Zimeng He

Master My Flight

Improving Sleep Experience for Passengers in Long-Haul Flight via Mobile-Based Application and In-Flight Entertainment System

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Master Thesis

Faculty of Industrial Design Engineering

Delft University of Technology

May 2020

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CONTENTS

EXCLUSIVE SUMMARY

This master graduation project explores the possibilities for enhancing passenger's in-flight sleep experience during different stages in an economic class in a long-haul flight. The main purpose of this project is to get deeper understanding of sleep in cabin from passenger's perspective, and try to use interactive design help them throughout the flight journey. This thesis project consists of five phases, context exploration, research, project redefinition, conceptualisation and verification.

Discover

Most research activities were executed in the first two phases. During the context exploration phase, the goal is to gain basic knowledge and comprehensive information in aviation field, including the market trend, the stakeholders, and the contextual constraints. Therefore, the scope is relatively broad and literature research is the main method.

After that, the research scope was gradually narrowed down based on the findings from the previous research, and the focus now is on long-haul flight passengers and sleep in various environment. Through desk research, several theory models were analysed. In order to gather opinion from different types of passengers, several user-centred methods were also used, like co-creation, online survey, field research. The insights from this phase benefit the next phases as solid evidence.

Define

Combining insights gathered from these research activities, a concrete project definition was obtained. The design goal is

"to make passengers who want to have a nice sleep feel more in control during different phases in long-haul flights".

An interaction vision was also defined as

"being in control".

Additionally, the specific requirements were listed as the evaluation criteria of concepts.

Develop

In conceptualization stage, several rounds of ideation were performed to generate initial concepts. According to the requirements and the difficulty of the implement, one concept was chosen for further development. Then a low-fidelity wireframe was used to fast-iterate the concepts by walkthrough.

Deliver

The final concept was then concluded in the final phase of verification. The digitally interactive prototype was built for evaluation of the effectiveness and usability. The evaluation results were analysed to see whether the final design meets the design goal and how participants experience the design. Due to the restriction of the social distance policy, most offline activities were prohibited, more than half of the evaluation tests were done via internet.

The future recommendation has also been proposed in the last stage. The design of phone application could be the starting point for the future development of the digital platform, connecting different journey phases for passengers. And the improvement on in-flight entertainment system might also be applied in the near future.

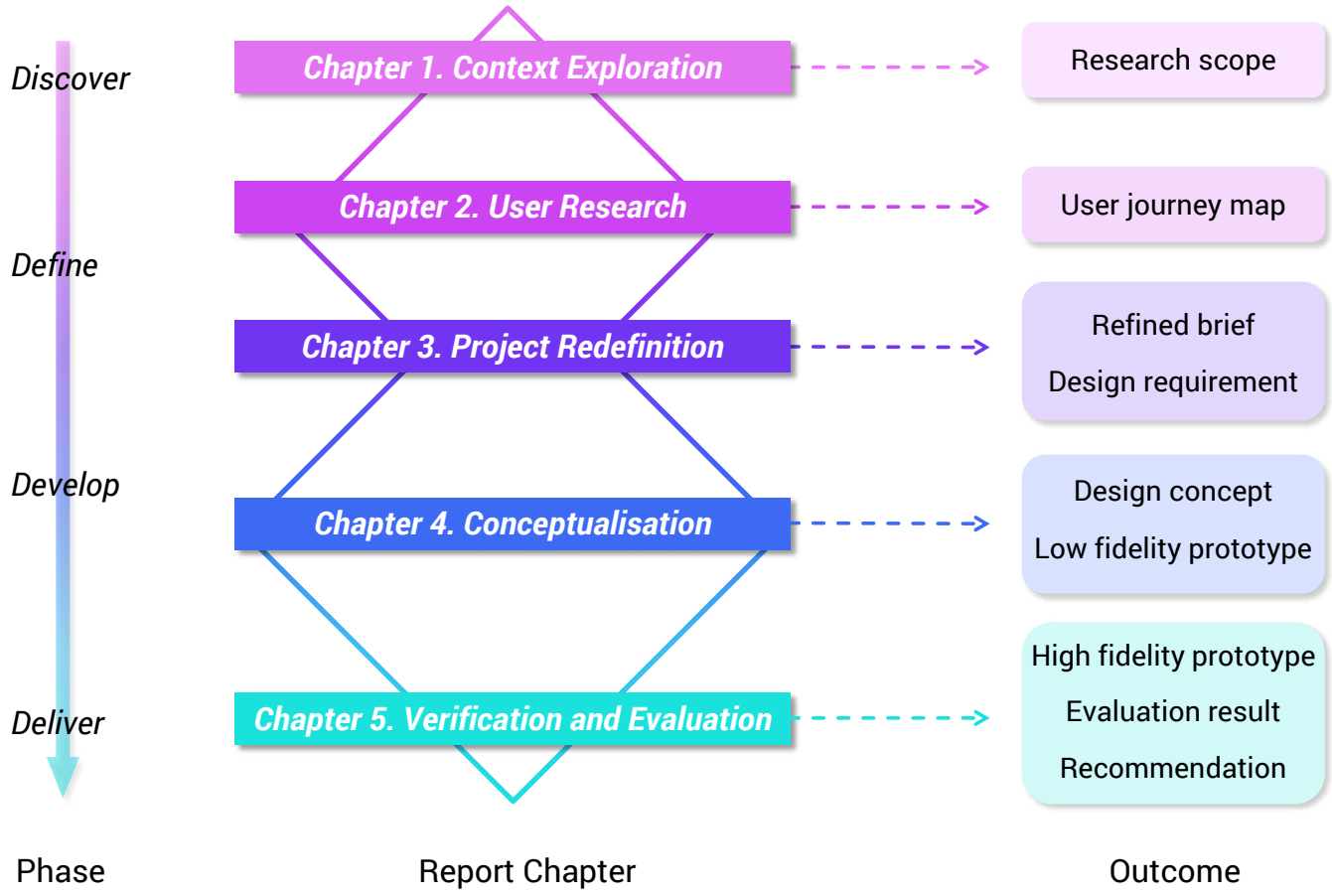


Figure 1. Overview of the project (Design council, 2005)

Abbreviation

EC
Economy Class

ECP
Economy Class Passenger

FA
Flight Attendant

IFE
In-Flight Entertainment, the system on board of an aircraft to entertain passengers, often offering movie, games, interactive flying map, etc..

LHF
Long-Haul Flight, the flight takes more than 8 hours (there is no international standard definition and many airlines use air time or geographic boundaries).

SUS
System Usability Scale

RQ
Research Question

UI
User Interface

UX
User Experience

INTRODUCTION

Assignment

This initial assignment is based on the interior design of the Flying-V, which is an innovative energy-efficient airplane for long-distance trip, first proposed by TU Berlin student J. Benad in 2015. The spectacular V-shape was integrated with passenger cabin, cargo hold and the fuel tanks in the wings, with the same carries as the Airbus A350, but 20% less fuel required for the same distance (Faggiano et al., 2017). An experimental cabin was designed and built in Industrial Design Faculty, focusing on improving passenger experience. This assignment is on creating a user-friendly sleep journey for economy class passenger (ECP) in the Flying-V, which is planned to fly in 2040-2050.

Project Objective

The way of travelling by air is changing. It has been affordable for more people to take LHF for cross continental travel. Additionally, the technologies make it possible to fly longer and more sustainable than ever. Some routes offering travelers non-stop flights in aircrafts configured especially for flying times of 18, or even 19 hours. The question is: how to provide better in-flight sleep experience when passengers prize the convenience of a nonstop route, instead of putting up with diabolically long flight times?

Sleeping is one of the highest performed activities inside an airplane during LHF, but scored lowest on comfort (Bouwens, 2018). A lot of academic research has been done to

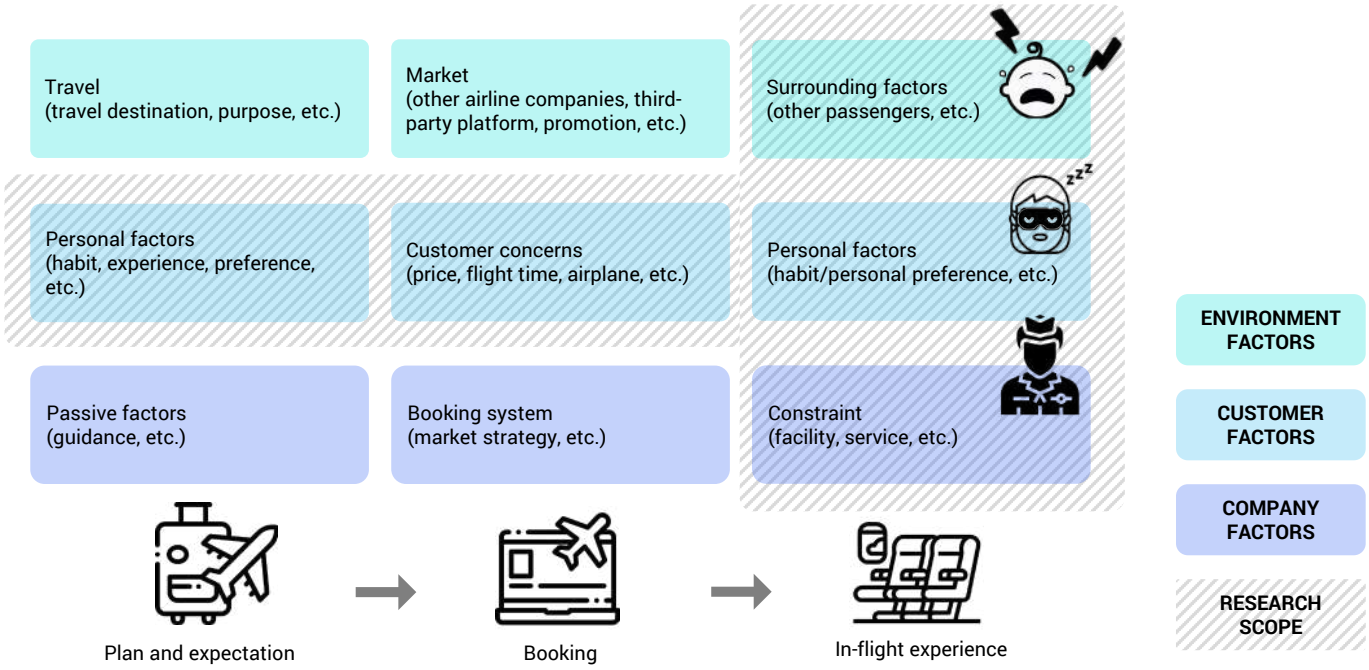


Figure 2. Overview of the research scope in the initial project brief

improve the seat in the aircraft, but the other relevant aspects that also influence sleeping have drawn little attention. To increase passenger's sleeping comfort in the cabin, it is necessary to take all influential factors into account, like ergonomics, psychology and service design. To fit the vision of the Flying-V, a satisfying sleep journey should be provided by supporting system.

During these four months, the current situation as well as multiple types of passenger's journey in various contexts has be analysed, for developing design concepts for the digital platform to facilitate a good sleep. The passenger journey consists of separate phases, from before boarding, in-flight, to landing . The main purpose of this project is to **explore the factors related to the passenger's in-flight sleep experience, and the design possibility to enhance the comfort throughout the whole customer journey (Figure 2).**

Supervisory Team

Peter Vink, Professor of Applied Ergonomics and Design, is working on the oval shaped cabin, and offered me this assignment brief as the starting point. Then I assembled the supervisory team with postdoctoral researcher Dr. Haian Xue, who is experienced in human well-being design and mood experience.

Personal Motivation

My interest and passion is on user experience (UX) design, which has grown through the Master Design for Interaction courses and previous projects, like the course Design for Emotion and UX redesign for IKEA Delft self-scan check-outs. Therefore, this assignment provoked my interest and offered me the opportunity to work on design for comfort under guidance by the supervisory team.

01 Context Exploration

Introduction

This chapter will explore the context of this graduation assignment by looking into literature and relevant information. It consists of several sections analysising different subjects of the background and environment. Then a summary of the context will be served as fundamental undertanding from a macroscopic perspective. This benefits the in-depth research and ideation phases, and help make decision on conceptualisation phase.

