

CS3240 Project Report

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1. Contributions

At the beginning of the project, we did a brainstorming session together and decided on the problem to solve and our solution. Three user groups were identified.

Then each team member invited a target user to do a semi-structured interview for our user study. Data analysis, task analysis and requirement analysis were carried out to better understand users' needs.

The team then refined user persona and identified three key tasks users can perform on our proposed interactive system. Each team member then continued to build a prototype individually and invited users for prototype evaluation.

In the last phase of the project, as there are multiple deliverables to be submitted, the team decided to appoint two members to be in charge of each area, while the whole team will still contribute to all deliverables. The job allocation is:

- Refined prototype - Rickard and Josefina
- Report - Chen Di and Duoduo
- Poster - Duoduo and Josefina
- Video - Rickard and Chen Di

In this way, each member can focus more on the items they are in charge of. This ensures the efficiency of work and quality of the deliverables.

2. Problem Overview

This project aims to solve the problem with the inflexibility of the shuttle bus system at NUS. During peak hours the demand for them is higher than the supply, resulting in overly crowded buses and sad passengers. During off-peak on the other hand the buses do not run as often, resulting in longer waits. In the worst case there is no bus service at all leaving passengers with few options for how to get around other than walking long distances.

2.1. Initial Solution

To mitigate this problem we propose to design a smartphone application which could be used in unison with a bike rental system on campus. Such systems have previously been adopted on campuses worldwide, for example at University of British Columbia in Canada and University of Nottingham in the UK. It is our opinion that a well designed interactive mobile application for people to use the system would be a large part in the success of deploying such a system on campus and thus we are looking into the requirements and design of an application would such a system become available at NUS.

2.2. Refined Solution

After analysing the interview data from user study and the feedback from first round of prototype evaluation, we have decided to change traditional bike to electric bike because of the hot weather and strong sunlight in Singapore. An electric bike serves the purpose of easy transportation better. Requirements for interface design are similar, although now we need to take into account the battery level of the electric bikes. Users can check the battery of their bikes, and are warned if the battery is low.

3. Development and Evaluation Process

3.1. Development

User Study

In order to precisely define our target user group, we started our project with user study. We defined three user groups, firstly we have the “Stressed Out” student group who are having a rushing time taking the NUS shuttle bus for classes; secondly we defined a “Health Concerned” student group who are keen in taking daily exercises; lastly we defined “Environmental Friendly” student groups who have concerns on carbon foot print of public transportations.

Upon defining user groups, we carried out a series of semi-structure interview where we had our target users described their experiences with shuttle bus in general. The purpose of the interview is to gather user opinions of the current shuttle bus system and their essential need in using bike system.

User Data Analysis

We started off the data analysis by concatenating all of the interview answers into the same document to get a better overview of where the respondents had similar opinions and where they differed. We also transcribed the voice recordings from the interviews in order to more easily be able to find relevant parts and compare the data from the different interviews with each other.

Next up, we looked more closely into the highlighted data by reading the interview transcripts for the different sections in order to make sure that we didn’t miss anything by just looking at the notes or that we misinterpreted the notes. We then summarized the core findings on post-its in order to make an affinity diagram (Figure 1).

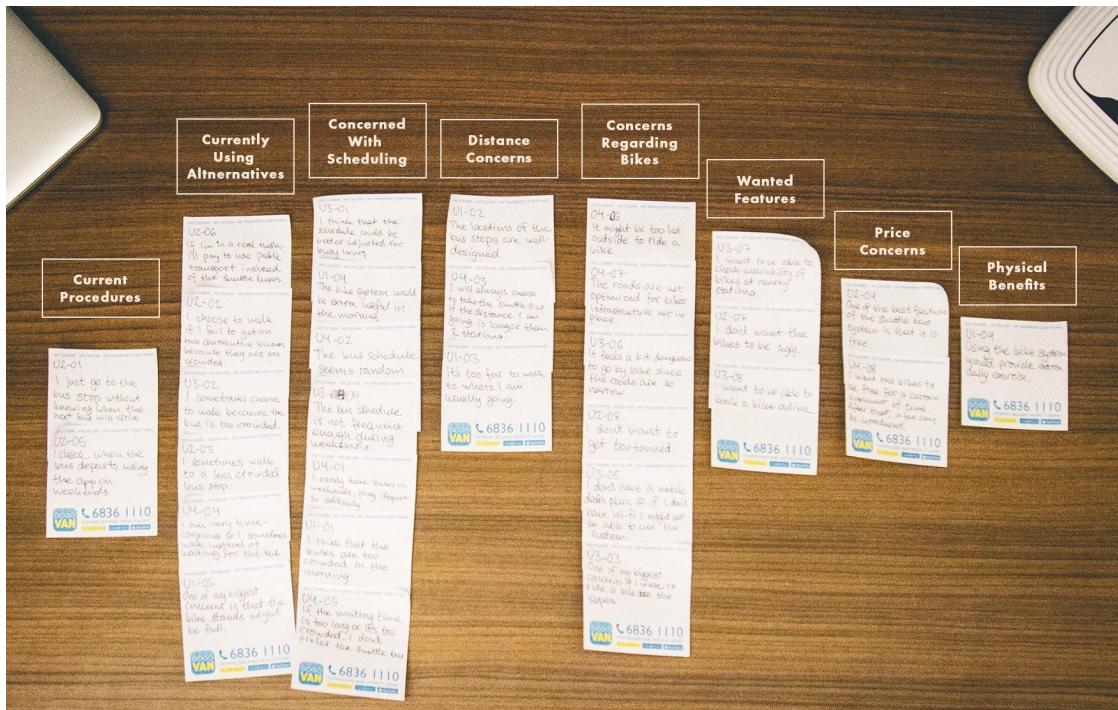


Figure 1. Affinity diagram

Task & Requirement Analysis

From analysing interview answers and affinity diagram, we further came up a few main tasks from within our project scope. 3 tasks were defined at this phase. They are “Plan trip & check bike availability”, “Route planning” and “Usage fee”. These three tasks reflected users current issue with the shuttle bus system and defined users’ actual needs in using an alternating bike system.

