User Centered Design and Usability Evaluations of Microsleep Mobile Application.

Department of Computer Science, Universiti Teknologi Malaysia;

Nuramyra Natasha Binti Ismalludin B19EC0035,

Nurul Syafiqah Binti Yusry B19EC0036,

Nik Nur Fatini Binti Nik Ahmad Azhar B19EC0027,

Nur Farzana Alia Binti Mohd Sanori B19EC0045.

Abstract

Microsleep are a serious concern that involve fatal road accidents. The main reason is that the driver being drowsy behind the wheel, measure to alleviate this problem becomes the major task. This project is built to explore the user's experience in microsleep that happen among the vehicle's driver and how they get rid of it with technology that can help them stay awake. Result indicated that microsleep has experienced the most among long distance driver. Usually, microsleep involve people who are suffering from insomnia, sleep apnoea or sleep deprived and any other symptoms. However, microsleep can be prevented in certain ways such as changing lifestyle, planning activities and setting their sleeping schedules. In this paper, we design an application and usability evaluation to alarm people if the microsleep situation is detected. Interviews were conducted and some questions were asked about microsleep and also to find out how someone had experienced microsleep while driving. Besides, online surveys were conduct to collect information about microsleep. Five people who are expertise in interface design and natural language processing appraise the prototype using Nielsen's set of heuristic. The results and incrimination for further interaction design that had been developed are widely discussed.

Keywords: Microsleep, road accidents, application, evaluation, experts, prototype, Nielsen heuristic.

1. Introduction

There are already lots of microsleep detection device in the market most of it had been proved incompatible due to a variety of factors such as insensibility or the issue of alleged driver acceptance. It requires continuous alertness during driving and a sudden microsleep can lead to bad things happen. In United Kingdom only, around 20% of road accidents happen are caused by driver sudden sleep during driving, with 1 in 25 fatal road accidents caused by fatigue[1]. To assess the aftermath of driver fatigue detection devices on the behavior of drivers to the application evaluation. Microsleep happen due to exhaustion and is associated with progressive improvement in

performance variability and neurocognitive impairment, where micro-sleep became an extreme symptom. [2].

However, it also can be extreme risk due to lots of exposure rates and factor of the lifestyle the individuals. Although drivers aware of the tiredness that the possess while driving, they continue to drive and placing not only themselves but other people to, in danger. The earliest search for information on fatigue detection technology in the scientific literature that can be include Medline, Embase, Transport, IEEE Xplore, and PsycINFO by using the search terms that known as "driver monitoring and fatigue". A reasonable amount of the literature expectedly would be in the commercial or 'grey' area of the literature searches of the web that were also conducted using Google. What is more, a number of articles published that are focusing on how fatigue detection systems (e.g., ALVINN, MANIAC, DAISY, DriveCam, faceLAB) were sought in the IEEE Xplore database[3]. The focus is to calculate driver state or the effects on driver performance and timing also nature of the warnings used.

The best way to prevent microsleep from happening is to get 8 hours sleep or short-nap. But, the most effective way is a combination of coffee and nap. Caffeine can have a disruptive effect on your sleep. The stimulus is that it can make it hard for you to fall asleep[4]. An analysis of police, fatal road accidents by age and gender reveal that 85% of sleep-behind-the-wheel vehicle accidents (those accident conforming to a specific set of criteria based on research by Home & Reyner, 1995) involve male drivers, with 38% of all are under 30 years of age (Flatley,

Reyner & Horne, 2004)[5]. The method experimental of microsleep can be measure in many ways such as manual scoring of the electroencephalograph (EEG), spectral analysis of the EEG and video of the face to indicate sleep, usually from eye closure. Each has associated technical problems for obtaining adequate recording and interpreting the data, particularly when data is recorded in the field[6]. The electroencephalograph (EEG) is a test that monitoring and provides evidence of electrical activity that happen in a person brain[7]. Moreover, microsleep can be measure by electrooculography. The movement of eyes was recorded using electrooculography while driving to detect the condition of driver[8]. There some of type of behavior fatigue driver produce like head jerking, sighing, yawning and face or eye rubbing. During this episode other dangerous behaviors may also be observed including prolonged eye closures that may happened during microsleeps. Automatic behaviors are stereotyped, repetitive behaviors performed without awareness and are a common auxiliary symptom of narcolepsy[9]. Fatigue-related accident occurs when during late night or early morning[10], driver is alone in the vehicle[11] and driving long distances[12]. How to prevent microsleep happens, drink energetic drink[13], turning on the radio [14] and drive with partner[15].

2. Methods

All the evaluators are among the drivers. The selected evaluators are of various age and gender, who encounter microsleep or not. The applications evaluated according the 10

heuristics evaluation developed by Nielsen, include user interface, usability of the mobile applications, advantage and recommendations for improvement.

i. User Requirement

We conduct an interviews and online surveys to identify user needs for this application. All the participants among the drivers. This interview focuses on two main groups who have experience in microsleep and on the other hand who have not experienced microsleep. We collect the information based on their feedback to meet the needs of our users. The outcome of the FGD is divide into six themes – lifestyle and self-monitoring, education and awareness, motivation and commitment, attitude, social support and coaching, and technology. These themes emerged from the responses of the participants.