1.1 Trend of Long-Haul Low-Cost Flight

Under the influence of the rapid development of public transportation, passengers have more options on short-distance trip with lower expense, like high-speed rail. But for the long-distance trip, travelling by air is still the dominant option. In the recent years, there is a boom in long-hual low-cost flights from airlines like Norwegian, easyJet, AirAsia X and Eurowings, which indicates the trend of the travelers' preferences in the next few decades.

The long-haul low-cost model has been iterated for a decade, but the size of the market has just recently become significant, especially the intercontinental flight routes in Asian and Australian markets (Centre for Aviation-CAPA, 2017).

"The long-haul low-cost sector will likely again double in size over the next two years and surpass a 1% share of global capacity."

- CAPA, 2019

On the one hand, it made the flight relatively affordable and expanded the market, so more passengers can enjoy flying. However, on the other hand, in order to control the cost as well as improve the satisfaction of passengers, there are many challenges need more attention. Especially these ECP care more about cost-efficiency instead of luxury service and facility. Airlines also adjusting their marketing strategies, gradually transfer their focus to premium economy class in LHF, which usually provides bigger leg room, wider seat and better service with only slightly higher price than EC.

These changes have indicated the growing demand of in-flight comfort with high cost-performance. There is huge potential to make improvement from service and system design, highly depending on the airlines. However, there is no universal criteria or standard yet, which means it is difficult for passengers to choose flights and evaluate their flight experiences.

Figure 3. The world's longest non-stop flights (Statista Charts, 2019)

1.2 Challenge and Restriction from Stakeholders

To answer the question “how to provide better in-flight sleep experience during around ten hours in the cabin with an affordable price?”, it is necessary to find a balanced point in the complex aviation system, as well as balance different interests of stakeholders.

First is the passenger, who has limited space to sit and stretch the body in an enclosed public space for several hours, suffering from unstable environment (e.g., pressure, light, humidity, noise). Therefore, the comfort of the cabin experience is one of the most important requirements from passenger’s perspective.

However, their desire to the highest cost performance has conflict with the airline company, which is mostly driven by market and revenue. In order to maximise the passenger capacity, the living space is compressed as much as possible, which constrain the adjustability of the seats. What is worse, there is hardly any direct communication between passengers and airlines. Most interaction is based on the digital platform (e.g. online booking system), air crew and ground crew. These also increase the boundaries between these two major stakeholders, leading to misunderstanding from each other.

Furthermore, everything in the cabin has to meet the strict requirements of safety, which means neglecting the efficiency, aesthetics, and comfort in some extent. It is necessary for government, regulator, airline and the manufacturer to share the great responsibility. Additionally, the service supplier like airport, travel agents, air navigation service suppliers also play an important role in this system.

Under the current circumstance, travelers have little possibility to participate in the system from the start, and are always passively put at the end of chain. Therefore, most people who don't fly frequently are suffering from the unbalanced situation without much support.

The complexity in the aviation industry largely comes from understanding the services, which bind the providers into operating in tightly set boundaries (Reaktor, 2018). To conclude, it would be rather difficult to implement changes without accounting for the interests of all involved stakeholders, or only focusing on optimise individual components.

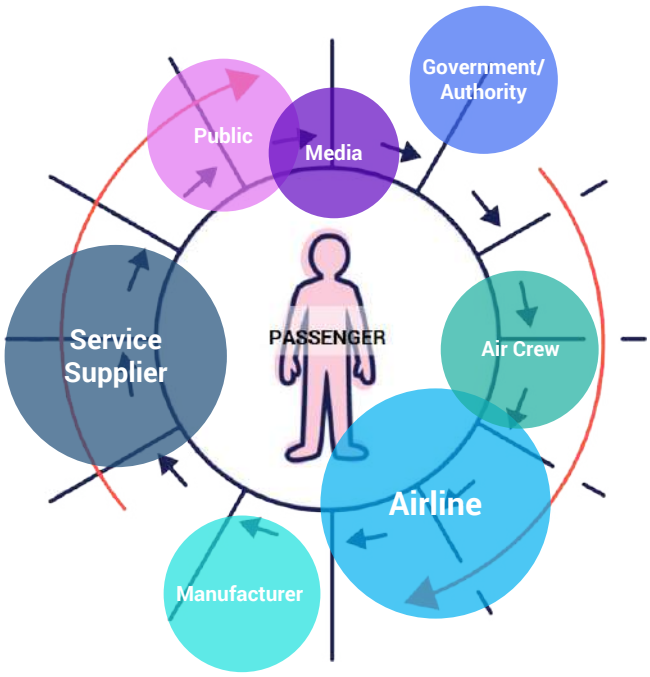


Figure 4. Skateholders in passenger-centred aviation service

1.3 Suffering from Long-Haul Flight

For a user-centered designer, it is crucial to pay close attention to the activities performed by passengers. More than half of passengers would like to have a nice sleep or rest during the air journey, but some researchers found that sleeping during the cruise flight was one of the most negative activities in a LHF (Bouwens, et. al., 2017), influenced by all aspects, including the cabin environment, facilities, services, and passengers' physical and psychological factors. Compared with other public transportation, the following factors are more pronounced.

Stiff Posture

When take approximately ten hours in the LFH, mostly during the cruise flight, passengers are locked without much flexibility to do desired activities as usual. It was shown that discomfort of passengers increased over time when they keep the same posture (Hiemstra-van Mastrigt, et. al., 2016; Liu, et. al., 2019). But if providing larger seats and increasing the seat pitch and leg room, it means higher costs and fewer seats in the cabin.

Even though airlines are trying to provide better seats with higher supportability, adjustability and affordance, the postures of passengers are still limited, especially in EC. Most passengers wouldn't notice they have stayed the same posture for a long time until they perceive the discomfort. Therefore, how to motivate and guide passengers to change the fixed posture for comfort in the cabin need more exploration.

Jet lag

Compared with other long-distance transportation, jet lag is an critical issue for bad sleep. In general, the internal body clock controls the sleep and wake-up circadian rhythm by received light through eyes. However, the natural adjustment speed does not keep up with the airplane, where sunlight is replaced by artificial light at most duration. After a flight of more than ten hours to reach the destination, passengers are often unable to sleep or unable to wake up when they should be, feeling tired and weak during the day, difficult to concentrate (Sack, 2009). Although several management strategies seem to offer slight benefits, like using cool color lighting systems, and turning off most light during the cruise flight, there are no effective treatments to solve the problem.

Climate

Additionally, the climate in the cabin is oppressive and the direct factor causing uncomfortable sleep. The air pressure is similar to that atop a 2.4km mountain, where the relatively lower pressure makes oxygen levels in the blood decrease, as a result it is easy for passengers to be at health risks (Carvalho & Poirier, 2009). Also, relative humidity of the aircraft cabin dropped to levels below 10%, which leads to the rapidly decreased skin hydration and slowly decreased body hydration (Guéhenneux, 2012). It has also been proved that dehydration reduces the production of melatonin, which is the key to the effective sleep.

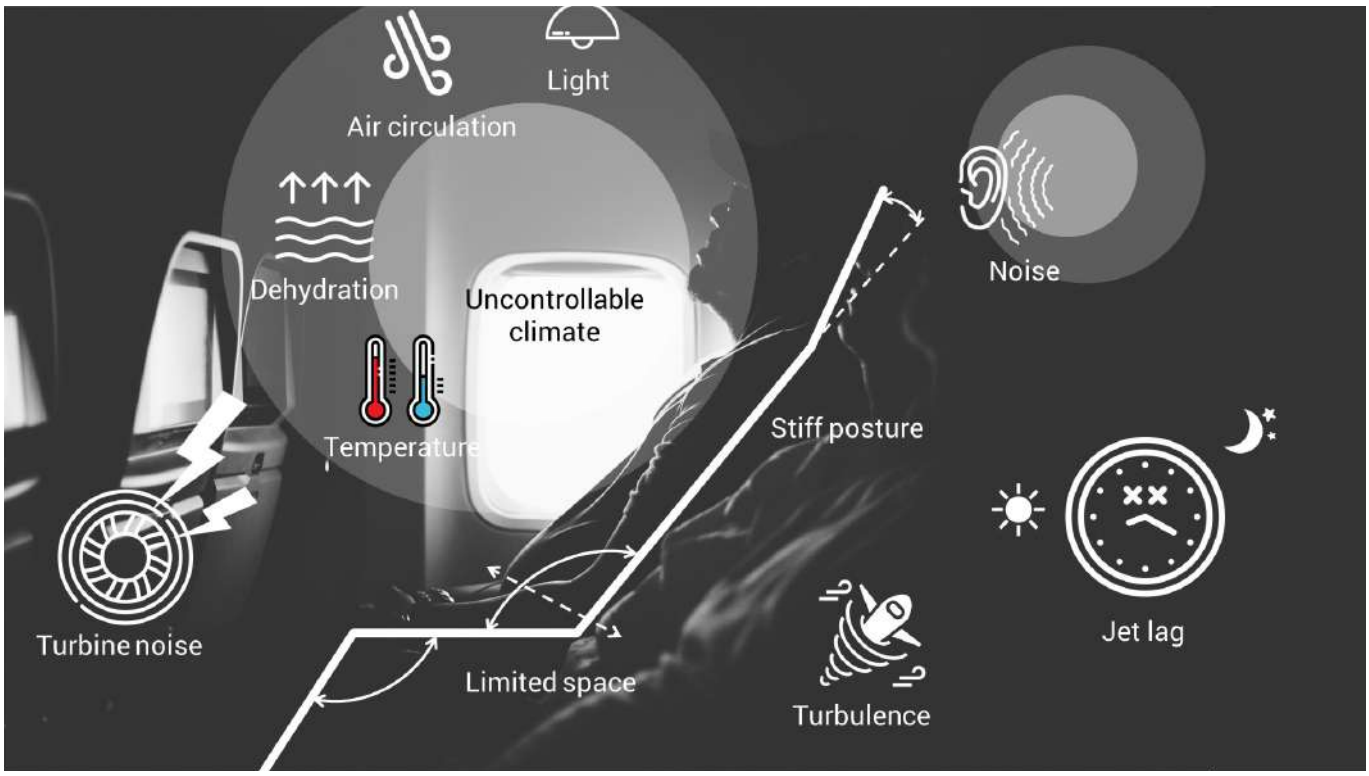


Figure 5. Influential factors contribute to discomfort in EC of LHF

According to Bouwens and other researchers in 2017, in-flight meals and snacks play an important role to distract passenger's attention on the discomfort and anxiety of insomnia. However, under the impact of combination of background noise, low air pressure and humidity, our senses of smell, taste can be robbed, leaving bland food and drink (Burdack-Freitag, 2011).

Emotion

Furthermore, the environment also influences passenger's mental health. According to a customer survey conducted by the Gatwick Airport in London in 2017, passenger's negative emotions tend to be more frequently triggered during LHF. Researchers also found that hypoxia and dry air are environmental triggers of increased anxiety level and slightly impaired human cognitive function (Xu, et. al., 2014; Sracic, et. al., 2014; Mündel, et. al., 2015).

Conclusion

All these factors contribute to the physical discomfort, and further lead to the inadequate sleep, either in duration, continuity, or quality (see Figure 5). Palme and Alfano (2017) suggested that inadequate sleep is a direct cause of greater negative emotions, less positive emotions, and has negatively impact at the emotion regulation process. This might explain why there are endless complains towards in-flight sleep experience from passengers, although most of them have been provided passionate and patient onboard service. All of these demands are interdependent and may be complementary or conflicting. Therefore, it is essential to reach a balanced state in LFH. There are still many efforts designers can do for the improvement, especially from passenger's view.

1.4 Airline Service Trend

In the competitive market, more and more airline companies are focusing on improving in-flight experience for ECP. Compared with more advanced services and hardware facilities in first class and business class, it is more challenging to provide satisfactory experience in EC where the resources are relatively insufficient.

1.4.1 Airbus-Airspace Cabin Vision 2030

The airspace cabin vision 2030 described a customer-centric future flying experience inspired by airlines technology companies, and start-ups (see Figure 6).

This customer-centred vision suggests that personalisation is a trend to achieve diversed needs in a public space, where the private choices might be restricted. Additionally, the analysed data has huge impact on improvement of well-being during the flight. Furthermore, the seamless journey from the airport to the cabin reduces the gap of transition, increasing the convenience for travelers.

