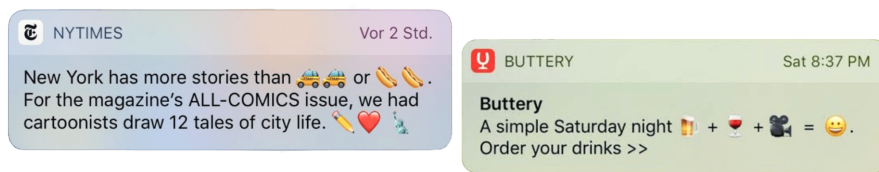


Figure 5.2: Example of Notifications using emojis for higher CTR.

A push notification consists of 2 elements, the icon and name of the application and a description telling the user what the notification is about.

To make a notification successful[9] there are three categories of descriptions that are most effective. These are notifications that are either funny, inquisitive or urgent.

There has been testing on what increases the click through rate(CTR) of push notifications and adding emojis will help increase it as they illicit emotions. In figure 5.2 there are some examples of notifications that heavily uses emojis, even as replacement for text.

Not just the content of a push notification is important but also it's timing and frequency. It's important to consider time zones of users, as you don't want to send a notification about a nudge in the middle of the night.

The smart nudge backend architecture would have some defaults set for the frequency of sending nudges, but these frequencies should be personalized for each user depending on how they behave to the nudges. The content of the nudges can also vary depending on what a user is responding to. Some users might respond better to emoji heavy descriptions while others prefer a more plain one with simple and straight to the point information.

5.3.2 Recommending Transportation Options

Once the user has received a push notification and is shown the smart nudge inside the mobile application, as seen in figure 5.3, they will be given multiple options for transportation to choose from. In this case the user just arrived in Tromsø on vacation, and from it's calendar data and the users position the nudge system knows at what hotel he will be staying at.

From section 2.2 we learned that from UX research middle option bias will increase the likelihood of a certain choice being made when 3 or more options are given to a user. In the case of this smart nudge we know, lets assume, from

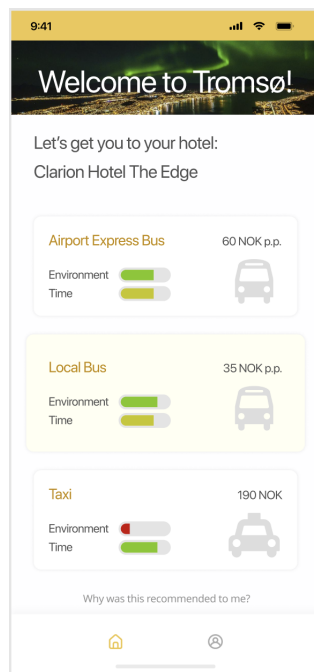


Figure 5.3: Smart Nudge: Transportation Choice

the user that they prefer to take a taxi when they arrive in a new city. The goal of this nudge is to get them to choose the local bus alternative, so it's placed as the middle option.

To give that option a higher chance of getting picked the color and sizing has also been slightly changed to make the user take note of that option.

5.4 Transparency

To make sure the nudges don't seem coercive the application will give the user insight into seeing why a particular smart nudge was created for them. In figure 5.4 the user can see what data sources was used to generate the nudge, and the user can easily revoke access to location data or calendar data if the user is uncomfortable with the system having access to it.

In addition to this the service that provides this data can explain with a sentence why this nudge was created. Such as the goal it thinks the user want to perform and based on the users constraints.