After performing a task analysis we have concluded a few requirements for the mobile application which would work in unison with a bike rental system on the NUS campus:

- Booking a bike** - The users expressed their concern on the unreliability shuttle bus system. Enabling user to book a bike from a remote application would allow the users to either plan their trip beforehand and check which bikes are available right now.
- Unlocking and locking a bike in a hassle free way** - To make the system flexible to use there can be no extra work included with keys and such but rather the unlocking and locking of a bike take place from inside the application.
- Plan route** - The application would provide the user with the option to find a route to take in case the user is not sure where to go. Different routes for fastest travel, less trafficked roads and roads with less hills would address the users personal preferences.

4. **Making sure there are places to return the bike** - To make the returning process easy to cope with, the application would have a function which allows the user to book a return station before he or she starts biking.
5. **Seeing when to pay** - The application would show how long the user can use the bike before it starts costing money and how much money it is costing after that period, which gives the user substantial information to decide how they want to use the system.

Persona & Storyboard

With our application requirements been precisely defined, we then started our prototyping. From the three user groups, we came up with their corresponding personas, each one of them gave us a background story of our target user group therefore we can design a specific user scenario dedicated for it.

To achieve a universal agreement of the main usage scenario among our group mates, we made a storyboard (see full storyboard in appendices) that describes how the primary users, could go about to achieve their goals through three key tasks:

1. Finding available bikes based on user's geographical location and unlocking a bike
2. Plan trip on campus, provide suggestions on different types of routes
3. Return bike at destination

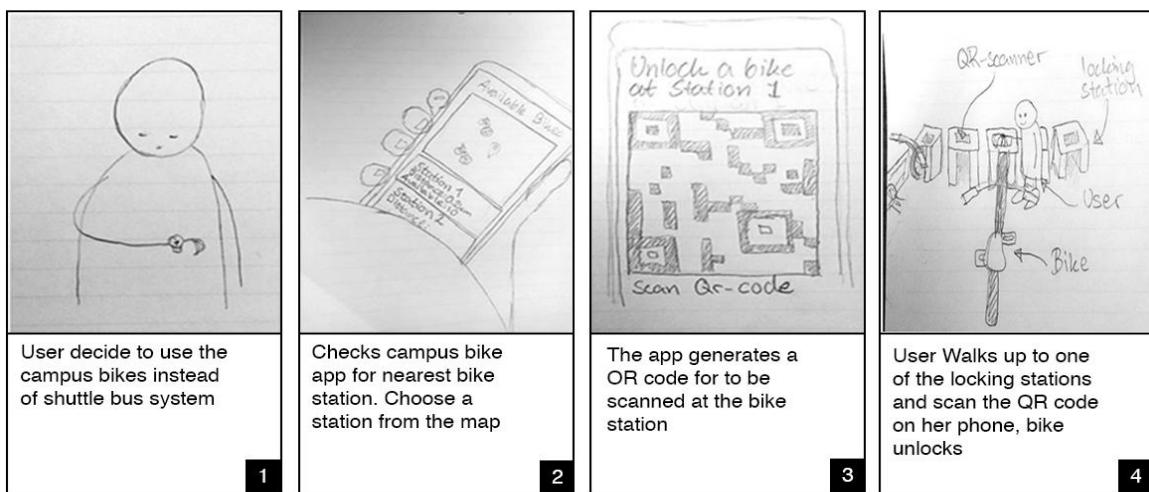


Figure 2. Part of Storyboard
(full version available in Appendix)

Initial Prototyping

To achieve better prototyping result, we built our prototypes in parallel. Among four group members, each one of us built our own prototype individually. We believed that in this way we could generate more creative ideas and covers more potential problems. As a result, four “Hi-Fidelity” prototypes were created, three of which are built with Just-in-Mind and the other one built with Adobe-Illustrator (see full view in appendices). All four prototypes made a full cover on main tasks so that the user can have a full experience of completing a bike usage task.

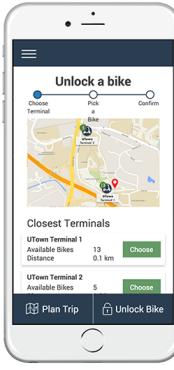
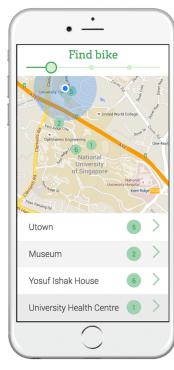
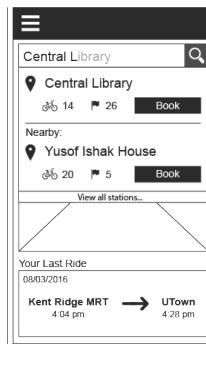
	Rickard	Josefine	Duoduo	Di
Prototypes				

Table 1. Initial prototypes

Refined Prototyping

Based on the evaluations of the initial four prototypes, we adjust the prototypes requirement accordingly and built a refined prototype. This high fidelity prototype is built using AngularJS in combination with the Google Maps API. We chose these technologies since a functional web-application prototype provides a more realistic map interaction experience to the users in the last user study. We also gain more control of the behaviour of the application than we would if we were to use Justinmind or some other similar prototyping tool.