Although many of the technologies are not fully mature enough for practical application, the vision provides much inspiration by combining the customer's needs and the development of cutting-edge technology.

Figure 6. Customer-Centred flying experience in vision 2030 (personalised mode, health monitoring data, sleep facility)

• It provides passengers more **individual choice** and better cabin experience with **cabin layout optimised** by artificial intelligence;

• The digital innovation will create a truly **unique space** seamlessly blending engaging ambiences with **intuitive functionality**;

• Tailor-made experience for family travel, business travel, or relaxing travel. **Personal preference and data** will be easily access and applied for better **mode setting**;

• Smart material and big data combined to deliver enriched services and a new level of **well-being** while sitting and sleeping.

1.4.2 The Ultra-Long-Haul flight of Qantas

Different from the typical flight, this 19-hours flight from London to Sydney is a delivery flight and a research flight, which spans 11 time zones and experiences two sunrises. The aim of the research is to identify strategies to reduce jet lag and promote inflight health. Passengers were fitted with wearable device technology to track movement and light exposure. On the flight, there are three strategies helping passengers perform better sleep during the ultra-long cruise.

• The **bright daylight** was used to maximise delay the body clock, and the **low-light artificial lighting** system was used to avoid advance;

• The **special in-flight meals** were prepared to promote sleep or wake. For example, the high-glycemic-index carbohydrate has effect of shortening sleep onset (Afaghi, O'Connor & Chow, 2007);

• Small **in-flight exercise** was encouraged to release physical and emotional tension halfway through the flight. This also contributes to a nice sleep or a quick snap.

1.4.3 Current In-Flight Sleep Promotion

Calm ambience (Finnair)

Finnair provides large panoramic view windows, letting natural light flow into the cabin. This could help passengers get used to the local time at the destination. The body clock would be adjusted by perceiving the sunlight.

In addition, the latest LED lighting technology can emit a colour range of up to 16.8 million different colours. The lighting and colours can be customised to fit the time of day,

Figure 7. Strategies to reduce negative impact from jet lag in the ultra-long-haul flight of Qantas research flight (light, food, exercise)

In the research flight, these strategies got much positive feedback from participants, including air crew and passengers. Additionally, changing cabin temperature and meditation also plays key roles according to the research results. In the future, the detected data, like polysomnography and melatonin from flight crew and pilots would be further analysed and might be applied.

destination or season. The cold-coloured light on the ceiling is used before sleep time (see Figure 8), following by very low light. And the warm colour, like orange and pink is used to formulate sunrise, helping passengers wake up before landing.

Figure 8. Ambient lighting system in the cabin designed by Finnair Airline

Well-being audio and TV (Lufthansa)

Addition to the movies, games, and music provided in in-flight-entertainment, there are also multimedia enhancing in-cabin well-being. There are different kinds of well-being TV programmes, including *Space to Relax, Guided Meditation for Peaceful In-flight Sleep,* ranging from 13 minutes to half an hour. Guided meditation with soft music is believed help people be less in our head and more aware of the present moment, then easily fall asleep.

Figure 9. Meditation for in-cabin well-being provided by Lufthansa Airline

1.5 Interior Design of the Flying-V

After proposed by Justus Benad at DLRK (Deutscher Luft- und Raumfahrt Kongress) 2015 in Rostock, the Flying-V has drawn a lot of attention from academics, medias, manufacture industries and airline companies. Addition to the technology of aircraft structure, aerodynamics shape, and fuel versus electric propulsion, the Flying-V also provides researchers a unique opportunity to improve passenger experience in aircraft, from the seating layout in the wings, to the design of the seats and in-flight service.

Figure 10. Rendering model illustration of the Flying-V

The current mockup of Flying-V's interior displays an integration of multiple concepts by design students, based on TU Delft's scientific research so far. In order to maximise the efficiency gain the new aircraft shape provides, everything should be designed as lightweight as possible with special structure and material. Mentioned in the section 1.1, the number of ECP taking LHF is growing rapidly. Compared with Airbus 350, the Flying-V carries about the same number of passengers - 314 in the standard configuration.

To enhance comfort of different types of passengers, including family type, single type, their requirements are also taken into account. The Flying-V pioneers four innovations, including group spaces, staggered seats, sleep bed, and chaise longue (Vink et. al., 2020). Also more activities, like sleeping and leaning, are allowed to performed freely in certain areas.

However, there is no specific supporting service or system in the cabin yet. So, it is important to take these into account along with the facility design. This assignment would be developed based on the current interior design (see Figure 11), and focusing on the supporting service, fitting the high-efficiency principle of the Flying-V. The target groups are all passengers in the EC, with more attention to people who sit in private seat, because they have the same need for comfortable sleep, but less flexibility to perform.

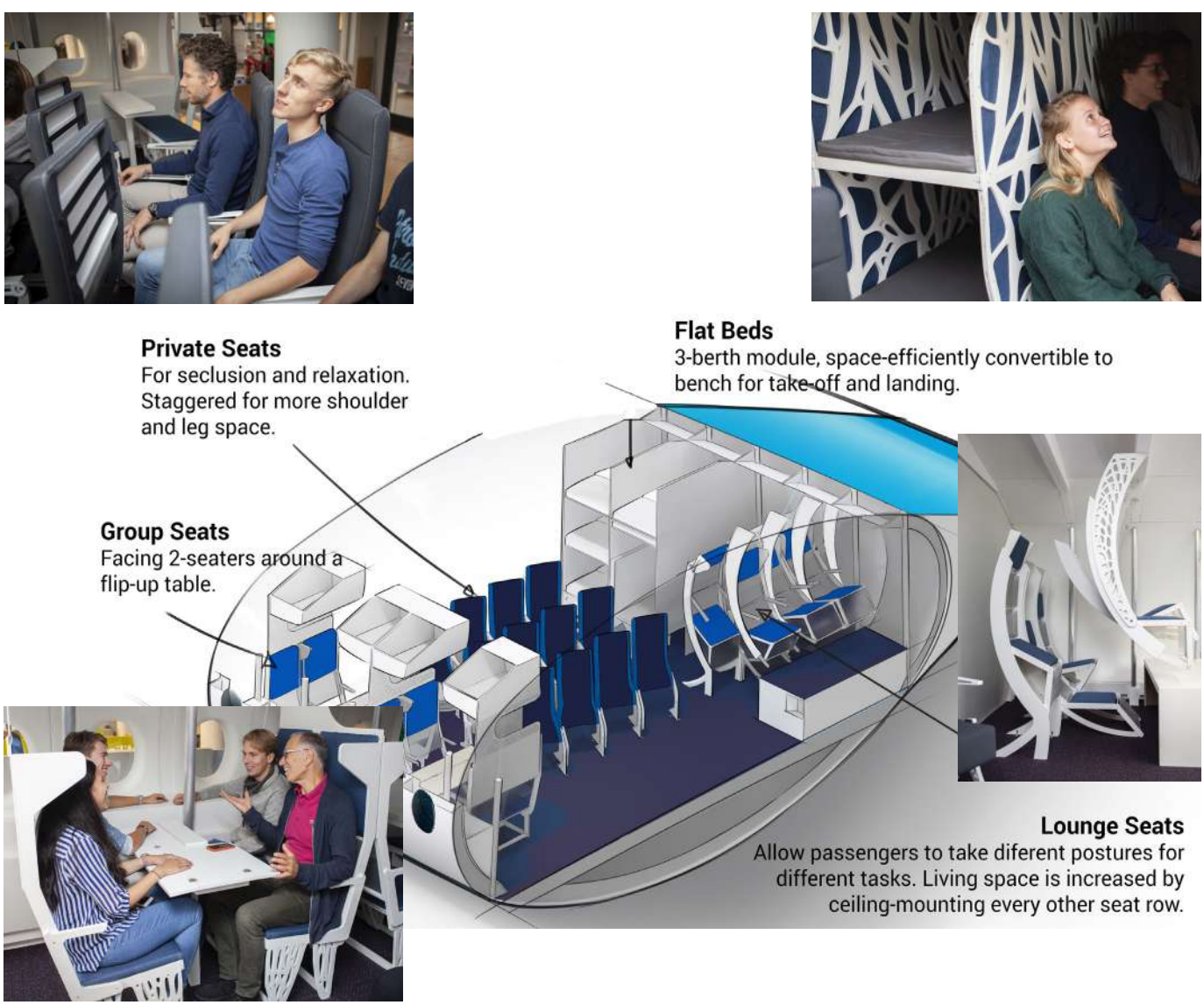


Figure 11. Four types of innovative seats in the Flying-V (Retrieved from: https://www.tudelft.nl/en/ae/flying-v/cabin/)

1.6 Conclusion

In this project, the scenario for Flying-V is developed for the EC in a LHF in 2040-2050. The marketing trends show that there will be more customers valuing the convenience from LHF and the comfortable service at a reasonable price. Among different types travelers in the Flying-V cabin, passengers who sit in staggered private seat are main target group, who needs more support from the interactive design.

As mentioned in section 1.2, there are several challenges to deal with for better in-cabin sleep experience, like the limited resources, conflicts among stakeholders, and harsh environment. Therefore, it should be kept in mind that a designer needs a holistic view to understand the problem, instead of be immersed in one particular role.

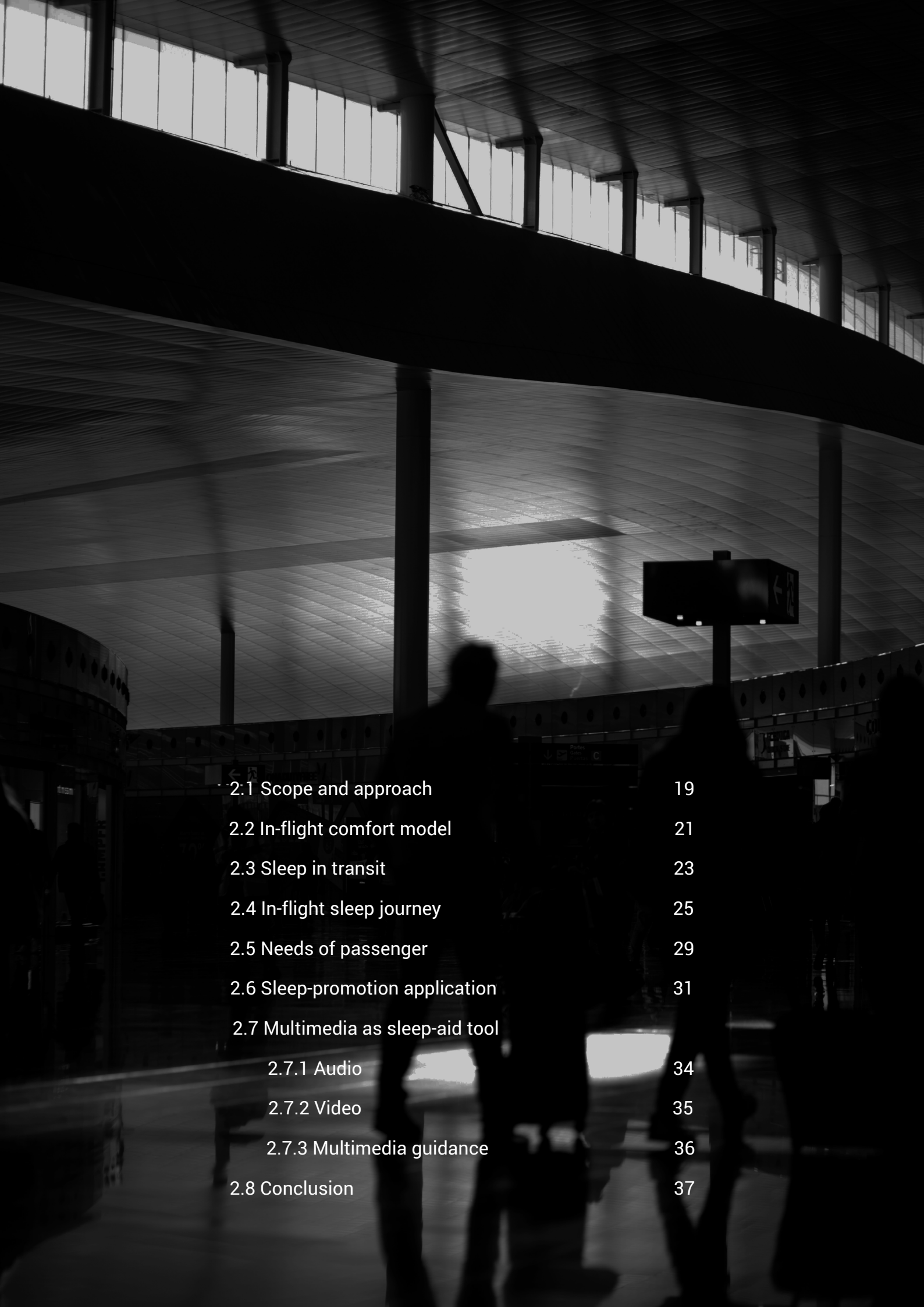
As a design student, I have the responsibility to address the passenger's requirement and their deeper needs, as well as those from other stakeholders. Only in this way can I find the breakthrough point and the pivotal problem in the complicated context. It is also challenging for me to design something that might take place in an innovative aircraft. However, these could also be regarded as new design opportunities for idea generation or evaluation standards in the design phases. Therefore, in the next chapter, in-depth user research will be done in order to gain morevaluable insights.