Table 1. Characteristics of the 18 participants.

Category	No. (%)
Age (years):	
18-20	2
21-30	5
31-40	8
41-70	3
Gender	
Male	14
Female	4
Patient type:	
None experiences microsleep	11
Experiences microsleep	7

ii. Prototype design.

Based on expert suggestion, we decided to use Adobe XD in designing our alternative prototype. The prototype is evaluated among members of group to identify the best prototype for the application. additionally, prototypes and tasks are also compared to the similar and existing applications.

iii. Severity Ratings

The evaluators will answer the questionnaire provided to collect severity ratings after the actual evaluation sessions. The evaluators will list the usability issue that has been found and will rate the severity of each problem.

Table 1. Nielsen's Set of Heuristics

H-1	Visibility of system status
H-2	Match between system & real world
H-3	User control & freedom
H-4	Consistency & standards
H-5	Error prevention
H-6	Recognition rather than recall
H-7	Flexibility and effiency of use
H-8	Aesthetic and minimalist design
H-9	Help users recognize, diagnose & recover from errors
H-10	Help and documentation

iv. Prototype Heuristic Evaluation

Heuristics evaluation is a usability inspection method that used in user interface design to find usability issues. It contains many advantages such as cheaper, speed and conciseness pointed out that usability heuristics provided realistic guidelines for evaluating building systems. This application has been evaluated using 10 usability heuristics developed by Nielsen. Many positive comments received from the evaluators as they evaluate the application. After the evaluation, the evaluators provide some recommendations and give their opinion to improve the mobile application.

3. Result

For our second interface design, we decided to perform a more formal user evaluation with a group of people who are expert in this fiend. We invited five experts to participate in interface designing and natural language processing. Before we start the evaluation, they received a short briefing on the objectives and methodology of our project. They allow us to record the interview sessions by signing a consent form that we had prepared. A toolkit set was provided to each expert to made up of three structures, a list with Nielsen's heuristics (see table I), as well as a blank paper sheet to make notes. The structures contained different tasks, such as to sign in to the application, set the alarm, set time, connect to device, examine the statistic of heart rate and identify if microsleep did occur. One of our team members moderated the sessions while the others in charge of recording the sessions and setting up the application for the next test. The sessions lasted approximately 1 hour. The experts carried out the evaluation using the think-loud approach, which explains their observation while performing the scenarios chore. The recordings were manually transcribed to facilitate the analysis after the experiment,

These themes emerged from the responses of the participants.

3.1 Lifestyle and Self-Monitoring

All the participants mentioned that lifestyle needs to be changed in order to manage and prevent the microsleep. Proper diet and physical exercise should be taken care of to keep the body fresh all the time. One participant shared why he suffered from microsleep: "I'm a single man. I always eat outside instead of cooking at home. Therefore, I often eat unhealthy foods and do not count the calories taken throughout the day. As a result, I gaining weight because I not exercising. Having a heavy body makes me feel tired easily. Therefore, sometimes I have microsleep problems while driving to work early in the morning".

All the participants were strongly supported the proper diet and exercise to manage and prevent microsleep. They shared that they are constantly alert on what they eat. Change their lifestyle by eating small portions and finding food that will help them feel better for a day while they are driving. Eight participants shared that they often take caffeine when they are drowsy while driving. Some of them drink cold water and chew a gum to stay alert. One of the participants mentioned: "Not all the five fingers are the same. Everyone's lifestyle is different".

Besides that, 6 out of the 18 participants exercise frequently. They either do brisk walking, jogging, swimming, breathing exercise or simple stretching, at least 3 times a week. This exercise helps them manage their focus and concentration when they tend to do something. One out of 6 participants shared: "I work out and it helps me feel good after I sweat. And when I'm doing activities all day that make me tired, it helps me get a good night's sleep. So, the next day I woke up fresh to start a new day!".

Another participant shared that in his early years, he used to play football and he ate well. But after he became old, he started to

focus could hardly concentrate while driving. He easily gets sleepy after 30 minutes of driving.

Overall, studies show that involvement in self-management influences outcomes of improved health status: managing a right lifestyle and self-monitoring are important in taking responsibility for your own health.

3.2 Education and Awareness

The participants claimed that there was lack of awareness about microsleep and the factors that led to microsleep many years ago. Now, much awareness has been gained about the disease and managing the lifestyle. Currently, there are also many discussion sessions organized by many governmental and non-governmental organizations to educate the public. The participants said mass media are actively educating people how to prevent microsleep from happening while driving. One participant said: "When you read or heard about microsleep, it will tell you how harmful and dangerous microsleep can cause death to yourself or other drivers on the word with you. Therefore, ways to overcome microsleep should be taken into consideration for the safety of others".

By reading all these talks, the participants more aware of microsleep and how lifestyle changes can prevent microsleep. One of them shared: "Now before we drive, we make sure we get enough sleep for 8 hours and plan ahead for our journey when we start driving and how long it will take to reach the destination". However, one microsleep participant said there must be more awareness created among the younger generation. She mentioned: "if we could get more information easily about microsleep, even from social media and all that, it will be better to create the awareness and realization among the drivers".