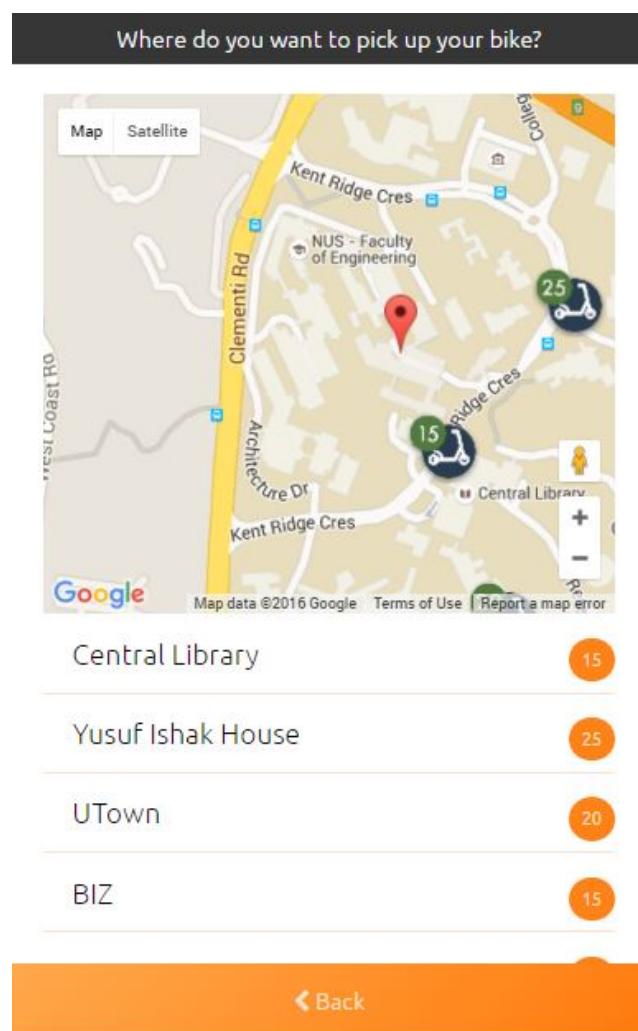


Figure 3. Refined prototype for final user tests

3.2 Evaluation Process

The “Think-Aloud” method is a powerful evaluation technique as it allows us to gain more insights into what the users really feel than other commonly-seen methods like observing. Thus we invited four users to evaluate our prototypes using the “Think Aloud” method where they are encouraged to voice out their thoughts while they perform tasks in a given scenario.

However, users tend to describe what they are doing rather than what they are thinking. In such cases we try to prompt them by asking questions when we observe that they may have something to say. And in some cases thoughts were also shared after the user had tried the prototype, more in line with a retrospective think-aloud.

The table below shows how the initial user evaluation was done.

Evaluated by	User 1	User 2	User 3	User 4
Prototype 1 Rickard	o		o	o
Prototype 2 Josefine	o		o	o
Prototype 3 Duoduo		o	o	o
Prototype 4 Chen Di	o		o	o

Table 2. User evaluations on initial prototypes

The evaluation of the refined prototype was conducted with three more users, once again using the think-aloud method.

4. Findings of Evaluation

Findings of initial prototype

For the “Borrowing a Bike” scenario, since our smartphone application is based on a bike sharing system which is not yet available, many users are confused about the whole borrowing and returning process. Users were unsure about types of bikes provided and the infrastructure to be implemented at bike stations. As a result, they made assumptions about the system, which might be different from what we had in mind.

Due to the lack of experience with a bike sharing system, users sometimes are not sure what is the expected outcome of certain procedures. For instance, since we do not have a real bike stand for users to visualise the bike unlocking process, some of them had no idea about the purpose of the confirmation QR code generated upon successful booking. Considering users may have different understanding of the system, explanatory instructions are needed for first-time users to know how the bike sharing system works and what are the actions they need to carry out at the bike stations to borrow a bike.

Another important finding is on the choice of information to be displayed on the main screen. Since the system provide users with a grace period of “free ride”, most users suggested to have an easy-to-notice icon that indicates the time left before free usage ends. For instance, a countdown clock could be shown on the main view after the completion of borrowing. Besides, some users raised the point that a campus map is not always useful because the target users are mainly NUS students and staff who are supposed to be considerably familiar with the campus. It might be more user friendly to make the map available only when it is needed, such as planning the route.

Findings of refined prototype

We summarise the pros and cons of the refined prototype into the table below.

Pros	Cons
<ul style="list-style-type: none">- Use of NUS colors, easy to recognise- Clean and neat interface- Purposes of all stages are clear (stated at the top of the screen)- Show bike battery while riding, preventing cases of no battery before reaching destination- Show free time left- Useful animated instruction on how to	<ul style="list-style-type: none">- Some descriptions/instructions too wordy- Usage of different icons on the map and in the list- Map and station list tend to be used separately- “Booking return station” stage: icons are ambiguous- “Cancel navigation” means no return station is booked- Success screen can contain more

return the bike	information such as duration and distance - Users should be informed about the possible costs after free time is used up
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Table 3. Summary of pros and cons of refined prototype

From the feedback gathered, it is easy to notice that consistency really helps with users' understanding of the whole system. Having the purpose of each screen stated at the top makes the users easily realise which phase they are in now and what actions they are expected to take. This creates a continuous flow so that the users can perform the tasks better. There are cases where the prototype fails to follow consistency, such as the station icons are different on the map and in the station list. As a result, users tend to interpret the map and the station list separately although they are supposed to serve the same purpose of selecting station.

The neat minimalist interface is generally well received by users probably because cognitive load is reduced to some extent. However, there are certain cases of long description or instruction that are pointed out by users. It is important to make all texts concise and readable so that users can get the correct message

5. Possible Adjustments

Consistent sets of icons can be used to make users know they can select a station from both the map and the station list. For the “book return station” screen, we can use icons that suggest empty bike stands instead of available bikes to avoid confusion.

Long paragraphs of text can be shortened or broken down to smaller segments. Only key ideas are necessary for users. This is especially useful for novice users as they are unfamiliar with the application and reading long texts further confuses them.

Some confusion arises from the “choose return station” step where “cancel navigation” means no return station is booked. As the user groups for this project are expected to be familiar with NUS campus, it is usual that some users may want to book a return station but do not need the navigation map at all. Therefore, we can either make the navigation map optional (toggle view) or allow users to cancel navigation while their return stations are still booked.