02

User Research

Introduction

The last chapter has explained the complexity of the context from a macroscopic level. Thus, the exploration was started within a quite broad scope. In this chapter, in-depth research work from passenger's perspective has been done. I will explain the research questions followed with various user-centred approach, including literature research, field research, co-creation, and online survey, then present the results and discussion. Also, some insights will be concluded as the supporting argument for the next step, to refine the project with a concrete design brief.



2.1 Scope and Approach

In order to have a holistic perspective of the project, I tried to deconstruct “in-flight sleep” from two dimensions. Firstly, zoom out the cabin to compare the “in-flight” sleep with other in-flight activities, like watching IFE, eating, reading. Secondly, focus on the “sleep”, compared with sleep in transit, like railway, ship, bus, waiting hall, as well as in a normal private space. Since a lot of studies have been done in this field, the literature review was used as the main research method for the comparison.

After that, I zoomed in on the user journey of in-flight sleep to verify if there is a pattern for passengers. In the untrodden tract, there is hardly any academic resource. To fill the blank, I hosted a co-creation session to draw a journey map for the in-flight sleep, then designed a online survey to test the result in wider range for verification. Additionally, I interviewed several groups of passengers in the real context for more specific information. In the end, these gathered data pieced the whole picture of in-flight journey from passenger’s perspective with solid evidence.

Based on the preliminary results, further interpretation was developed from human fundamental needs, linked with in-cabin comfort model described by Dumur, Barnard and Boy (2004). Compared with the physical elements, the experience elements like security, privacy, inspired me with more design opportunities. As a design project for the future, I also did market research from airline companies, manufacture industries to see the latest trends.

Through these approaches, I found lots of insights, which serve as foundation helping me find the accurate entry point to formulate the design goal, and related interaction vision.

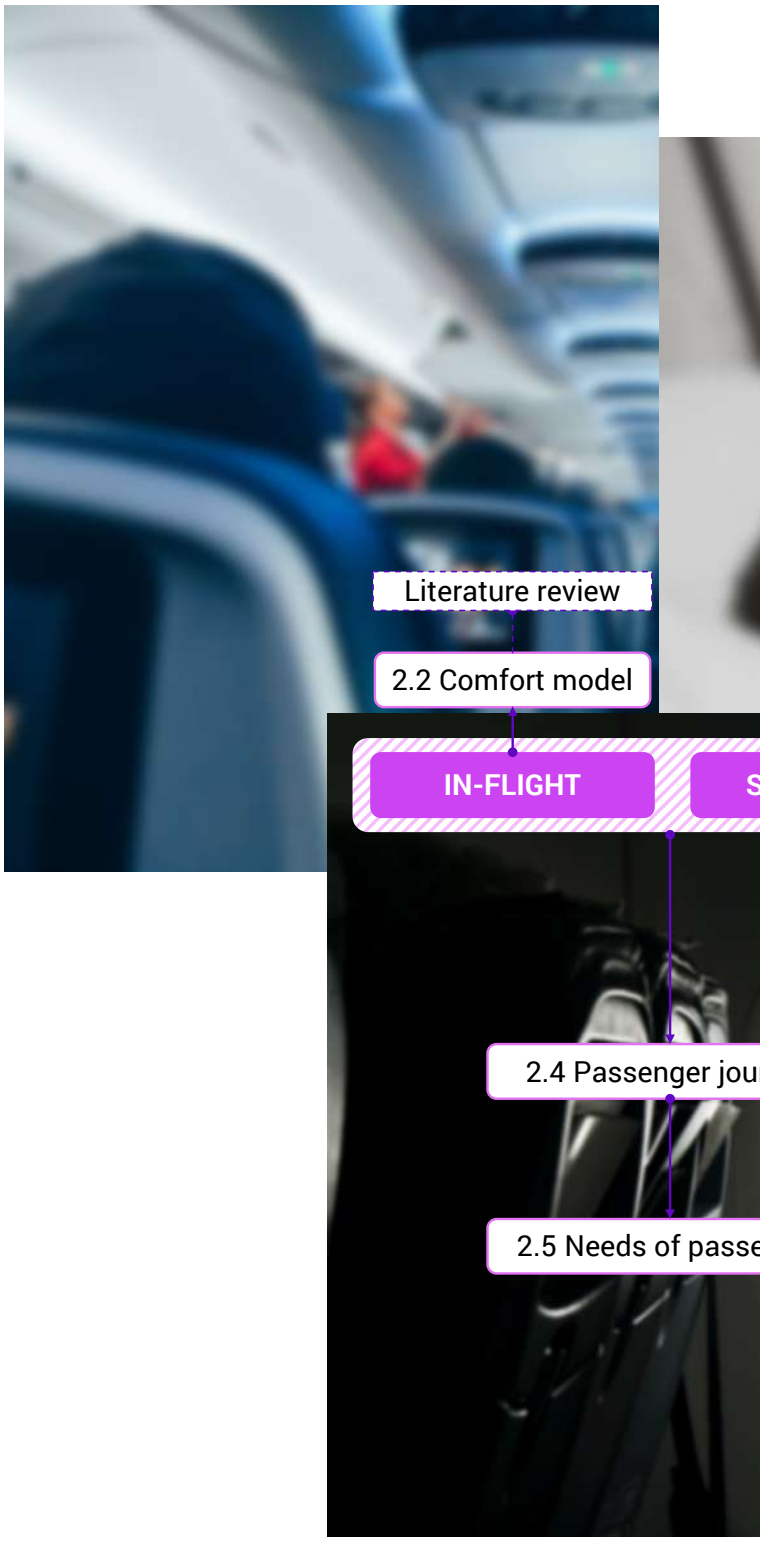
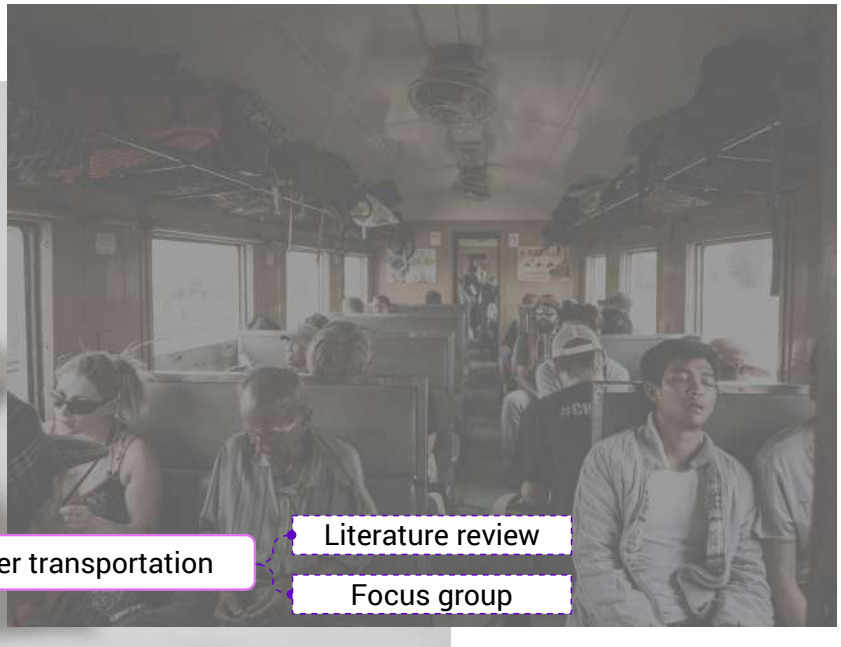
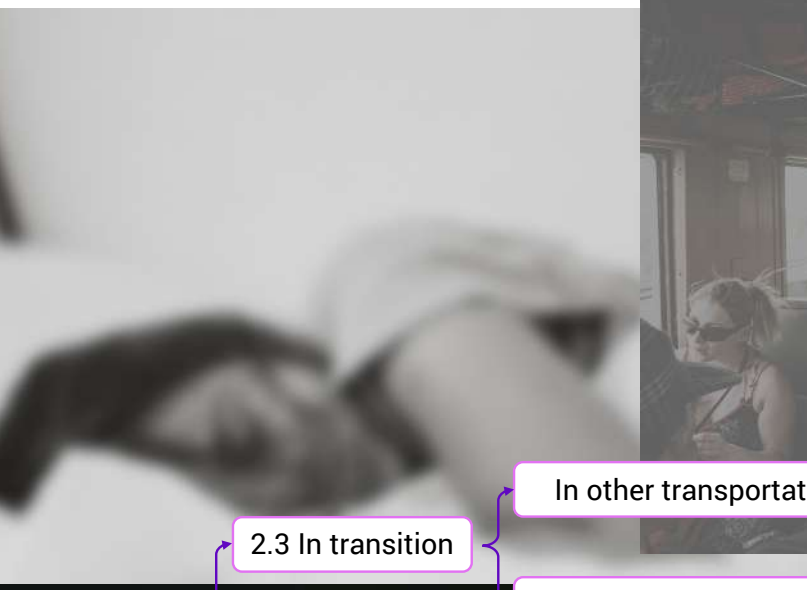
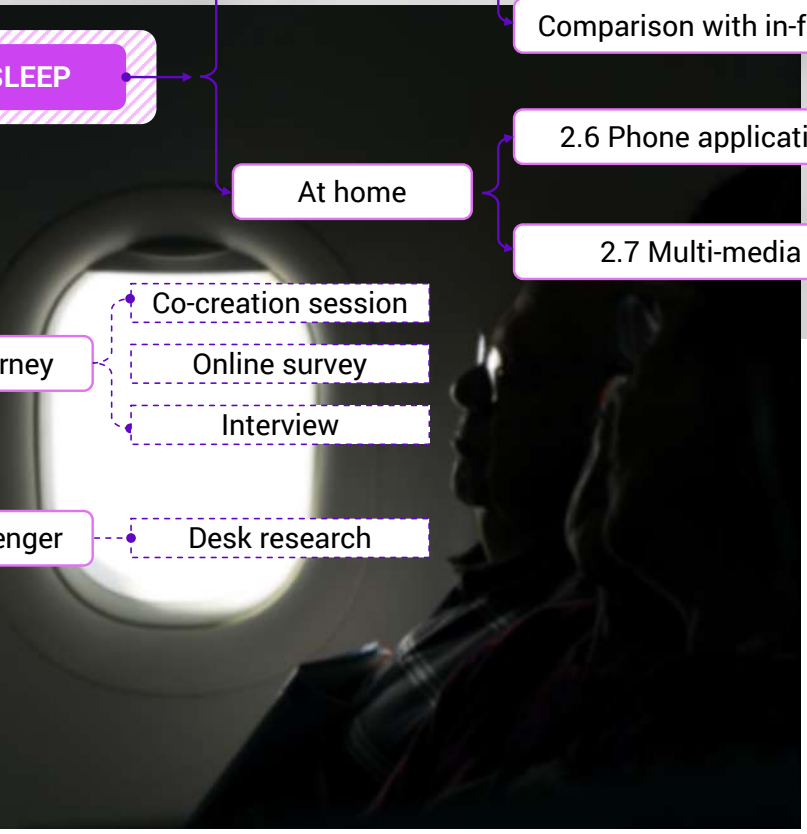


Figure 12. Scope and approach of user research







- SLEEP
  - 2.3 In transition
    - In other transportation
      - Literature review
      - Focus group
    - Comparison with in-flight
      - Online survey
  - At home
    - 2.6 Phone application
      - Diary study
      - Desk research
    - 2.7 Multi-media
      - Literature review
- rney
  - Co-creation session
  - Online survey
  - Interview
- enger
  - Desk research

SCOPE

SECTION CONTENT

RESEARCH METHOD

2.2 In-Flight Comfort Model

***RQ 1:** What is the general comfort level in the cabin perceived by passengers?*

Artefact-User-Task-Organisational Environment Pyramid

In section 1.3, unsatisfactory cabin environment and how it effects on passenger's sleep have been discussed, like dry and cold air, lighting system, engine noise. In this section, more comprehensive results of literature research on in-flight comfort would be shown.