3.3 Motivation and Commitment

There are several factors that contribute to the motivation of the participants and remain committed to the lifestyle changes. They indicated that motivation is important to change their behavior. Thoughts about family, awareness of the future, education on the right lifestyle, fear of death and tragic accident keep them motivated to keep them alert about microsleep. They also said that desire to change must come from within themselves. Self-discipline is considered very important. One of the participants shared: "I feel motivated is outside in, inside out. If you ask me, I feel motivated to start driving carefully while thinking about my family. I should arrive at my destination safely for the sake of my family. I need to stay safe and not make my family worry about me when I get to my destination".

3.4 Attitude

Four participants who are student in course of Architecture indicated that lack of sleep was the main cause of microsleep. After they changed their attitude to become more relaxed and the perspective on how they view their lives, they manage their sleep schedule and start scheduling to organize their time. One of the participants shared: "Lots of assignments, chasing a seemingly endless project deadline made us students

stay up all night and fatigue for the next day".

Apart from that, two participants emphasized not being angry and following the schedule they made explained that: "Positive attitude means always being aware. As student, we must aware with all the assignments and project deadlines, which is why we need to organize schedules to keep our work on track".

3.5 Social Support and Coaching

Eight of 18 participants shared that they needed social support from family, friends or a support group. Family is a institute where they stay together, so they needed support from their families.

Sixteen participants shared that they would rather discuss things with others and hear people stories. In this way, they learn a lot about the experiences of people who are exposed to microsleep and recognize the dangers of microsleep. Moreover, all the participants would like to hear more about microsleep, they want to find out more about microsleep on a regular basis.

3.6 Technology

When technology was mentioned, 15 participants responded positively. About 72% of participants wear watches. In modern times, there is a smartwatch connected to the phone that can detect and track our heart rate and daily activities. One of the participants shared how he used his watch for his daily activities: "I use my smartwatch for track the frequency to record my sleep time, water intake and track

my pulse rate. However, one function that effectively for me is that I can hear beeps sounds when I start to fall asleep and yawning. It will start vibrates when I continuously yawning. It will wake me up from being drowsy because I can feel the shock and pain provided by the watch. It really helps."

Ten participants surfed through the websites and used Google to find microsleep information and news that happens on the road. One participant always read the news through an online website, since then she has learned more about the causes that leads to microsleep.

Seven participants claimed that they quickly found the information they needed from the internet and via WhatsApp. When reading it, especially parents they would advise the younger generation to drive carefully, pull over the car when you are tired and take a nap. One participant shared his view: "Nowadays, older generations read information through WhatsApp, some of them do not know how to use Google search engine. So, it we can get information easily through the group WhatsApp and it much better".

The participants said the use of smartphones and the internet often helped them in many ways. They said microsleep apps would be a good help to monitor their activities to prevent microsleep from happening. Someone with microsleep shares their concern that microsleep apps should be multilingual so that many can use them. In addition, some of them also mentioned that it would be better if the microsleep app could give them a path that drivers should

avoid to prevent drowsiness in traffic congestion.

Components of the Proposed Microsleep Application: Participants highlighted the important components they wanted in a microsleep application by ranking the components. The priorities of the microsleep applications components have been divided: microsleep experience and no microsleep experience. Priorities here means the most important to the least important components from the participants' viewpoints. Table 2 shows the percentage of microsleep experience and no microsleep experience who have chosen each component. Figure 1 illustrates the comparison between the microsleep experience and no microsleep experience in their priorities.

Table 2. Priorities of experiences microsleep and none-experiences microsleep on self-care application components.

Components of Self-care Application	None Experiences Microsleep (%)	Experiences Microsleep (%)
Self-monitoring	100	100
Exercise	90	50
personal Data	92	77
Driving planning	95.8	88.9
Goal settings	85.5	75.8
Social Support	90.2	75.2
Alert/Reminders	100	76.3
Medication	49.9	32
Email	87.7	67.2
Rewards	80	71
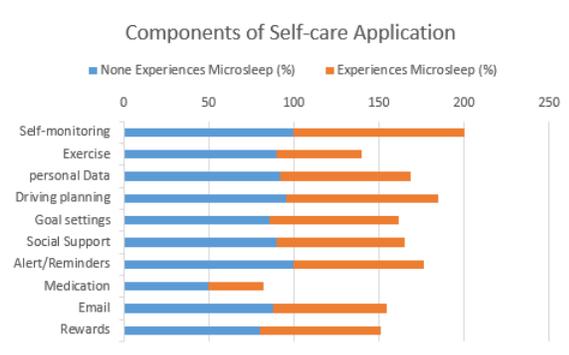
Figure 1. Comparison between microsleep experience and no microsleep experience on microsleep application components.

Based on the participants' choices, self-monitoring and alerts/reminders stays as the top priority for both groups. This followed by personal data, driving planning, social support, exercise, email, goal settings, rewards and medication for no microsleep experiences. Meanwhile, for microsleep experience, self-monitoring is followed by driving planning, personal data, alerts/reminders, goal settings, social support, rewards, email, exercise and medications. It is interesting to note that medication is not being considered as one of the top priorities for microsleep experiences compared to no microsleep experiences. No microsleep experiences have chosen personal data, driving planning, social support, exercise as their priorities as they would like to have a microsleep application which is personalized to them and keep track their activities while driving.