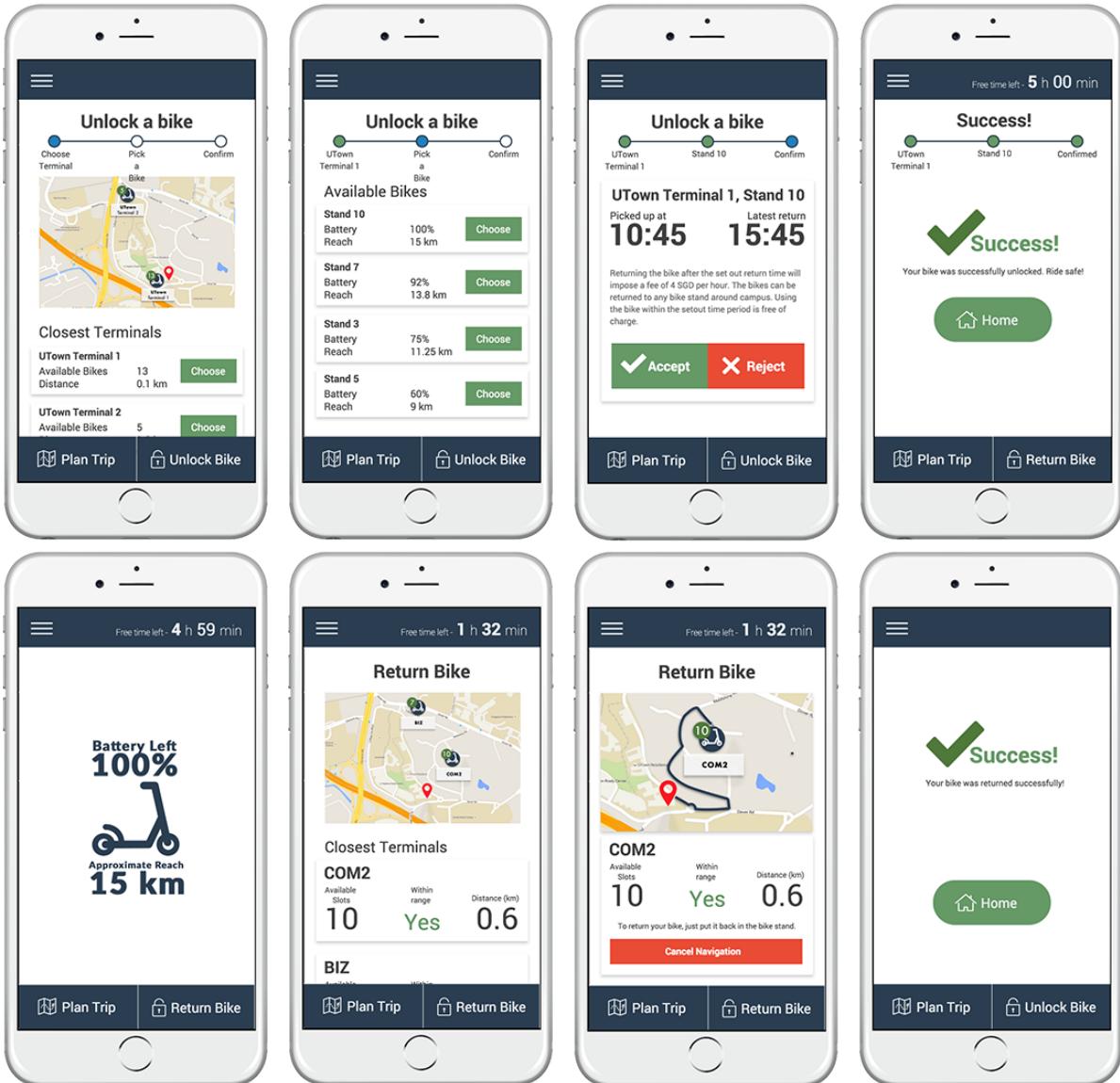
6. Learning Points

One of the main learning points from this module is the design thinking methodology which is crucial to problem solving in many areas including Human-Computer Interaction. The highly interactive style of lectures allow us to get hands-on exercises to reinforce the concepts taught in each phase of design thinking. The group project also links different stages of design thinking together, so that we can better make sense of the whole process. Through these important steps like proposing ideas, carrying out user study, prototyping and evaluating, we experienced a small-scale but nevertheless complete cycle of interaction design process. The experience gained can definitely be applied to future projects.