First of all, several in-flight comfort models have been proposed, complementing each other and showing a relatively complete picture.

Macroscopically speaking, there are four elements decomposed from the passenger's situation in the aviation, including artefact, user, task, and organisational environment (Boy, 1998). **The A-U-T-O pyramid model** shows the basic relation among these four elements:

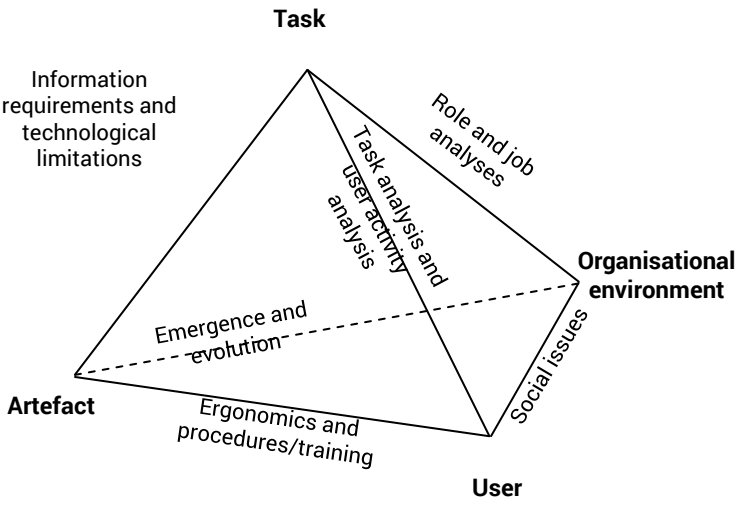


Figure 13. Artefact-User-Task-Organisational environment pyramid (Boy, 1998)

(1) Artefact;
(2) User;
(3) Task;
(4) Organisational environment;

which are all interconnected to form a harmonious in-cabin experience. It means no matter which one is changed, the consequences would appear on the other elements, further influence the whole to maintain a balance. When decompose the model, there are four design principles (in the triangles) for in-flight comfort (Dumur, et. al., 2004):

(1) Affordance;
(2) Situational awareness;
(3) Individualisation and customisation;
(4) Variability and flexibility.

The relationship of each element in the cabin has been explained clearly in Figure 13&14. These literature outcomes could be applied as evaluation criteria to test the design whether it reaches an overall equilibrium state or not.

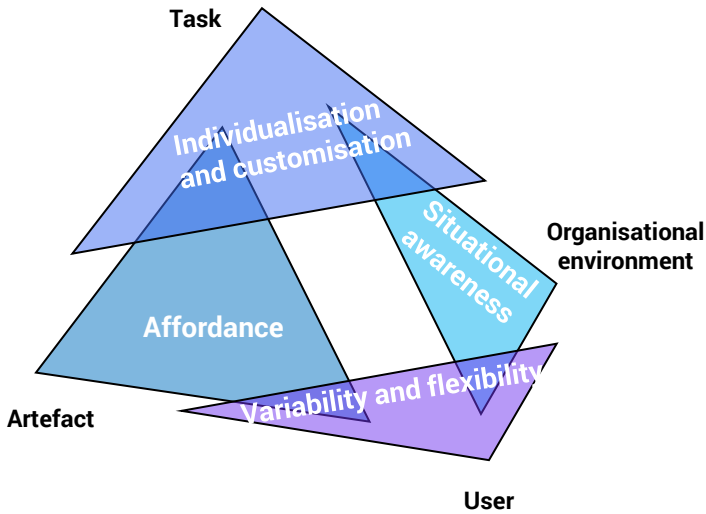


Figure 14. Four design principles in A-U-T-O Pyramid (Dumur, et.al., 2004)

Artefact-User-Task-Organisational Environment Pyramid

In another comfort model proposed by Harshada and Mirabelle (2018), passenger was put in the centre (see Figure 15). Instead of taking user as a fixed element, they took the dynamic situation into account, like the personal travel context, and the interaction with others. The time range was also expanded due to the changing situation and requirements of passenger throughout different phases. Compared with the previous one, this model emphasises the importance of subjective experience from passengers, so it might be more suitable for idea generation and conceptualisation because of the wide user-centred view.

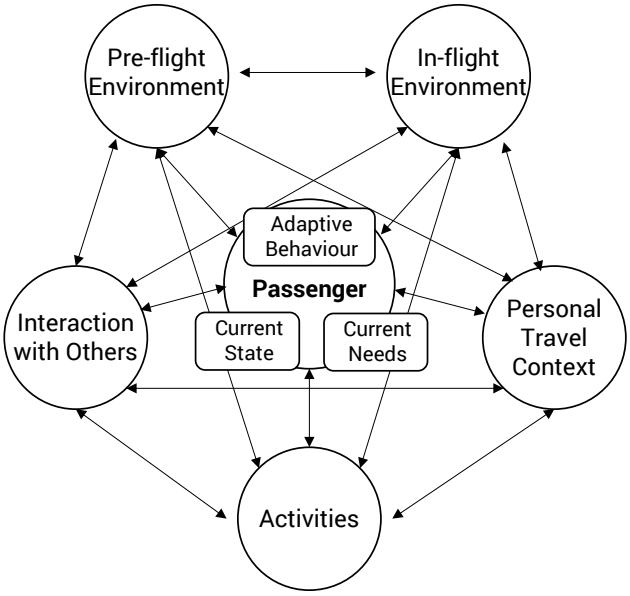


Figure 15. Passenger-Centred comfort model (Harshada and Mirabelle, 2018)

It is also interesting to look into detailed in-flight activities from passenger's view. The research of Bouwens, Tsay, and Vink (2017) indicated that feeling boredom and sleeping are most uncomfortable activities, also the cruise period was regarded as the most negative phase by participants. To be more specific, sleep and boredom have the lowest comfort scores among all activities performed in flight. The paper also reported that food and drink service, watching IFE are regarded as distraction from discomfort by passengers. Some improvements have been investigated or proven effective for in-cabin comfort, like affective atmosphere, friendly in-seat service, encouragement for body movement, space optimisation (Lewis, et. al., 2016; Lin, 2015; Chen, 2008).

Conclusion

The literature review above suggests a lot of possibilities for in-cabin comfort design. Especially for the user-centred design, not only the physical facility needs improvement, but there is also various interaction needs to be further investigated in the dynamic environment. The theoretical comfort models (see Figure 15&16) provide comprehensive understanding of the context and the passengers. Also, in the next phases, these models and principles would be served as evaluation standard.

Figure 16. In-cabin comfort models (Dumur, et.al., 2004)

2.3 Sleep in Transit

***RQ 2:** How do passengers sleep on other transportation?*

Sleeper Berth in Other Transportation

It has to be admitted that sleep in transit is a big challenge. Therefore, there are sleeper berths designed on railway, bus, and cruise ship for better sleep and rest, most of which are provided on overnight trip (see Figure 17).

Figure 17. Sleeper berths on railway, bus and cruise ship.

On railway

- Separate with seat carriage;
- Private room with two layers of berths;
- Multi-functional and foldable berth;

On bus

- On top of seats;
- Only used in night period;
- Have safey issue and gradually be replaced in some countries;

On cruise ship

- Similar layout and arrangement with railway on small ship;
- Private room that is similar with hotel room on cruise ship, and there are many other activities allowed, services provides.

To conclude, the sleeper berths are used to lie mostly used in night and have more function during the day time. Although these help passengers to sleep in the night on the travel journey, it is difficult to take the advantages from one to another without consideration of the environment and qualities of each transportation.

***RQ 3:** What are the differences between sleeping on other transportation and sleeping on an airplane?*

Comparison and Evaluation of Sleep-Related Benchmark

Compared with other public transportation, flight is the fastest and probably one of the most expensive choices, but the comfort level sometimes is not matched with the ticket price. Jet lag, limited living space, and unstable environment all contribute the the discomfort.

To understand the problem from a deeper

level, the comparison among different transportation was done by 8 participants who have relevant experiences. They were asked to score sleeping related aspects in different transportations, including bus, railway, cruise ship and airplane. The scale is from 1 to 10, and the average scores were calculated by Microsoft Excel.

The results show that among various kinds of transportation, sleep in aircraft is the most negative experience, having the lowest average score.

The most significant one is jet lag, because the speed of flight is much faster than the adjust speed of human beings. Compared with noise from other transportation, mechanical noise in airplane also got the most negative score. The noise is mostly from the turbofan engine and the airflow, which has largest impact on passengers sitting behind the wing and near the window. The other annoying factors, including insufficient privacy space, disruptive lighting and slightly dehydrated cabin air, were also scored relatively lower than in bus or railway.

According to the comparison in the bar chart, there are many limitations objectively existed, which are not easy to be improved, like jet lag and engine noise. To deal with these problems, passengers tend to look for direct solution. For example, experienced traveler would wear noise-canceling headphones to block out the environment noise, and some of them would take sleeping pills and melatonin to reduce jet lag. But on the other side, there are still many design opportunities behind those limitations and challenges to improve the current situation.

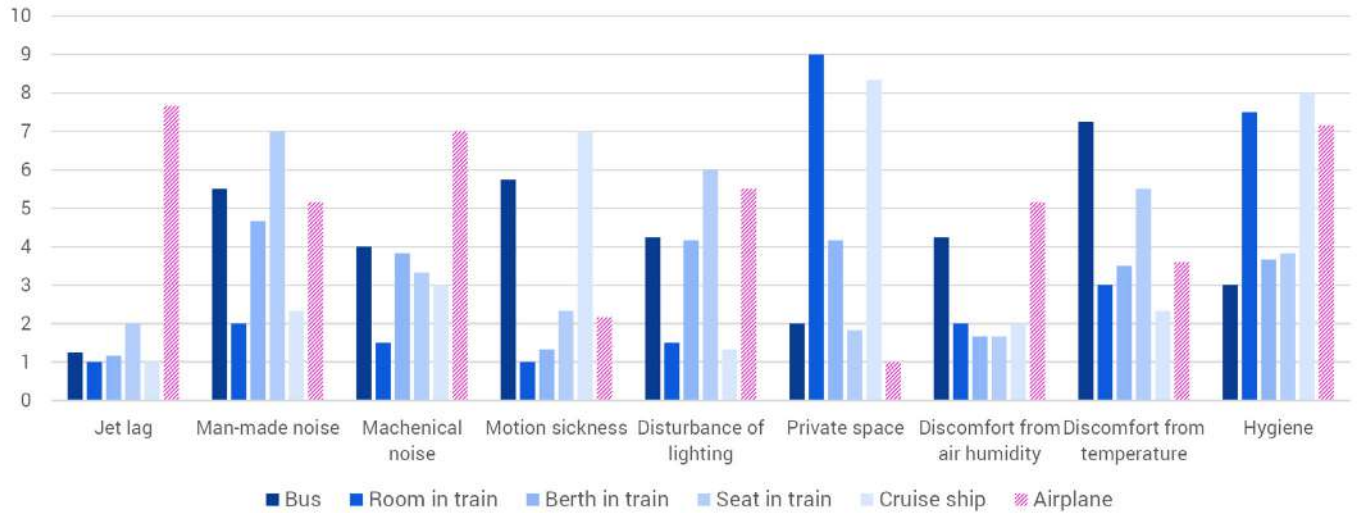


Figure 18. Comparison and evaluation of sleep-related benchmark among different transportation

2.4 In-Flight Sleep Journey

***RQ 4:** Is there any routine or pattern for LHF passengers to perform sleep in cabin?*

***RQ 5:** How do they feel during the LHF journey?*

***RQ 6:** Why do they have these emotions during the journey?*

Generative Co-creation Session

To look for the answer, I did a co-creation session first with 14 design students who had relevant flying experiences . Standers et al. (2008) described this method as an effective tool to collaborate researcher, designer, and user for insights generation. In co-creation sessions, the common routine of LHF passengers was captured, and the future visions for inflight experience in were clustered.