The medication system is the least priority for both groups. They mentioned that they should be self-motivated by thinking about their own awareness and not through medication. Besides that, alerts/reminders are a higher priority for no microsleep experiences than microsleep experiences. It was also noted that rewards did not differ significantly between two groups.

Table 1. Nielsen's Set of Heuristics

H-1	Visibility of system status
H-2	Match between system & real world
H-3	User control & freedom
H-4	Consistency & standards
H-5	Error prevention

H-6	Recognition rather than recall
H-7	Flexibility and effiency of use
H-8	Aesthetic and minimalist design
H-9	Help users recognize, diagnose & recover from errors
H-10	Help and documentation

RESULT (ii) USER CENTERED DESIGN-

3.7 Evaluation Results

Many positive comments were given by the evaluators to this application about its utility and conceptualization, in the another words easy-to-navigation, fun interface design, additional useful features (set alarm and time and statistic of heart rate) and organized layout. But, several violations of the heuristics were detected.

A main point of discussion surrounded the "BACK" button. User may select system function by accident (H-3). "You need to provide an emergency exit for user to leave. I also recommend that putting an undo button to your device."

The application should always informed user by receiving feedback within reasonable time (H-1). "The application should also provide feedback platform for user to interact such as Help and Settings".

Systems should have a careful design in order to prevent problems (H-5). The Three button which is the HIGH, MEDIUM and LOW could make the user have a compilation. "it could have more description in order for user to understand the use of the button."

One evaluator found that the set time interface really did achieve the purpose of

the task (H-3; H-7). ".... it contains everything that setting time should have, the time in hour, minutes, seconds and also the button to set the button which is the start button. I can also understand the description of the task."

Another point of discussion focused on the connection between SLEEPYHEAD application and the SmartS device (H-2; H-8). "the interface uses simple words and does not show irrelevant information that will confuse user." However, it does have an error prevention problem (H-5). "… but the color of the description does not suit the background. I can barely see the word."

Besides that, two evaluator comment that the statistic of heart detection does match between system and real world (H-2). "the statistic uses the concepts of its users as well as follow real-world rules and logical order."

When the alarm activates, it will show an interface where a flashing screen of blue and yellow background. In order to stop the alarm, user should tap the 'X' symbol. But it seems that it had encounter some error to users (H-7). "… if I was a new user, this would take time. It makes me confuse where to tap."

The final interface is when the user has arrived to the destination. It will show notes whether the user has experience microsleep or not but it appears that there is a tool that can make user confused (H-8). "...the interface has a good design; however, they seem to have an excessive and irrelevant tool which is the on/off button."

EVALUATION OF THE SLEEPYHEAD MOBILE APPLICATION

SleepyHead (SP) mobile website is evaluated by bench making an opposition to the Drivelert (DE) and Stay Awake (SA) based on the 10 usability heuristics developed by Nielsen (1994). The findings are as follows:

VISIBILITY OF SYSTEM STATUS

Nielsen (1994) suggests that system should constantly informed and give proper feedback to the user within reasonable time. The SP mobile application keep user informed. For example, in the mobile website, "Days", "Results", "Heart Rate", "Timer for Journey" and "Alarm" are available for users to choose (based on Fig.1). Therefore, users are aware of what functions that are provided by the application. Similar with SP mobile application, both DE and SA display the main page in mobile website (see Fig. 2(a) and Fig.3(a)).

However, the DE and SA mobile websites provide less function than SP one. For example, the mobile application for DE only shows the "Time Sensitivity", "Menu", "Select Sound" and "Start" to be heard during microsleep (based on Fig. 2(a)). The SA mobile application provide "Menu" and "Tap Screen" function, which did not exist in the mobile application SP.

Furthermore, the user did not get inform of the waiting time from these three mobile websites. When loading the website, they do not display the loading icon. However, users may want to be informed for the duration that they have to wait for the response, but it does not provide much information to users.