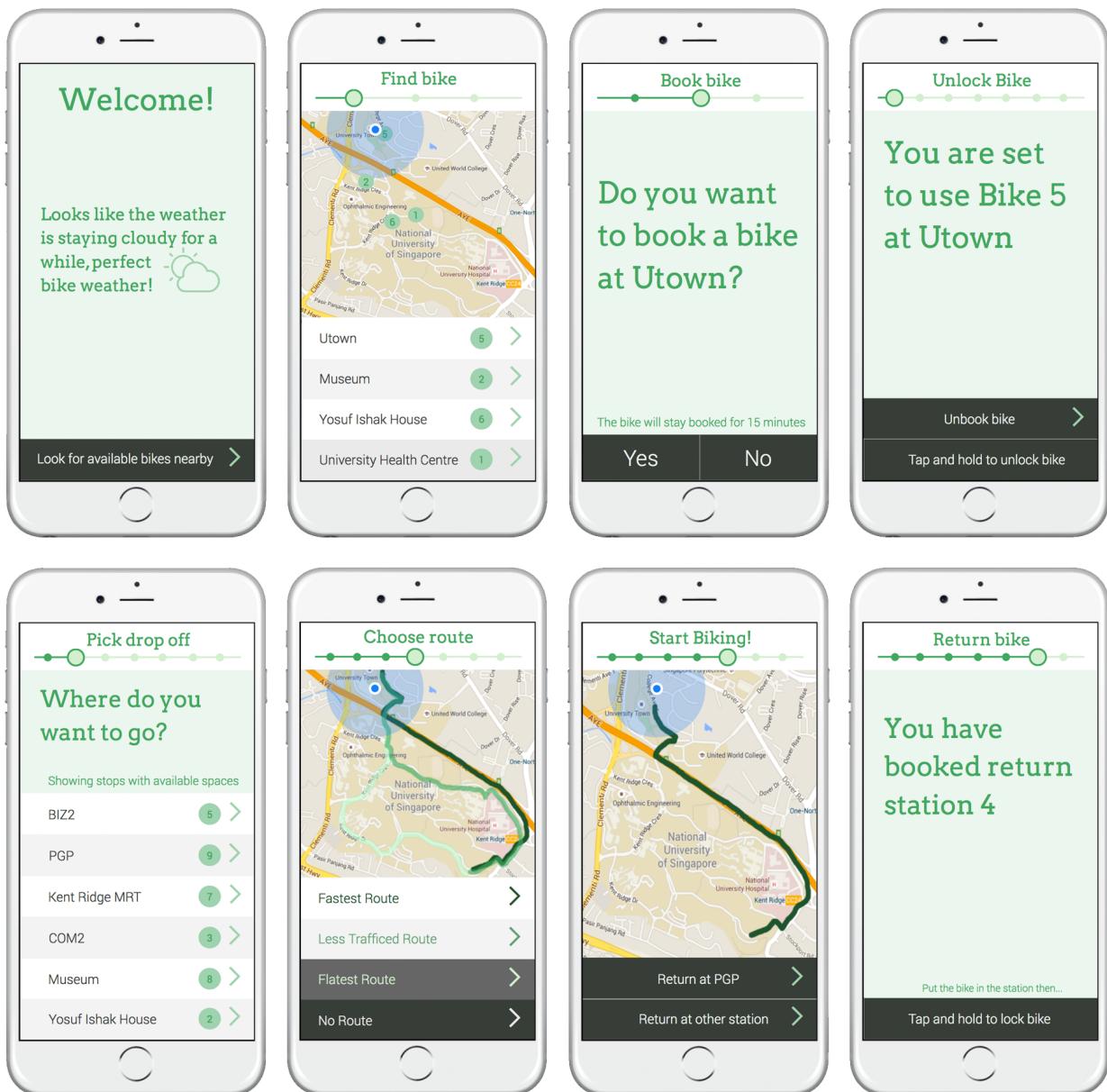
In addition, we gained a better understanding of interaction design, including its past developments, recent applications and future trends. Users' preference may change over time, but there are design principles that should be considered in order to produce user-friendly designs. Principles like reducing cognitive loads and using harmonious colors have been recognized for many years and are still relevant now. On the other hand, knowing the new trends in interaction design allows us to stay up-to-date with rapid developments in interaction design.

7. Appendices

1. Rickard's Prototype



2. Josefine's prototype



3. Duoduo's Prototype

Left Screen (Login):

RidersNUS

User ID
Password

Log In

Remember me!

Middle Screen (Search Results):

Enter station name...

NUS map with current location and bike stations denoted

Your Last Ride
08/03/2016
Kent Ridge MRT → UTown
4:04 pm 4:28 pm

Right Screen (Search Results):

Central Library

Central Library
14 bikes, 26 parking spots. Book

Nearby:
Yusof Ishak House
20 bikes, 5 parking spots. Book

View all stations...

Your Last Ride
08/03/2016
Kent Ridge MRT → UTown
4:04 pm 4:28 pm

Left Screen (QR Code):

Central Library

Please scan this QR code at Central Library bike station within 15 minutes to unlock your reserved bike.

OK

Your Last Ride
08/03/2016
Kent Ridge MRT → UTown
4:04 pm 4:28 pm

Middle Screen (Booking Confirmation):

Enter station name...

NUS map with current location and bike stations denoted

Your Current Ride
09/03/2016
Central Library → ???
11:02am ???

[View QR Code](#) [Cancel Booking](#)

Right Screen (Booking Confirmation):

Enter station name...