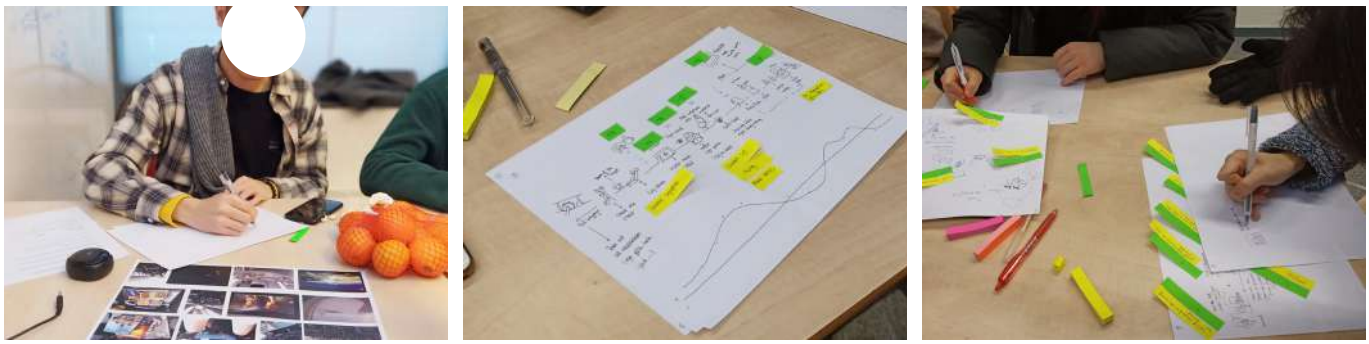


Figure 19. Generative co-creation session

After briefly introduced the background information, participants were sensitized with stimulated video and collages. Then they were asked to draw and write down their flying experience with an individual interview explaining the in-depth information. Lastly, a generative group discussion for better in-flight experience was executed (Appendix A).

Filled paper forms were gathered for comparison, and collective patterns among the 14 experience reports were identified. A transcript from audio recording was clustered by high-frequency words, and then incorporated into four models for comfort in cabin mentioned in Section 2.2.

The results of the co-creation session showed that a complete sleep experience consists of four stages, including preparation before the flight, adaptation after boarding, cruise flight, and refreshment before landing. The ideal flight journey experience of participants were further analysed for the deeper understanding of their needs (in Section 2.5).

***RQ 7:** Are these findings applicable for more LHF passengers?*

***RQ 8**: Is there any other neglected factor influences in-flight sleep?*

Online Survey

After gaining the basic comprehension of passenger journey, I designed an online survey (questionnaire) to gather more quantitative data from passengers of different ages, flight purposes, and background (Appendix B).

The 215 complete answered questionnaires were received via Microsoft Forms.

Some questions were only answered by 109 participants who have related LHF experiences.

The results validated the common routine for LHF concluded from the previous session. More than half of passengers are trapped in the state of being between asleep and awake (see Figure 20). It means that they suffer from keeping awake when they want to have a good sleep.

It was also showed that disruption from non-mechanical factors (e.g. broadcast, neighbours noise, flight attendant service) has the largest effect on being awake from sleep, following by the unsatisfactory cabin environment (see Figure 21).

It is also interesting to see that there is a significant difference of perception between experienced and inexperienced passengers (see Figure 22). Experienced passengers have higher satisfaction levels, probably because they have a better preparation (e.g. book the preferred seats) and lower expectations.

Verifying the findings from Bouwens et al (2018), the survey shows that the comfort of seats is the factor most frequently mentioned by experienced passengers. However, it is possible that it is not the dominant reason for

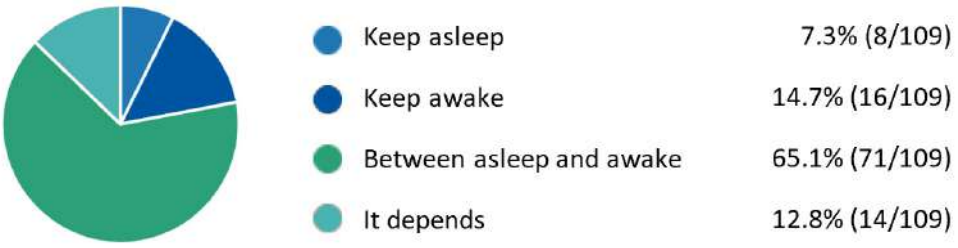


Figure 20. In-flight state based on the previous long-haul flight experiences

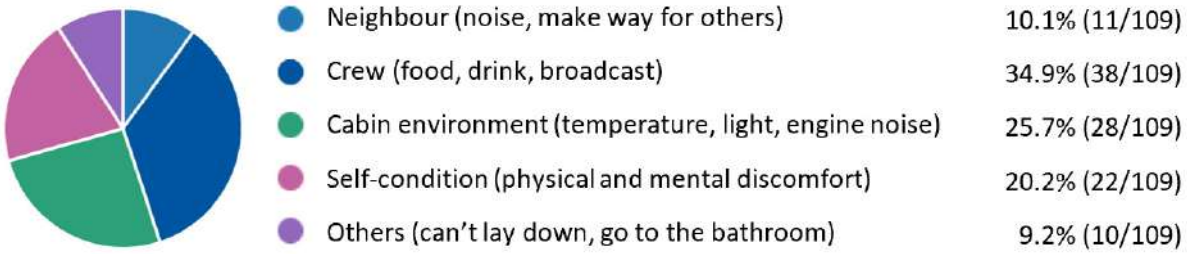


Figure 21. Dominant reason for being awakened based on the previous long-haul flight experiences

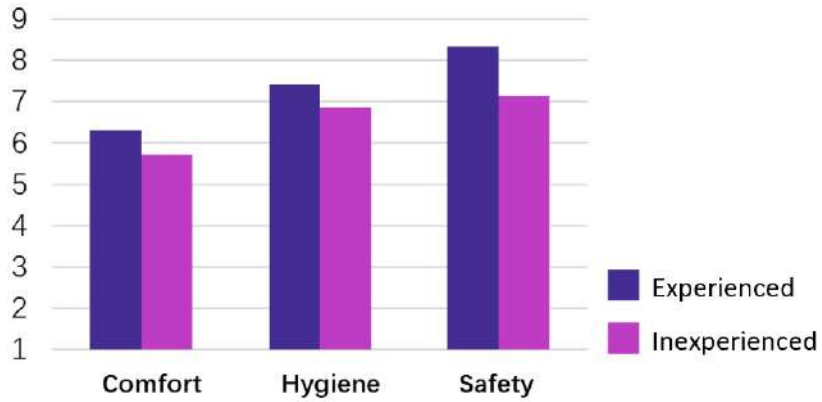


Figure 22. Average expected comfort score of long-haul flights (t-test, p>0.05)

being awaken, but might be the leading factor to the physical discomfort or perhaps leading to a potential physical complaint after the sleep.

Passenger Journey Map

Based on the time frame of the in-flight sleep journey, change of emotion during separate phase was drew by participants in the co-creation session. Also, the reasons of these changes were further explained by themselves. A mood waving line was fit by connecting emotion peak points and turning points.

A passenger journey map was concluded after these research activities (see Figure 23). The journey map suggests the qualitative results of the changing emotion trend,

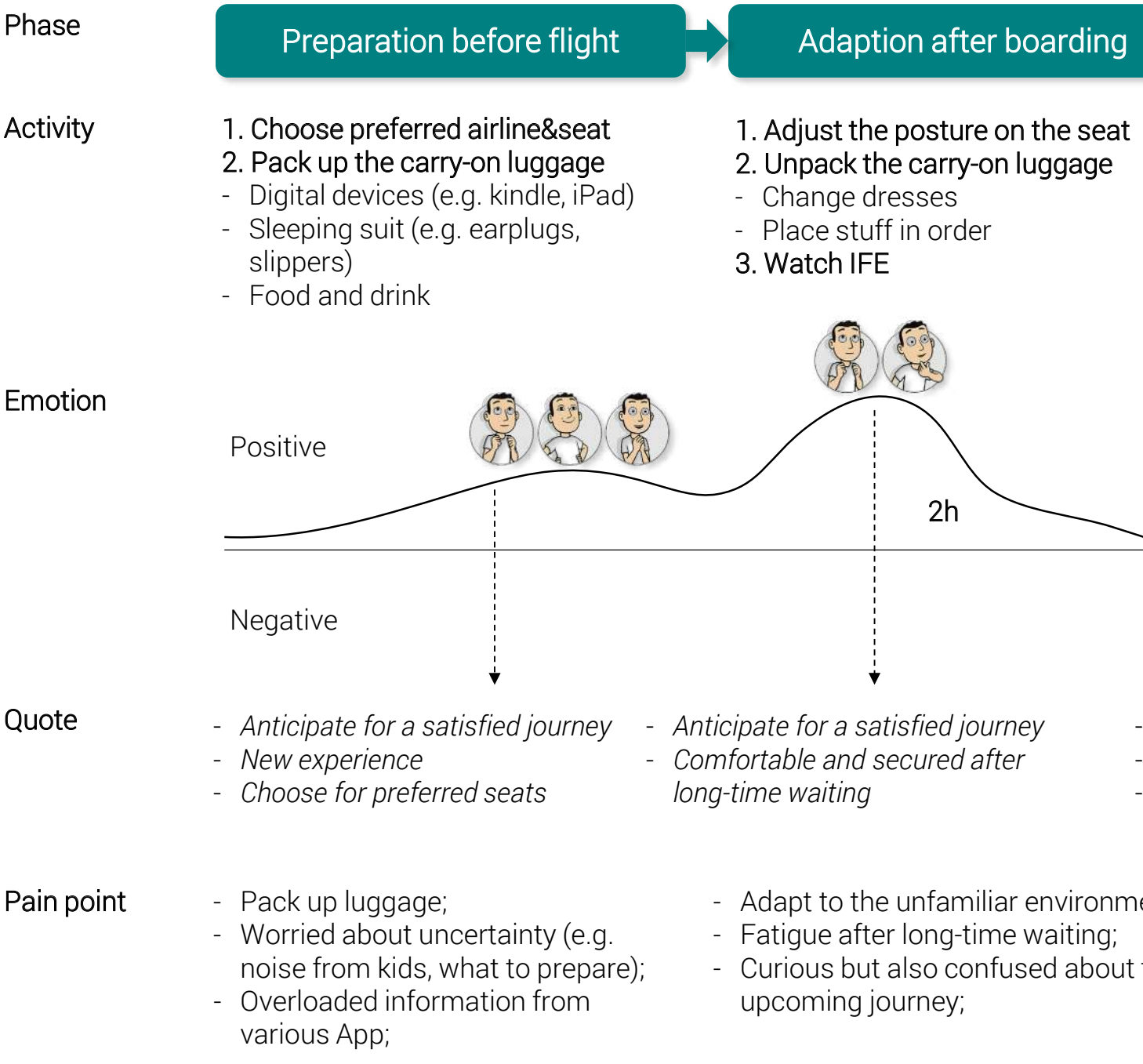
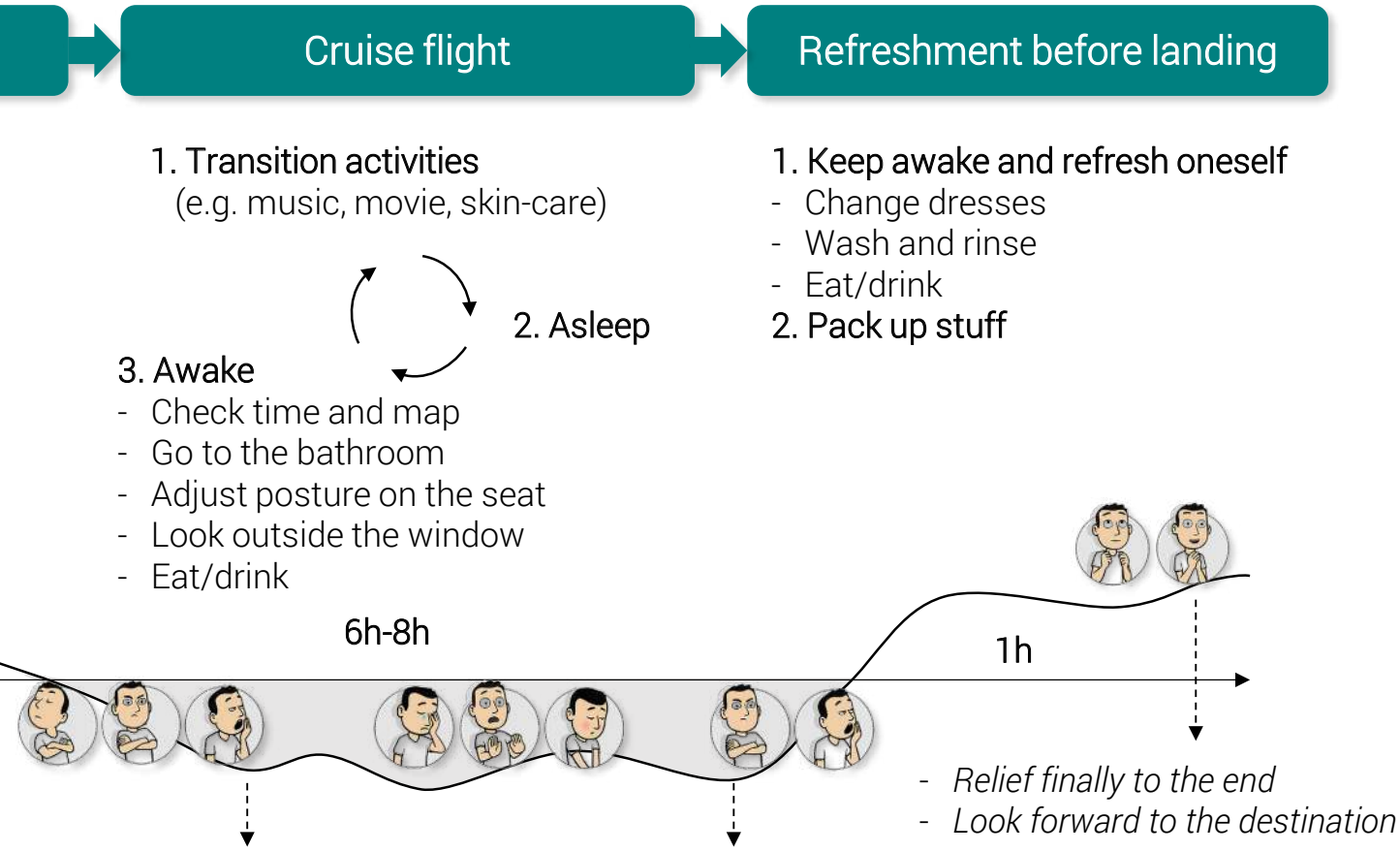