MATCH BETWEEN SYSTEM AND THE REAL WORLD

Instead of using system-oriented terms, Nielsen (1994) proposes that a system should conform to real-world rules and logical commands in implement the language and concepts of its users. The mobile application of SP does quite well in applying users' language in the system. It used simple word "Days" that shows seven days in a week, "Results" which will display the results of the activity to the user, "Heart Rate" refers to heart rate during the activity, "Timer for Journey" section will display the timer to be set for the journey that will be taken, and "Alarm" section to set the volume of the alarm that will be activate during microsleep (see Fig.1). The information of DE and SA mobile website are not as transparent as the BD one. For example, the mobile website of the DE show "Time Sensitivity" (see Fiq.2 (a)), which may not be clear enough to the user. The SA shows "Tap Screen" which may cause the user confuse.
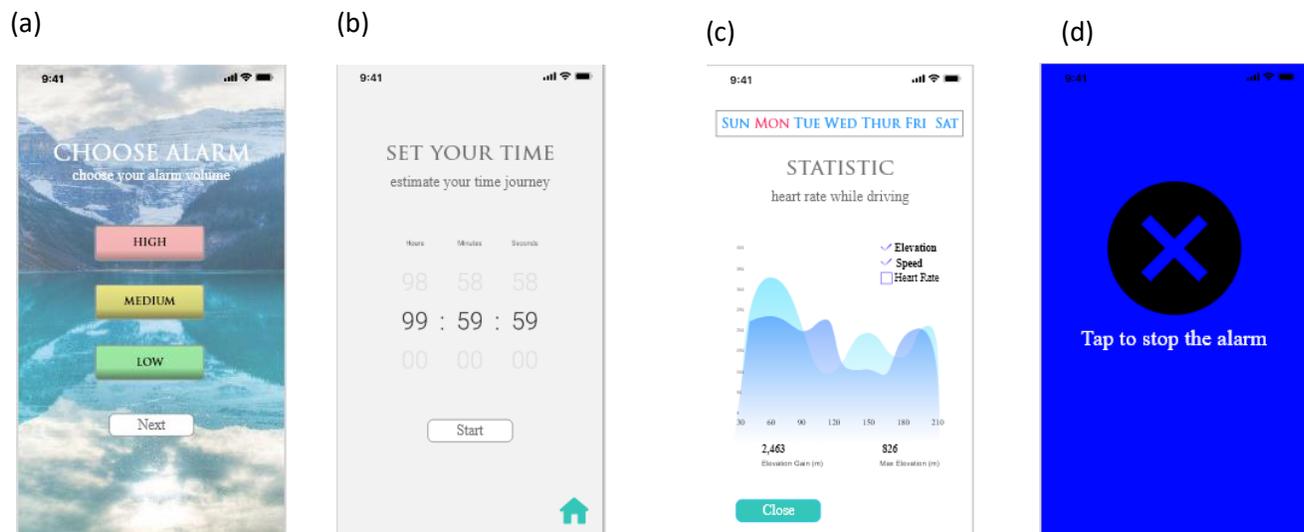
(a)   (b)   (c)   (d)

Fig 1. SleepyHead Mobile Website

(e)

Fig 1. SleepyHead Mobile Website

All three mobile website shows minimalize number of features in one page.

USER CONTROL AND FREEDOM

Users can accidently select system functions. Nielsen (1994) proposes that the systems should provide an "emergency exit" for users to get out from apps, as well as cancel and redo commands to give support for user. SP mobile application provide a "Cancel" button for the user cancel the incorrect input (see Fiq 1(c)) and "Home" button so that the user can go to the main homepage of the mobile website (see Fiq 1(c)). For SA mobile websites, they have no buttons or options that allow users to return to the previous site or the BD homepage if they wish to leave the unwanted site. Since nowadays devices already had inbuild "Back" button or "Main Screen" button. However, for DE mobile websites, it provided "End" button for the user to go back to the main page (based on Fig 2(b)).

CONSISTENCY AND STANDARDS

Nielsen (1994) proposed the contents of the system should be presented in the same in the same manner. To a certain extent, the mobile website of the SP is not able to produce consistent content layout.

The situation of DE and SA is the absence of an "emergency exit" in some pages, as mentioned in the previous subsection, can also be classified as inconsistency problem.

Compared BD to DE and SA, DE and SA have a simple yet minimalize layout in the mobile website as they just prevent the microsleep from happened. BD on the other hand has more complicated layout and more result to be displayed as it also analyses the user and create the report.

ERROR PREVENTION

As stated by Nielsen (1994), systems should prevent problems by having a careful design. The SP mobile application have considerable effort to prevent input error. For example, it shows "Cancel" button to cancel or undo the changes of that have the wrong inputs (which has been explained in "User control and freedom").

Much like SP, the mobile websites of DE also strive to prevent errors. For example, in the "Menu" slide-out navigation bar, user can see "Contact Us" under "Communicate" section. Users can write an email or submit the complains or feedbacks on Facebook or Twitter (see Fig 2(d)). Same goes to the SA mobile websites. However, a details of description are needed in order for user to understand the use of each button and tasks.

RECOGNITION RATHER THAN RECALL

As stated by Nielsen (1994), systems should create a comprehensible objects, options, and instructions to help users from remembering unnecessary information. The mobile application of the SP does quite well in this part. For instance, for each page of the SP, each is followed by its own name. The names are understandable of each top webpage (based on Fig. 1). However, the data has a bright colour which make user hard to read.

Similar with the SP mobile website, both the SA and the DE mobile application have satisfactory design in this feature. In the mobile application of the SA, the select mode and options are visible and easy to locate at the top left of the webpage (based on Fig.3). The instruction is also very comprehensible for the users. For example, the "Start" button are clearly visible as it is big and highlighted. As for the mobile website of the DE, the it does not have a lot of option but it does display a simple list of options such as "Time sensitivity" and "Select sound" filter function depends on the user preference (See Fig.2 (a). The instruction is also very clear and simple.