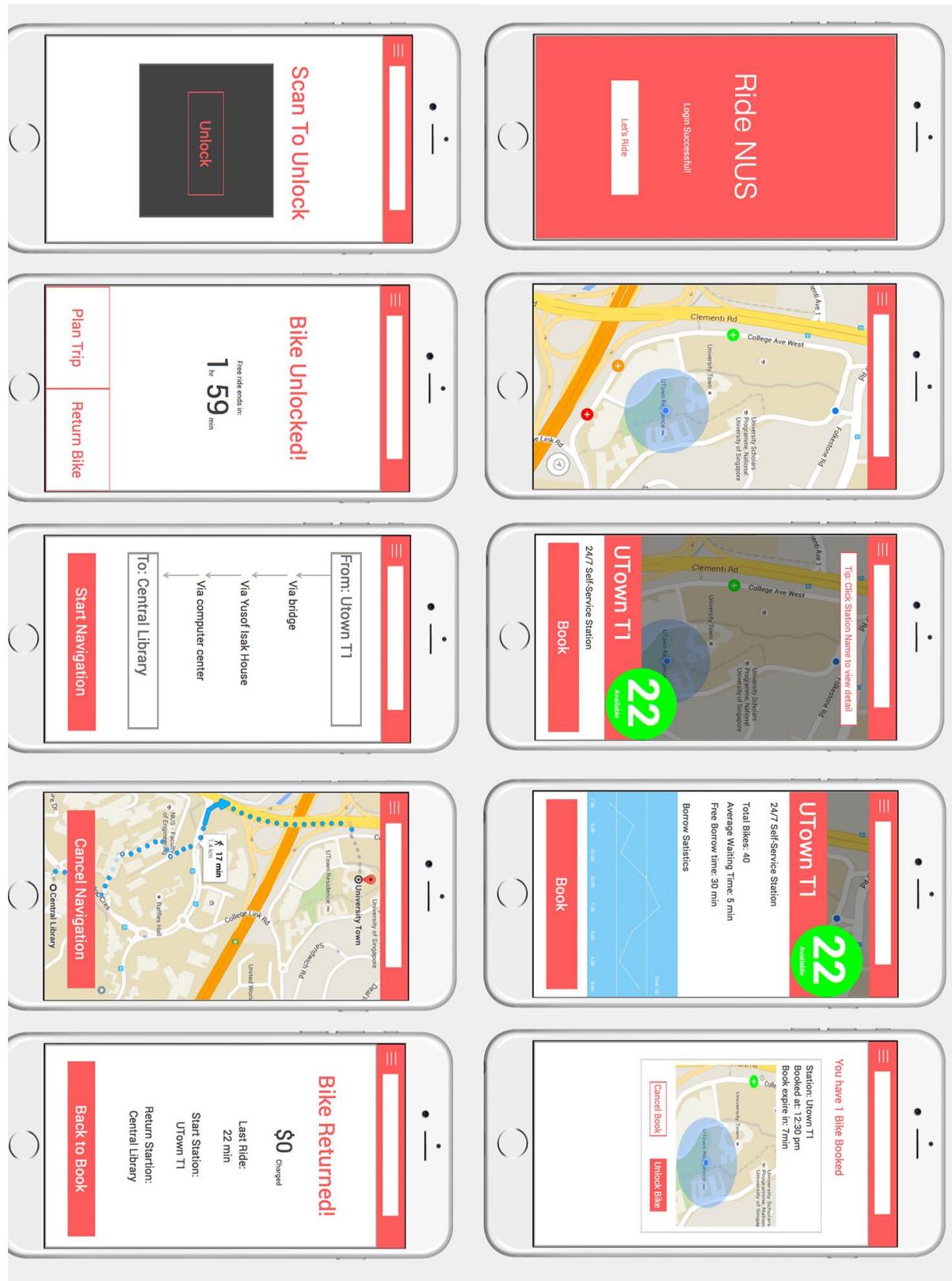
NUS map with current location and bike stations denoted

Travel duration - 13 minutes.
This ride is free of charge!

OK

Your Last Ride
09/03/2016
Central Library → Computing
11:02 am 11:15 am

4. Chen Di's prototype



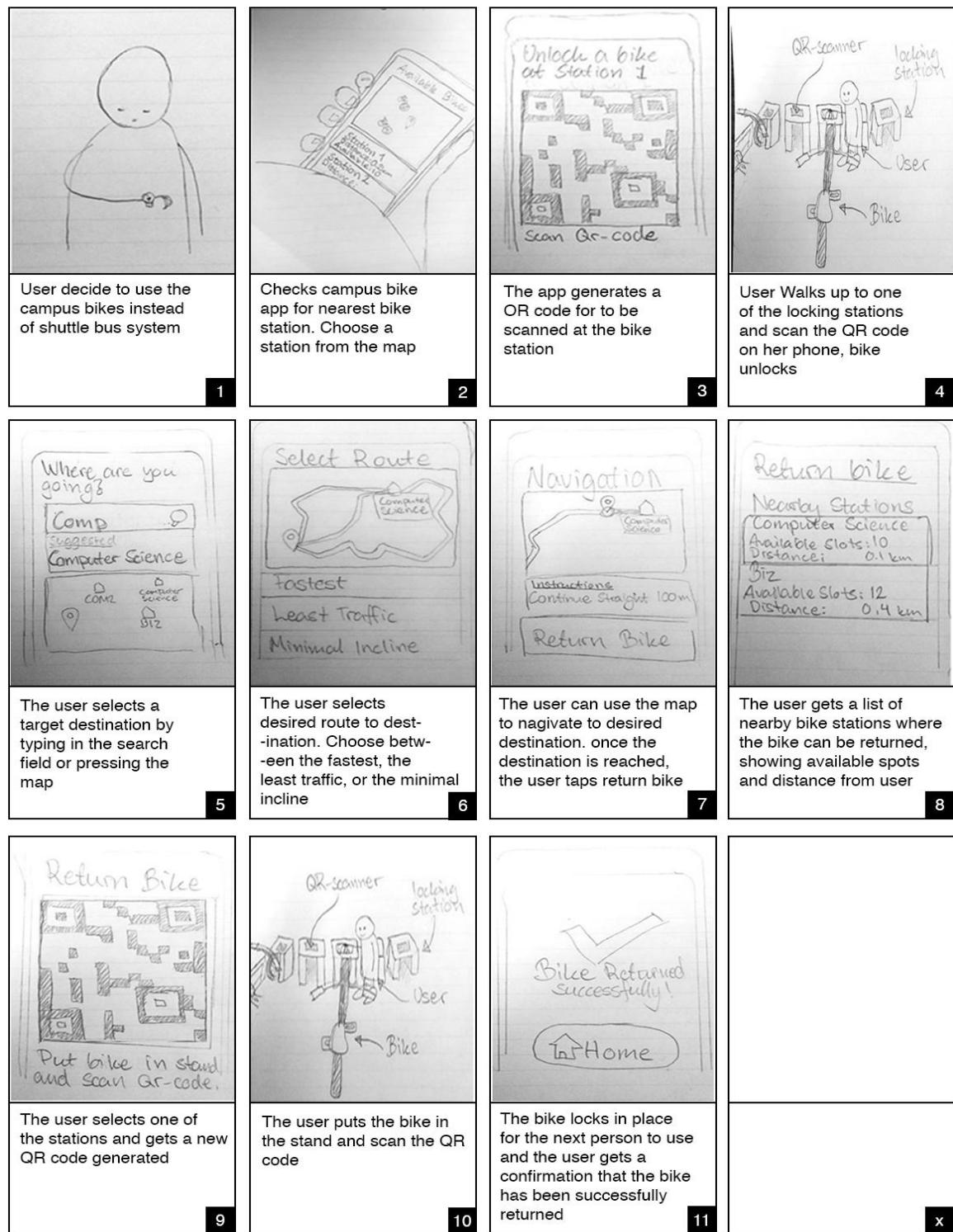
5. Refined Prototype

Full version of refined prototype available at <http://bergeling.com/CS3240/Prototype>