Figure 23. Passenger journey map (activities performed, emotion trend, participant quotes and pain points

instead of accurate quantitative statistics. The negative experience mostly appears during the cruise flight, which lasts six to eight hours, more than half of the flying time. This stage goes through a cycle of falling asleep, waking up, and transition activities, so many passengers would feel tired, annoyed, impatient or frustrated. The other phases are relatively satisfactory, because they are relatively clearer about the upcoming stages, which make passengers anticipate, and feel relieved.

Addtionally, there are several pain points concluded from the transcript. Even though passengers are positive at the beginning and the end, there are still problems need attention during separate phases. For example, some passengers are eager to contact with their friends immediately after landing.



Tired and sleepy
Annoyed of narrow space
Impatient with broadcast

- *Awkward and embarrassed to disturb others*
- *Hesitate if it is good time to go to the bathroom*
- *Discomfort of keeping one posture, bad environment*
- *Disappointment of short and light sleeping*

ent;
the

- No clear information about the time;
- Embarrassed to disturb others;
- No help to reduce discomfort of keeping the same posture;
- Not easy to have long-time sleeping;
- No feedback for the airline;
- No self review on the trip;
- Eager to connect with the outside world;
- Hasty and hurried ending.

during separate phases in a LHF sleep routine)

2.5 Need of Passengers

***RQ 9:** What do passengers really need?*

Ideal flight experience

In the co-creation session described above, the question about the visions of future flights was answered by all participants individually. Then the results were gathered and clustered into six categories (see Figure 24). These ideas towards a desirable LHF (not necessarily including a better in-flight sleep) reflect the current problems or neglected requirements. Therefore, it is helpful to understand passenger's fundamental needs through analysing the results from a deeper level.

aesthetic-economical model (see Section 2.2).

This model also covers both physical and mental needs of most passengers during the flight journey, not only for the individual, but also taking the group travelers, like family, into account.

***RQ 10:** What is the relationship between these requirements and comfort model?*

A close connection between this model and the six categories of requirements was found (see Figure 25). Some of them are overlapped, complementary, or even conflict with each other, so not all of these needs could be satisfied at the same time by one solution.

Physical Comfort

- Lounge chair
- Less vibration (no airsickness)
- Lie flat
- Flexible seats
- Soft cushion
- More leg space

Isolated and private

- Not be disturbed
- Don't disturb others
- Self-service with less interaction
- Quiet and stable environment

(Curtain, board, helmet, rotating seats, conveyer, etc.)

Customised

- Self-controlled temperature, light, moisture
- Self-controlled meal time
- Self-serviced catering
- Can be selected/arranged in advance
- Family area for children

Informed

- Updated journey map
- Availability of the bathroom
- Time of catering service
- Clear about if neighbor is awake or needs to go out
- Information about the destination
- Environment of cabin (informed before the flight)

Organised

- Spacious space for food/water
- Organized storage space
- Safety for belongings

New Experience

- Theme flight
- Sleeping pill
- Separate cabin (gym, smoking area, cinema, gaming, family area)
- Transparent cabin
- Immersive VR experience

Figure 24. Clustered ideal experiences from session transcript

Connection with In-cabin Comfort Model

Dumur, Barnard and Boy (2004) proposed a model of in-cabin comfort, consisting of four categories, the passenger bubble, the community model, the healthy model and the

Connection with Fundamental Human Needs

Pieter Desmet and Steven Fokkinga developed the typology of thirteen fundamental human needs(2018). More than half of these

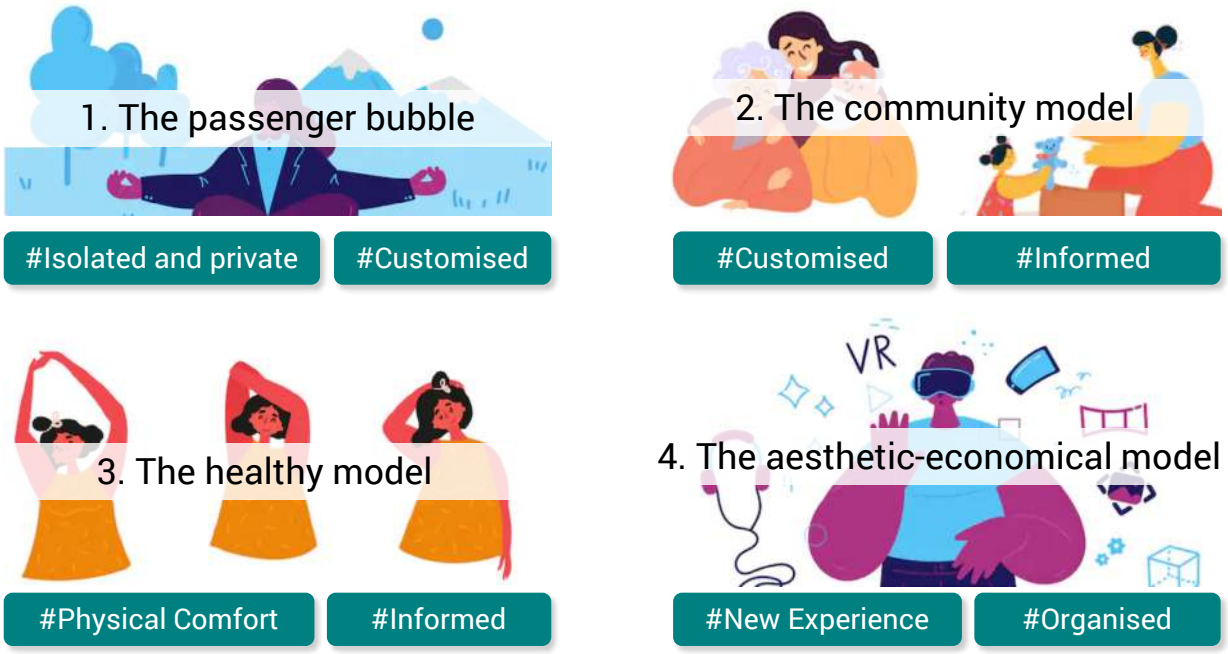


Figure 25. Categories of requirements fitting in four in-cabin comfort models

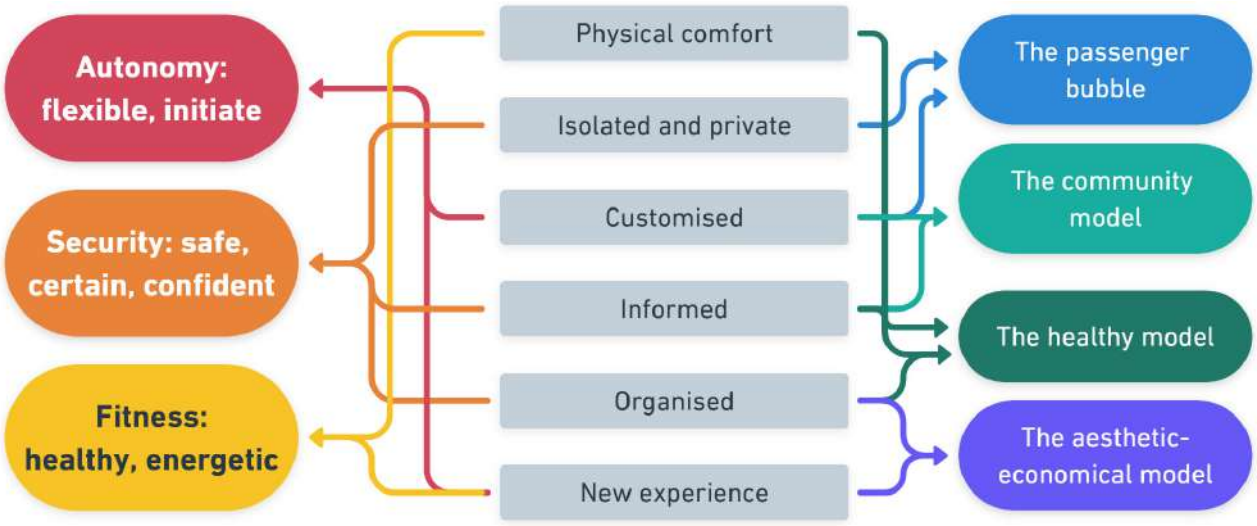


Figure 26. The links among ideal flight journey, in-cabin comfort model, related fundametal needs

fundamental needs are revealed in the vision, including both physical and mental elements. For instance, the requirement for informed upcoming service shows the need for security, the customised cabin climate shows the need for autonomy. Three main needs were generalised, autonomy for flexible choices, security for a safe and certain environment, and fitness for a healthy condition. However, what a designer should do is to find a relative optimal solution, maximizing the advantages, minimizing the conflicts.

Based on these findings, a detailed list of requirement from LHF passengers is further defined in the design brief (in Chapter 3).