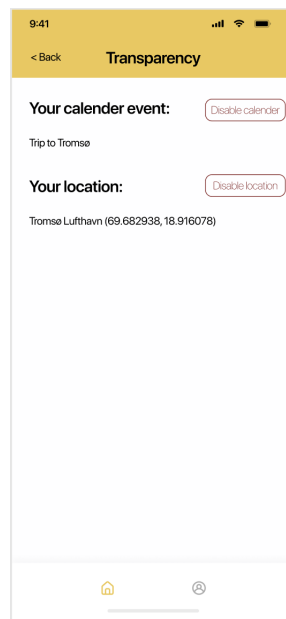


Figure 5.4: Smart Nudge: Transparency View

5.5 Incentivising Usage to Change Habbits

Incentivising the user to keep up with the goals and continue to form better habits we will be using methods from gamification to get users to want to complete more smart nudges they receive. There are many methods that can be borrowed from game design to increase user retention. We will primarily be looking at achievements for completing nudges, experience points and leaderboards as tools to implement.

5.5.1 Achievements to Motivate Nudge Completion

Getting achievements for completing smart nudges.

5.5.2 Leaderboards as Sosial Nudging

From section 2.1 we know that social norms is a method of nudging users to change their behaviour. As an example this was done by a power company that informed you about your neighbours power consumption to compare and with tips on how to use less energy.

To incorporate this into the application we will introduce points you gain for

completing different types of smart nudges and you can compare your progress with friends of yours who are also using the application.

If the user sees that they are falling behind they might just get the urge to do even better at their goals.

5.6 Types of Nudges

The app's primary goal is to nudge people to select green transportation options. To demonstrate the principles of this thesis we selected two types of smart nudges to visualize.

The first one is the daily commute nudge that a user will receive before they are going to work or to school. And the second type is a travel nudge, who's goal is to incentivize and inform the user about green transportation options when they arrive at a new location. When visiting a new city many people don't know what options for transportation is available, and often the easiest options that are advertised when you arrive might not be the greenest or even the cheapest.

As an example, when you arrive at the Oslo Airport the most convenient option and most visibly marked with signs is the Airport Express Train. However many locals know that the normal train is significantly cheaper and doesn't take much longer to arrive in the city center. Having a nudge informing you about this option could lead you to choose the second option instead.

5.6.1 Daily Commute Nudge

The goal of the daily commute nudge is to get the user to change their behaviour when it comes to transportation to and from work or school. For this nudge the backend architecture knows where the user lives and where they work, as well as what time their work starts. Using this the app will receive a notification in the morning before the user is going to work, showing them all the options

5.6.2 Travel Smart Nudge

...todo... describe how a nudge can help travelers use green transportation options while visiting new cities

/6

Implementation

This chapter will go through the implementation details of how the mobile application was developed and some technical choices that were made to make the client flexible to changes from the micro service architecture that is in the making and still has some uncertainty.

6.1 Prototyping

To test out how the application will feel and look Figma was used to create a high fidelity prototype.

6.2 Push Notifications

Expo has excellent support for making push notifications easy to implement. Usually there is some complexity since both Android and iOS have different services handling their push notifications and different implementations required.

An overview of how the Expo Push Notification service works can be seen in figure 6.1.