(c)   (d)
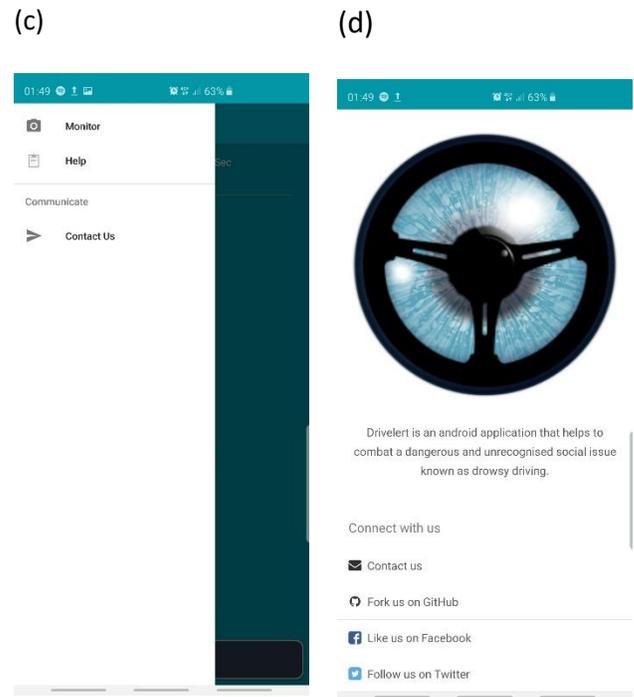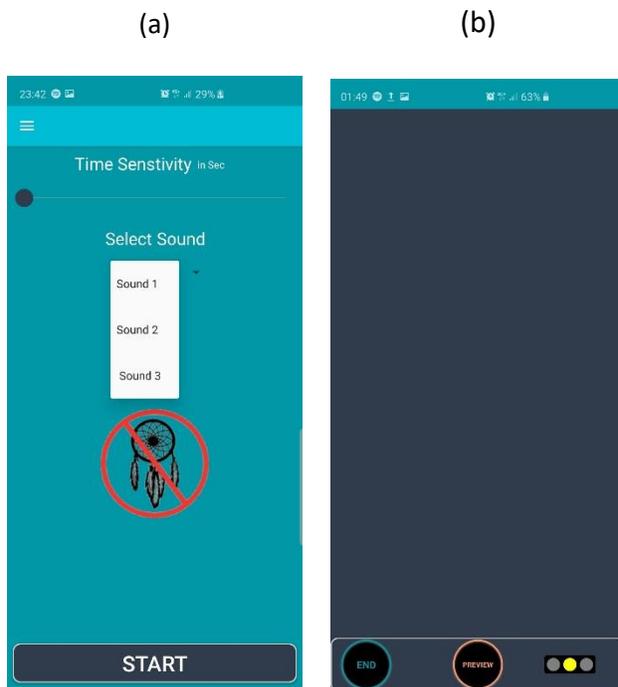
Figure 2. Drivelert Mobile Website

(a)   (b)

FLEXIBILITY AND EFFICIENCY OF USE

Nielsen (1995) stated that systems should provide services that is effective with tailored options for experts and inexperienced users. Contrast with the DE and the SA mobile application, the SP mobile website has a superior design in this section. The SP website does offer for expert user an advanced function. It allows users to see the heart rate during driving which connected to SP devices (see Fig. 1(c)). The statistic of heart rate shows to monitor the condition of driver while driving either the driver get drowsy or stay awake for driving. However, an advanced options for expert users was not offered by both the SA and the DE mobile application. It only provides a simple search options to choose and general user requirement (see Fig. 2 and Fig. 3). The option of choosing

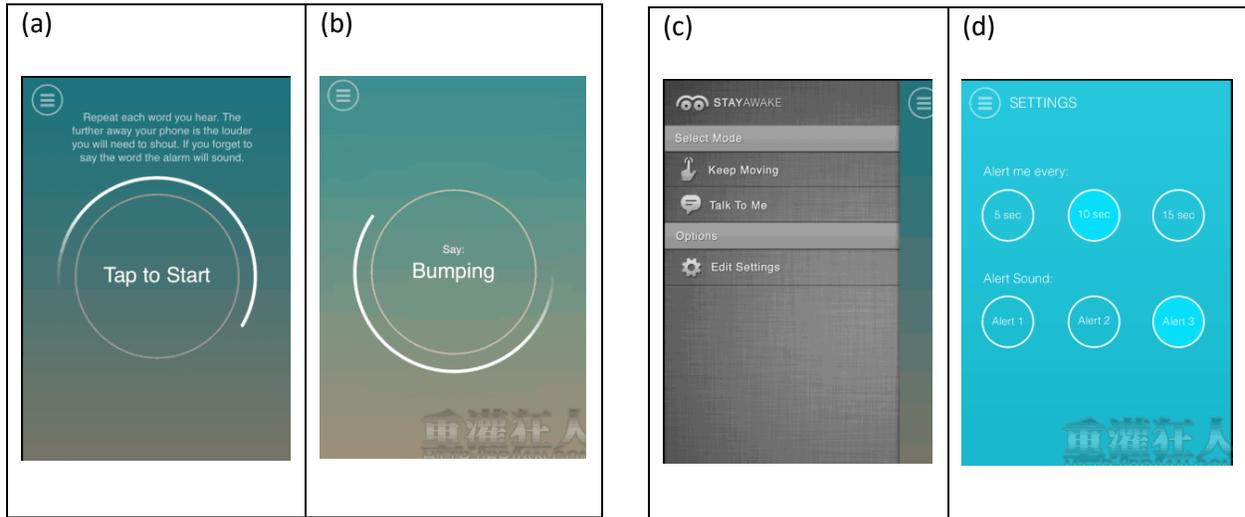alarm and set time for journey proved that the applications are flexibility and efficiency to use.