The screenshot displays the Ride NUS mobile application interface across several screens:

- Step 1: Hello!** Shows the "RIDE NUS" logo and a welcome message: "Welcome to Ride NUS, the service which lets NUS students and staff borrow bikes, ride them on campus and then return them at their final destination. We have stands by the bus stations all over campus".
- Step 2: Where do you want to pick up your bike?** A map of the National University of Singapore (NUS) campus showing various locations for picking up a bike, each with a red dot and a number indicating availability (e.g., 20). The locations listed are: BIZ, COM, Central Library, PGP, Yusuf Ishak House, and UTown.
- Step 3: Go unlock your bike!** A map showing the route from the selected pickup location (BIZ) to the destination (Central Library). The route is highlighted in blue, and the estimated time is 14 min 38 sec.
- Step 4: Ride Overview** Summary information including a scooter icon, free time left (59 min 46 sec), remaining battery (96%), and a note about route directions and return stations.
- Step 5: Navigation** A map titled "Navigating to Central Library" showing the route from BIZ to Central Library, with points A and B marked along the way.
- Step 6: Return Bike** A summary screen with options: Book return station, Return bike without booking, Change Destination, Cancel Navigation, Cancel, and Got it!.

6. Storyboard



7. Table of initial prototype evaluation

	Prototype 1 Rickard	Prototype 2 Josefine	Prototype 3 Duoduo	Prototype 4 Chen Di
Pros	<ul style="list-style-type: none"> - Consistent design - Showing free time left - Gives error prevention, clear information about the terms and conditions of using a bike - Showing bike battery and reach 	<ul style="list-style-type: none"> - Minimalist and consistent design, mostly clear what to do, not too many choices, good with options of what route to take - One click on each screen 	<ul style="list-style-type: none"> - Consistent design - Easy search function with nearby stations suggested to user - Showing number of available bikes and number of parking slots (for returning bike) - Easy to use, main functions accessible without opening side menu 	<ul style="list-style-type: none"> - Consistent design - Help user recognize than recall, station colors for showing bike availability - One click for each screen, return a bike view is simple
Cons	<ul style="list-style-type: none"> - Minimalist design sometimes violated, side menu was never used, might be redundant. - Lack of the system status, a lot of assumptions were made on how the bike system is to be implemented. 	<ul style="list-style-type: none"> - Some screens might be unnecessary - Lack of system status sometimes, unclear that a bike had been booked, why is there still an option to look for bikes nearby? - Should give more help and documentation, needs solution for not wanting to book a return station but wants to see stations nearby 	<ul style="list-style-type: none"> - Not intuitive to scan a QR code twice (for unlock and return bike) - Cannot find the QR code (button not obvious) - “Parking slot” icon meaning unclear, may use text label instead - Sometimes violate minimalist design, not necessary to show map all the time - Need more info on system status, need more 	<ul style="list-style-type: none"> - No visibility of the status of the system, user not sure what's next step after completing one task. - The meaning of the tip showing on the booking map view is not clear - Selection of words not intuitive, Menu item “My Bike” is unclear to user, may consider rename it to “Booking

		<ul style="list-style-type: none"> - Clearer which bike is unlocked and what return station to use 	<p>information about the current ride (e.g. duration, number of minutes before free usage ends, cost, etc)</p>	<p>Details”</p> <ul style="list-style-type: none"> - Need to match the system with the real world, Need to integrate landmarks in map navigation - Search bar should not always appear, should provide minimalist design. - Does not show where return stations are - A button back to “Ride time count down” should be provided.
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8. User Interview Scripts

About person

Age?

User 1: 23
User 2: 20
User 3: 20
User 4: 23

Occupation?

User 1: Exchange Student
User 2: Student
User 3: Student
User 4: Student

Attitude towards current Shuttle Bus System

Do you take shuttle bus for classes?

User 1: Yes, UTown, COM
User 2: Yes, every day
User 3: Yes, everyday
User 4: Yes ofc. Staying at PGP, takes A1 or D2 to Science as his everyday route.

Can you describe me how you take buses for classes?

User 2: Wait before and listen to music, does not check before when the bus leaves
User 3: before 10 am at UTown to science.
 Schedule beforehand and catch the bus on time
 If missed, need to wait for another 10-15 minutes
User 4: Just goes to the bus, the buses seems to depart at random. Rarely takes buses on weekends

Do you think the shuttle buses are scheduled well?

User 1: crowded in the morning, can't get on bus
late class, bus not as frequent, need to wait
User 2: No, they are irregular
User 3: No. Before 10 am, lots of people waiting. Bus usually come at 940, if missed then have to wait for another 10 minutes. Intervals should be shorter before every hour.
User 4: Not really, they don't have a preset timing for all days at the week. It seems random and the information should be open.

Do you think locations of bus stop are designed well?

User 1: yes, manageable, more stations means longer travelling time
User 2: Yes
User 3: the whole UTown only has one bus stop. took 5-10 minutes from further side of UTown to the bus stop
User 4: Generally it is okay

Do you always take a shuttle bus? Will distance affect your choice?

User 1: always go to computing, too far to walk, normally take bus

User 2: If it's too crowded, two busses not able to get on, walk.

Distance is not a problem, can walk to another bus stop where there is less crowded

User 3: Usually take bus from UTown to science or PGP, other time just walk because the bus is too crowded.

User 4: Most of the time (over two stations, then yes)

Do you find that there is always sufficient room on the shuttle bus?