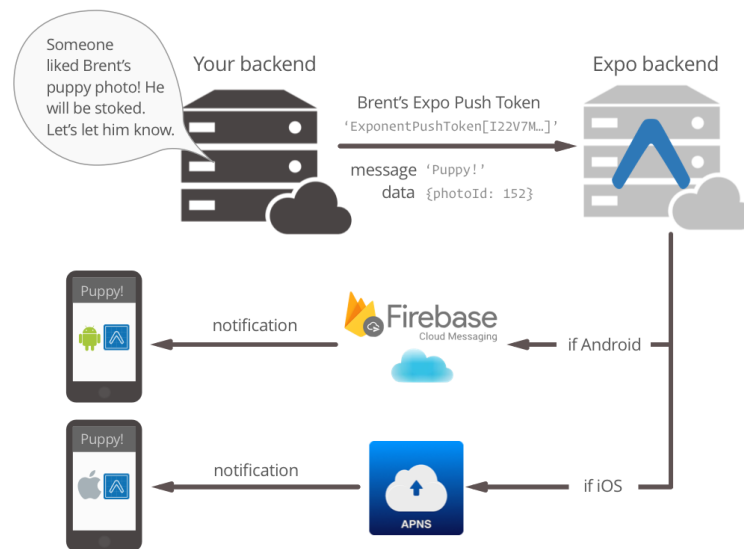


Figure 6.1: Expo Notification Service Overview

The first thing the mobile application does is to generate a *push token*. This is a unique identifier for the user and this device. This token will be stored in the smart nudge backend and linked to the user profile. Once a smart nudge is generated the backend service responsible for handling push notifications will tell the Expo backend service to send the notification to the users device. The rest is handles by Expo to see if the device is a Android or iOS device and perform the correct actions so the user will recieve the notification.

6.3 Dynamic Interface Templating

As we know, not only does the information in the nudge have an effect on the outcome but also how it is presented. Once a nudge has been presented to a user and evaluated, adjustments to the user interface can be made to increase the chances of the nudge being completed. This way not only the content but also the ordering of different elements on the screen can be changed up to create A/B tests to see what options will work better than others.

To support a highly personalizable user experience a user interface templating system was created to allow showing different variations of the user interface as a nudge. These differences could be the position of different elements on screen, or different types of text for users. Some users might be more responsive to a purely information text message, while others might respond better to a

more personal tone.

Listing 6.1: Weather widget

```
{
  "type": "weather_widget",
  "payload": {
    "location_name": "Tromso",
    "weather_string": "Sunny",
    "temp": "18"
  }
}
```

Listing 6.2: Route options widget

```
{
  "type": "route_options",
  "payload": {
    "options": [...]
  }
}
```

Listing 6.3: Route widget

```
{
  "type": "router_widget",
  "payload": {
    "steps": [
      {
        "step_type": "buy_ticket",
        "location": [69.682938, 18.916078]
      },
      {
        "step_type": "bus_route",
        "route": [[69.682938, 18.916078, ...]]
      },
      {
        "step_type": "bus_exit",
        "stop_name": "UiT",
        "location": [69.682938, 18.916078]
      },
      {
        "step_type": "walk",
        "route": [69.682938, 18.916078, ...]
      },
      {

```

```
    "step_type": "goal",  
    "name": "UiT",  
    "location": [69.682938, 18.916078]  
  }  
]  
}  
}
```



Evaluating and Testing the Effectiveness of Nudges

To adapt and evaluate the smart nudges, the backend architecture responsible for creating smart nudges will be requiring some feedback from the user. These types of analytics data points can be collected either passively or actively from the users device.

For any analytics data to have some value the smart nudges need to set some success goals. What counts as a success for the smart nudge, and how can we know if it was completed? These questions are slightly out of scope for this thesis, so let's assume we already figured that out and let's jump into looking at how the mobile application can collect some valuable data for the backend.

7.1 Passive collection

Passive collection consist of collecting data points when the user is interactive with the application, these most commonly consist of clicks on buttons, scrolling behaviour and timed events.

7.1.1 Notification CTR

The first and maybe the most obvious data point is the notification click through rate. If the notification is never clicked the backend should know about this and can adapt to this by trying different types of descriptions for that particular user to see what can make them open the smart nudges the system is trying to send them.

7.1.2 Smart Nudge Display Duration

One important data point to consider is the display duration of the smart nudge. If the nudge is displayed for a short period of time, or maybe shorter than usual for a user it might mean that something in it was not of interest or a A/B test from the backend made the content of the nudge undesirable.

7.1.3 Routing Completion Data

After the user selects a transportation option they will be given a route they can follow. For every step of the route they will be clicking a button to take them to the next step, these data points can be used by the backend as a indicator of nudge completion.

7.2 Active collection

Sometimes passive collection can be limited and we might need to ask the user a for direct feedback. This is usually done by showing the user a feedback prompt. A case where this can be necessary is if it's hard to know if the user completed a smart nudge they received. In that case in a timely manner a notification can be sent to the user asking them if they completed it and what transportation option they opted to choose.