Figure 3. Stay Awake Mobile Website

AESTHETIC AND MINIMALIST DESIGN

As stated by Nielsen (1994), the systems should prevent excessive and irrelevant information display as it will mislead the users. The overall simple design with relevant information is generated without the materials being irrelevant by the three mobile application of the SP, the SA, and the DE. Subject and classification and simple wordings are deploy in the design (based on Fig. 1, 2 and 3).

HELP USER RECOGNIZE, DIAGNOSE AND RECOVER FROM ERRORS

The error messages need to disclose the problems and suggest solutions for users in the system (Nielsen, 1994). However, this aspect are unsatisfactory from the three mobile websites of the SP, the SA, and the DE. For example, when user face is not detected by the camera, it does not inform user of the error which is camera unable to detects in DE mobile website. While the SA mobile website does not provide error message if the users voice is interrupted with other sound such as music in the car. The error messages are not encouraging and could not help the users to recover from errors.

HELP AND DOCUMENTATION

As stated by Nielsen (1994), it is required for searching to be easy to provide help and documents in system. The DE provides enquiry service if users have any questions about the function of the DE, the homepage of the DE provide available contact information and notable in mobile application (based on Fig. 6(b)). However, the SP and SA mobile website does not provide the enquiry service or the guidelines to help the user.

4. DISCUSSION

1)   The "BACK" button seems to be helpful for user. We cannot avoid using this method which it is a basic tool for user to use in an application. We plan to put a navigation bar at the top of each interface which it will always stick at the top. The navigation bar consists of some items which is BACK icon and OTHERS icon which will be represent by the three dots.

2)   Regarding feedback from user, we have discussed to add a feedback platform such as Help and Settings which can really make an improvement of the interaction between application and user. The feedback platform will be placed in the OTHERS section.

3)   We are aware that the button has so little description for their user. The reason for color scheme of the button is to make user aware of the uses of the button. But we realize that the color scheme is not enough to make user aware.

4)   Set your time interface is in good shape, however we might add some color to it.

5)   We will take careful look at how the color scheme suits the background. We found that it will help the user to see the description clearly and avoid error occur.

6)   So far, from our observation, the statistic does not have any new addition to be implement.

7)   The description should be more precise and more accurate to help user understand how the process or flow works.

8)   Regarding the irrelevant tool in the final interface, we are not in favor of adding it, since it has no use of the task in that interface. We will take a careful look on the other interface for this simple error.

Table 1

Summary of the comparison between the mobile websites of the 3 universities studied

Usability heuristics	SLEEPYHEAD	Drivelert	Stay Awake
Visibility of system status	• Displays the services of avoiding microsleep in the mobile websites	• Displays the services of avoiding microsleep in the mobile websites	• Displays the services of avoiding microsleep in the mobile websites
	• Did not notify the user of the waiting time.	• Did not notify the user of the waiting time.	• Did not notify the user of the waiting time.
		• More sensitive than the SLEEPYHEAD mobile application	• More sensitive than the SLEEPYHEAD mobile application
Match between system & the real world	• Use simple wording that user can easily understand	• Show "Time Sensitivity" which makes users misunderstand	• Shows "Tap Screen" which may cause the user confuse
User control & freedom	• Provide a "Cancel" button for the user cancel the wrong input	• Provided "End" button for the user to go back to the main page	• Do not have the back button that enable user to head to the previous interface
		• "emergency exit" are apparently absence in some interface	• "emergency exit" are apparently absence in some interface
Consistency & standards	• More complicated layout	• Simple yet minimalize layout	• Simple yet minimalize layout
Error prevention	• Shows "Cancel" button to cancel or undo the changes of there are wrong the inputs	• The "Menu" slide-out navigation bar, user can see "Contact Us" under "Communicate" section.	• The "Menu" slide-out navigation bar, user can see "Contact Us" under "Communicate" section.

Recognition rather than recall	• Provide a clear and visible object, options and instrucions	• Provide a clear and visible object, options and instrucions	• Provide a clear and visible object, options and instrucions
Flexibility & efficiency of use	• Advanced options are provided	• Advanced options are not provided	• Advanced options are not provided
Aesthetic & minimalist design	• Simple design and relevant information are created	• Simple design and relevant information are created	• Simple design and relevant information are created
Recognize, diagnose, & recover from errors	• Does not specify the problem and recommend solution	• Does not specify the problem and recommend solution	• Does not specify the problem and recommend solution
Help & documentation	• Does not provide the enquiry service or the guidelines to help the user	• Provide help and documents	• Does not provide the enquiry service or the guidelines to help the user

5. Conclusion and Future Work

The development of our interface is still in infancy since its key component. Our prototype was well received by the expert that gave us a good feedback on regards to its functions and conceptualization despite the minor difficulty during the process. There are few concepts that we introduced in our prototype which is a natural language interaction and user friendly to help navigate the drivers.

The evaluation outcome pointed out several area for improvement on regards to error handling, added functionalities such as another way to connect the device. We plan to integrate all design derived from our evaluation study into the new development cycle. Furthermore, we will improve the evaluation process for the next experience by including the specific data that could indicate the top priority for improvement of critical issue. In addition, the user evaluation will be set about after a complete examination. A qualitative data analysis is a high possibility for the next evaluation cycle.