User 1: larger buses will be preferred, too crowded, easier for wheelchairs

User 2: No

User 3: No, especially during peak hour, otherwise it is okay.

User 4: During peak hours it is quite crowded, can get on 90% of the time but 10% can not

So overall, are you satisfied with the NUS shuttle bus system?

User 1: Yes

User 2: Free, air con, would prefer the public transport if it was also free

User 3: Basically satisfied. Good way for transportation, convenient.

User 4: Yes

If so, What are the main positives you see with the shuttle bus system?

User 1: convenient way of transportation, no personal bike, buses better than cars

User 4: Air Conditioned, quite frequent departures during weekdays - doesn't have to worry about how long he'll have to wait (usually new bus within 10 min)

If not, which aspect(s) concerns you the most?

User 2: Too crowded

Are you happy with shuttle bus schedule during weekends and public holidays?

User 1: Works fine? live in UTown, special schedule does not affect the user much

User 2: Usually look at the schedule during weekends, it's okay for him since he can check for them on the app.

User 3: A bit infrequent. Not convenient.

User 4: Time conscious so would rather save some time instead of waiting.

If he walks from PGP to science (climbing the hill saves at least 5 minutes)

Discussion on alternative ways to travel around campus

What factors could make you not want to use the shuttle buses?

User 1: nicer to walk if distance is shorter

User 4: Waiting time too long or it is too crowded

Do you see any good alternatives to the shuttle buses if you want to travel around campus?

User 2: A public transport service at NUS, subsidy for public transport?

User 4: Walking, Running

If yes, how often do you use these alternatives? Do you wish there were more?

User 2: If in a real rush.

User 3: Walking. Cycling.

User 4: 3-4 days out of seven days, might take the bus somewhere but walk back.

If no, do you wish there were alternatives available?

User 4: Electric bicycles, scooters

What factors could make you choose to use the shuttle bus over these alternatives methods?

User 1: not very often, once twice a week to walk

User 3: Weather is too hot.

User 4: Faster and more comfortable.

Discussion on advantages and limitations of bike rental system

We are looking into designing a bike rental system for NUS campus, this would entail the possibility to unlock a bike using your phone and ride it from one location to another on campus without the need to own your own bike nor concern yourself with taking it back to where you started.

What are your initial thoughts on this concept?

User 1: convenient, will consider, esp in the morning

User 2: He has his own bike, three years ago biked to school. But too tiring to ride up and down hills. Dangerous because there are no biking trails.

User 3: Generally good idea. Can have a internal bike system within Utown. Set rental station near buildings/dorms in UTown. Other places on campus too much hills and not suitable for cyclings (UTown is slope-free!).

User 4: If it's not a long distance it would save a lot of times

What are some advantages you could see with this versus the shuttle bus?

User 1: more exercise, reducing CO2 emission from buses, environmentally friendly and health

User 2: Good if you are in a rush

User 3: Save waiting time, don't need to worry about getting on a crowded bus

User 4: If it's not a long distance it would save a lot of times

What are some concerns you might have with a system like this?

User 1: space for bike stations, what if bike station is full and user need to return bike to another location

User 2: Bike may break down half way, too tiring riding up and down hills. Accident, who is responsible? If bike is broken who pays?

User 3: Too many slopes

If no wifi, then cannot use system.

Dangerous to cycle, roads too narrow, cars too fast.

Better if we have a bicycle lane.

User 4: Weather might be too hot

Infrastructure not in place (no bicycle lane)

The roads are not optimized for bicycles

Would consider riding a bike if the road is more optimized (has to ride on the main road)

A lot of slopes, would like a lane that optimized distance

What features would be important for you to choose to use a bike rental system on campus?

User 1: time, temperature, weather
reduce the buses if we can!

User 2: Enough bikes, security system so they are not stolen, appearance of bikes not too ugly. Using student cards to rent the bikes. Prefer monthly rental if there is a fee, maybe 5 SGD. How long can you rent a bike? What if it is not put back?

User 3: check availability of bikes at nearby stations.
Online booking generates a QR code, scan to unlock your bike. Saves time.
Low usage fee. A small charge per semester.
User 4: More parking lots for bikes
Book via an app?

What would be a reasonable price range?

User 4: Has seen systems in other cities
Bicycle stations where it is free if you return the bicycle within a certain time period. (1-2 hours)
Could charge approx 10 dollars in a lump sum (if he takes the bike for a day or 5-6 hours it shouldn't be more than 5-10 dollars)

User group specific questions

- stressed out

Have you ever been late for class/exams due to late/overcrowded bus?

User 3: Yes, but not too often

- health concerned

Do you think you have enough exercise on an average school day?

User 2: Go jogging every night, if riding bikes it would be a good exercise
User 4: Do walk a lot but doesn't get enough cardio exercise.
Seldomly rides bikes (rides fake bike in gym)

If not, do you do anything about it? Do you go to gym? How often?

User 4: Exercises at least 3 times a week

Do you like riding bikes?

User 2: Do not want to be too tanned

Do you prefer to walk/ride a bike instead of taking bus whenever possible?

User 2: Currently, bus it first choice, then bike and lastly walk. In raining days prefer to walk.
There are no shelters for busses.

8. Consent Form

Consent Form: Interview regarding transportation on campus

I hereby consent to participate in a research study conducted by Chen Di, Zhu Duoduo, Josefina Martinsson and Rickard Bergeling for an assignment in National University of Singapore Computer Science 3240, Interaction Design. I agree to participate in this study the purpose of which is to gather information regarding limitations and alternate solutions for transportation around the NUS campus.

I understand that:

- The procedure to be used is individual interview.
- I will receive no compensation for my participation.
- I am free to withdraw before or any time during the study without the need to give any explanation.
- All materials and results will be kept confidential, and, in particular, that my name and any identifying or identified information will not be associated with the data.

Participant

Name _____ (please print)
Signature _____ Place _____ and Date _____

Investigator(s)

Name _____ (please print)
Signature _____