This type of data can be inaccurate, as people can lie, so if at all possible a passive approach to verify nudge completion is preferred.

/ 8

Discussion

8.1 Monetary incentives

As described in section 5.1 about incentives to acquire user we mentioned possible methods to accomplish this goal. The spirit of a Nudge is to alter the user behaviour in a non-coercive way. When they mention that it shouldn't significantly impact them monetarily they might mean in a negative way. Therefore I believe that using perks as incentive to on-boarding users is not in start contrast to what a Nudge want's to be.

One example from Nudging is from a super market where they use the concept of scarcity to get users to buy more of a product by only allowing them to buy 10 items of that product. It could be argues that this is not a Nudge in it's purest form but it might be hard to define properly.

8.2 Validating Nudge Completion

One challenge of digital nudges that play out in the real world is that it's hard to validate if the user has completed the task. If the smart nudge suggests the user to take the bus to work instead of using their personal car they could in the received nudge say that they took the bus when they actually did not.

You could probably use sensor data from the device to distinguish between a

user walking to work or using a car, but as both a car and a bus uses the same road it will be hard to prove either way.

Since it's hard to validate nudge completion the application should be careful about for example giving the user points for completing a task and allowing these points to be used for some monetary value, as it could be exploited.

/9

Conclusion

In this thesis we have looked at personalized nudges that will be served to user through push notifications and displayed on a mobile applications. Multiple aspects from UI and UX research such as middle option bias, colors, sizing and gamification have been used to enhance the perception and the experience of receiving a smart nudge to improve the likelihood of the Nudges to be more effective and to have a behaviour altering effect on the user.

The thesis gives a general overview over how data about the user can be gathered trough the profile creating portion of the app and other data sources such as the users position and calendar events to give the nudge creation service a better context of how to create immersive and informative nudges that are tailor made for the user viewing them.

We have also looked into how the application can gather crucial analytics data that the nudge creation service can use to adapt nudges to be more effective on a user to user basis. To conclude, this thesis shows how we can leverage principles from UI and UX research to enhance our smart nudges that try to alter the behaviour of the user regarding green transportation.

For future work, these and perhaps new principles from UI and UX research can be tested and verified once the backend architecture of the ODS group for serving digital smart nudges is up and running. As this thesis has been time limited there are still others working on the micro service architecture for the system and all the data gathering services required to create these

nudges.

Bibliography

- [1] R. H. Thaler and C. R. Sunstein, *Nudge: Improving Decisions about Health, Wealth, and Happiness*. Yale University Press. 2008.
- [2] C. Schneider, M. Weinmann, and J. v. Brocke, “Digital nudging: Guiding online user choices through interface design,” *Communications of the ACM*, vol. 61, pp. 67–73, 06 2018.
- [3] C. Sunstein, “Nudging: A very short guide,” *Journal of Consumer Policy*, vol. Volume 37, Issue 4, pp 583-588, 11 2014.
- [4] R. Karlsen and A. Andersen, “Recommendations with a nudge,” *Technologies*, vol. 7, p. 45, 06 2019.
- [5] B. J. Fogg, “Persuasive technology: Using computers to change what we think and do,” *Ubiquity*, vol. 2002, Dec. 2002.
- [6] N. Tromp, P. Hekkert, and P.-P. Verbeek, “Design for socially responsible behavior: A classification of influence based on intended user experience,” *Design Issues*, vol. 27, pp. 3–19, 07 2011.
- [7] J. Hamari, J. Koivisto, and H. Sarsa, “Does gamification work? — a literature review of empirical studies on gamification,” 01 2014.
- [8] A. Håkansson, “Portal of research methods and methodologies for research projects and degree projects,” 2013.
- [9] E. Varakina, “Effective push notifications: tips and best practices,” 2019.