6. Acknowledgement

Last but not least, we would like to express our gratitude to our close friends and classmate from SCSV2113 section 03 for guidance and share knowledge with us. Also, thank you to respondents who are willing to spend some time with us for the interview session.

7. Reference

1. Charles, P., Allport, P., Mills, F. & Hanlan, T. (2018, March 16). Air Partner Consultancy Clockwork Research: *The Unknown and Potentially Fatal Dangers Of Microsleeps and How to Avoid Them*. London, UK.

2. Jackson, P., Hilditch, C., Holmes, A., Reed, N., Merat, N. & Smith, L. (2011) *Fatigue and Road Safety: A Critical Analysis of Recent Evidence*. Department for Transport. London, p. 71.

3. Williamson, Ann & Chamberlain, Tim. (2005, January). Review of on road driver fatigue monitoring devices, viewed on 18 October 2019.

4. Tina M. Burke, Rachel R. Markwald, Andrew W. McHill, Evan D. Chinoy, Jesse A. Snider, Sara C. Bessman, Christopher M. Jung, John S. O'Neill, Kenneth P. Wright Jr., (2015, May 5) 'Effects of caffeine on the human circadian clock in vivo and in vitro', *Sleep and Chronobiology Laboratory*, vol 7, no. 305

5. Horne, Flatley, & Reyner, (2004) *Driver fatigue by age and gender*, p. 10.

6. Kennedy, Gerard & Howard, Mark & Pierce, Robert. (20010 *Microsleep Literature Review*, viewed on 25 October 2019.

7. Diamond Vrocher III, MD, *Electroencephalography (EEG) Introduction,* viewed on 25 October 2019, <https://www.emedicinehealth.com/electroencephalography_eeg/article_em.htm>

8. Andreas, B., Jamie, A. W., Hans, G., Gerhar, T., *Eye Movement Analysis for Activity Recognition Using Electrooculography*, viewed on 25 October 2019, <https://discovery.ucl.ac.uk/id/eprint/1535737/1/Ward_Eye%20Movement%20Analysis%20for%20Activity%20Recognition%20Using%20Electrooculography.pdf>.

9. Michelle, M. & Dorothy, B., (2013) 'Understanding Automatic Behavior in Narcolepsy: New Insights Using a Phenomenological Approach', *The Open Sleep Journal* Vol. 6, pp. 1-7.

10. Ahmad Erwan Othman, (2019), 'A second of microsleep can spell disaster', *Bernama Newspaper*, 28 May, p. 5.

11. Sabhan, (2017, July 28), *What is Microsleep During Driving?*, viewed on 25 October 2019.

12. n.d, *How To Stay Awake On the Road: Tips to Combat Drowsy Driving*, Overview and Facts, National Sleep Foundation, viewed on 30 October 2019.

13. Gauri Sard, J., (2017, April 27), Energy drinks have never been more popular and accessible. But what are the consequences for our sleep?, *Energy Drink: The Enemy of Sleep?*, University of Mumbai, India.

14. (2019), *Helpful Hints to Help You Sleep*, Sleep Hygiene, University of Maryland

Medical Center, Midtown Campus, Pratt Street, Baltimore.

15. Willson, A., & Jacobson, M., (2019, July 21), Microsleep, *Tuck Sleep,* Seattle, WA, viewed on 31 October 2019. <https://www.tuck.com/microsleep/>

16. Juli Clover, 2019, Mac Rumors, 2 December 2019, <https://www.macrumors.com/review/apple-beddit-3-5-sleep-monitor/amp/>

17. Kayla M., (2015, October 26), How to Stay Awake While Driving with These Anti-Sleep Apps, *Stay Awake Pro,* viewed on 2 October 2019, <https://www.makeuseof.com/tag/stay-awake-driving-anti-sleep-apps/>

7. Author

NURAMYRA NATASHA BINTI ISMALLUDIN
B19EC0035
Bachelor of Computer Science (Graphic and Multimedia Software)

NUR FARZANA ALIA BINTI MOHD SANOORI
B19EC0045
Bachelor of Computer Science (Graphic and Multimedia Software)

NIK NUR FATINI BINIT NIK AZAHAR
B19EC0027
Bachelor of Computer Science (Computer Network and Security)
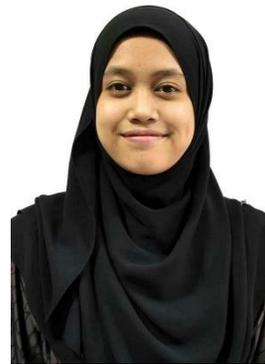
NURUL SYAFIQAH BINTI YUSRY
B19EC0036
Bachelor of Computer Science (Computer Network and Security)

The microsleep detection system is also develop by using the buzzer to alarm people if the microsleep condition is detected.

The pulse rate will display at the pulse rate amped visualizer to show the heart beat according to the pulse rate read.

By developing the microsleep detection system by using biosensor module and pulse rate, the accidents can be prevented as the pulse rate will detect the changing of pulse behavior when microsleep

The accidents that cause by microsleep can be prevented by detect the changing of pulse behavior by driver that experience microsleep.