2.6 Sleep-Promotion Application

***RQ 11:** How do people deal with insomnia when they are at home?*

***RQ 12:** Are these methods helpful?*

Although the sleeping environment at home is more stable and all kinds of conditions can be adjusted based on personal habits, many people still have problems to fall asleep. Besides environmental factors, insomnia often happens when people are sick or stressful. To help people to relieve the pressure from work and life, there are many sleep-aid applications in mobile phones.

Diary Study

I chose four top ones from the most popular sleep-aid app list in Google Play, and tried to use them for two weeks and evaluate the usability. In order to reduce individual difference, the online comments for those application were also used as preference and secondary evidence.

During two-week trial of using these phone applications, I personally got better sleep during night and some good snaps after lunch. What is more important for me is that I am more informed and clearer about my sleep qualities, length and deeper comprehension.

Analysis

These four apps have some overlapping functions, like using relaxing music to create suitable sleeping atmosphere, and setting alarm in an elastic time range (see Figure 27). Sleepa and Headspace are more like

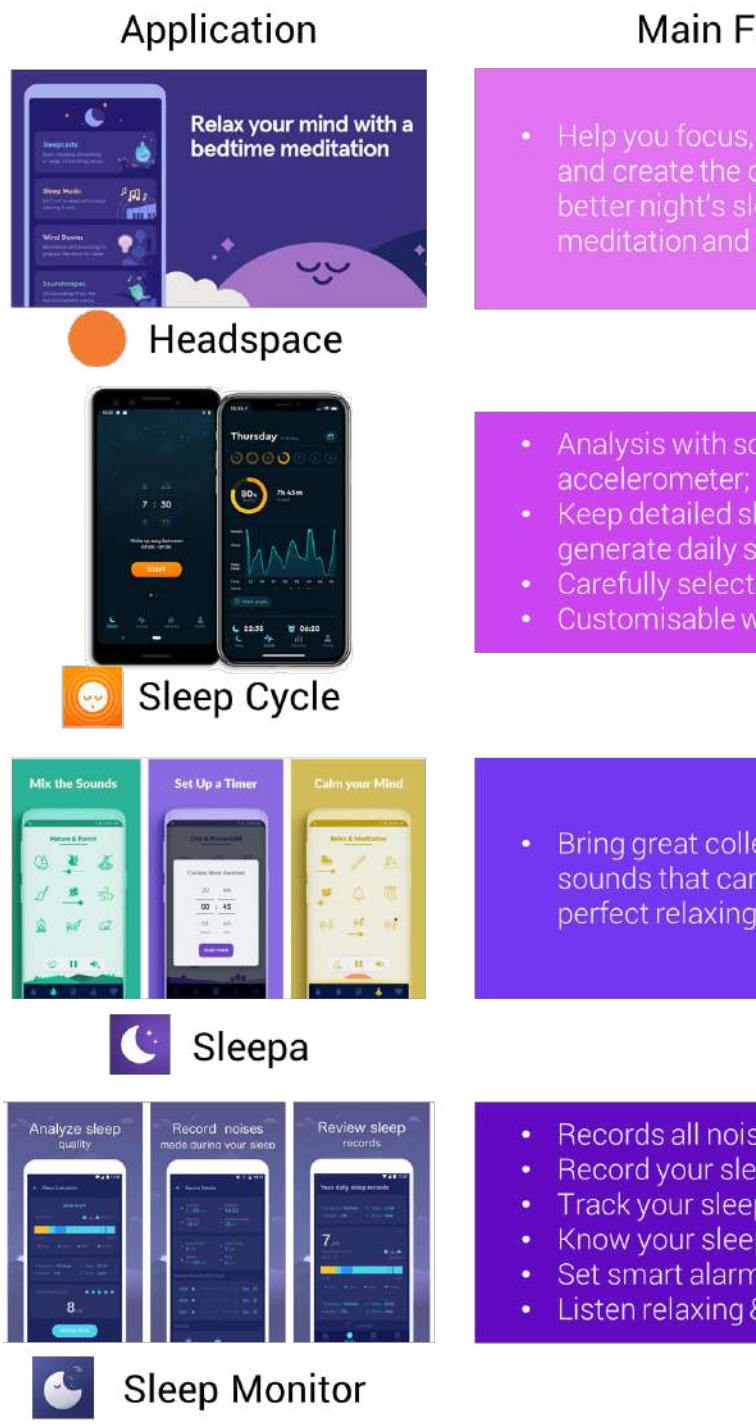


Figure 27. The comparison of four sleep-promotion ph

User Re

unction	Particularity	Inspiration
breathe, stay calm, conditions for a eep by practicing mindfulness.	✓ Create the perfect atmosphere to relax and sleep with sleep meditation music and sleep stories; ✓ Provide guided exercises to prepare mind and body for various purposes.	✓ For different users who are in various environment, should provide more options; ✓ The guidance is helpful for users who are not familiar with the application.
ound technology, or leep statistics and leep graphs; ed alarm melodies; vake-up window.	✓ Long-term sleep tracker trends; ✓ Compare your sleep data to world sleep statistics; ✓ Sleep notes - see how events such as drinking coffee, stress, working out, or eating late affect your sleep quality.	✓ Comparison with others is useful for users to understand their own condition; ✓ Keeping diary and notes for a long-term provides personal review, which is helpful for self-reflection.
ection of HD n be mixed into the ambiences;	✓ Create your own favourite mixture; ✓ Provide community to share the mixed music; ✓ The simplified function and user interface is user-friendly.	✓ Personalisation is important for users to adjust according to the changing condition; ✓ Community is important for users to get more engagement.
se during sleep; ep habits; p patterns; p quality; n clock; & soothing music.	✓ The diagnose service help users do self-diagnosis whether there are signs of poor sleep quality like sleep disorder, sleep disruption, sleep deprivation.	✓ Encouraging users to understand the statistic is more important than only presenting the data.

one applications

meditation guidance tools for relaxation, Sleep Cycle and Sleep Monitor focus more on the sleep with statistics and professional suggestion.

To conclude, there are four main methods to promote sleep provided by phone application:

1. Creating relaxing atmosphere (stories, music, mixed sound);

2. Providing guidance (guided meditation, movement and sports);

3. Providing information (monitor, analysis);

4. Doing long-term review (keep diary to record daily habit, see how activities influence sleep).

I've also gained valuable takeaways from these applications.

1. For different users who are in various environment, should provide more options and personalised service;

2. The guidance is helpful for users as the professional companion;

3. Community is important for users to get more engagement, and comparison with others is beneficial for users to understand their own condition;

4. Keeping diary and notes for a long time provides personal review, which is helpful for self-reflection;

5. Encouraging users to understand the statistic is more important than only presenting the data.

Increasement in motivation and perceived reward may lead to adequate sleep and successful emotion regulation strategies (Palme and Alfano, 2017). To a certain extent, the usage could provide a psychological implication. This might be one of the reasons to get high scores in the app store.

Although, it is still difficult to compare and prove the effectiveness of each application by this research method, their prevalence among people reflects relatively positive influence.

2.7 Multimedia as Sleep-Aid Tool

***RQ 13:** Are these methods supported by more academic evidence?*

Getting inspiration from the last section, I find that multimedia has great potential to help people as sleep-aid tool.

Multimedia means a combination of different content forms such as text, audio, images, animations, video and interactive content. It can be recorded, played, displayed, interacted with or accessed by electronic devices.

Some scientists are doing related research on the relationship between usage of various media and sleep qualities. There is some controversial arguments of the negative influence on the sleep quality from digital equipment. But it is very common for adults and teenagers to use these media as a self-treatment strategy for sleep difficulties based on self-reported data (Eggermont and Van den Bulck,2006; Exelmans, Liese & Van den Bulck, 2016). Exelmans, Liese, and Jan Van den Bulck (2016) did a survey with 844 adults about their media habits and sleep behaviour. A substantial proportion of the participants were using books, television, music, Internet, and video games before sleeping.

Considering the application scenarios in the flight cabin, audio, animation, and video are more suitable due to the space and equipment limitations. So, I'll do literature research on the promotion effect of these multimedia contents separately.

2.7.1 Audio

Listening to music is a widely used tool to improve sleep. It has been suggested that relaxing music can provide a low cost, non-pharmaceutical, easy-operated option to treat insomnia (Furihata, et al., 2011; Harmat, Takács, & Bódizs, 2008). However, there are various mechanism of explanation the principles. An online survey showed a large diversity within their responses of the musical genres, chosen as the sleep promotion (Trahan, et al., 2018). The main reason is to change one's state of mind, including relax, focus or initiate a change in mood (Saarikallio and Erkkilä, 2007). Also, music could function as a distractor from annoying thoughts and stress. Especially when people keep a routine or habit of listening to music before sleep, the positive effectiveness would increase. This is commonly recommended as an important component in the sleep hygiene treatment of insomnia (Stepanski & Wyatt, 2003).

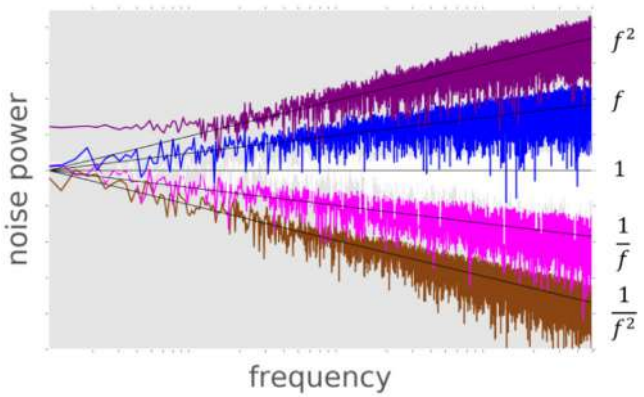


Figure 28. Power spectral distribution of colours of noise (Doyle&Evans, 2018)

In addition to music, some types of noise have the similar effectiveness to aid sleep, for instance, white noise, pink noise (see Figure 28). Many people have the experience of

enjoying a very sound sleep during the rainy night, or with the sound of waves lapping against the rocks. These natural sounds can be regarded as pink noise, which sounds very soft and gentle. A study did by Zhou and other researchers in 2012 demonstrates that pink noise has a significant impact on reducing brain wave complexity and improving sleep quality.

Also, the monotonous mechanical sound, like the washing machine and radio noise, is closer to white noise. The repeated, constant, steady sound can mask background noise, helping listeners focus, fall asleep faster, and sleep deeper. White noise is more frequently used in medical research, to help mothers calm their babies, to mask environmental noises in the coronary care unit (Spenser, et al., 1990; Afshar, et al., 2016). Compared with white noise, the masking effect for other sounds is stronger as a distractor.

2.7.2 Video

There isn't much validated research on the relationship on visual media and sleep. However, some videos are used for relaxation and amusement in the Internet.

Figure 29. Video clips screenshots of popular themes for sleep-aid

It is claimed that watching these materials can make people feel good, then leads to sweet dreams (Rosie, 2020). After analysing the contents of 20 most popular video, I've found certain themes that might aid sleep:

1. ***Human being doing good***: People like to be supported and be touched, so it might trigger some positive emotions, like belongings, warmth.
2. ***Cute baby animals***: People have the instinct to trust and protect babies, even the baby animals. It might helpful to increase the feeling of security.
3. ***Baby laughing***: Happy facial expression has strong contagious effects without any language or cultural barrier.
4. ***Natural scenery***: Beautiful scenery is used to clear the mind, which needs calm down and avoid disturbance.
5. ***Outside scene on a road***: Either urban scenery or countryside view, or natural scenery with the sound of vehicle engines, the repetitive video.

After watching these kinds of videos, audience tend to change their mind into a calm, serene status. Similar to the music aiding for sleep, videos with peaceful, repetitive scenes are helpful to create a better atmosphere before going to bed.

The background music also plays an important role to better regulate audience's emotion, like mentioned in the last section.

The biggest distinguish theme is feeling empathy when seeing the good qualities of human being, like helping others, hugging each other, supporting each other. The narrative videos could trigger the feeling of being touched.

2.7.3 Multimedia Guidance

Compared with pure music or noise, the audio guidance contains more contents, which needs language understanding. Some people believe these might aid as guidance for sleep. For example, listening to stories, audio books, or guided meditations. However, as the results shows that after listen to the audiobook, there is no significant improvement on sleep quality for those young people (Harmat, Takács, & Bódizs, 2008). It suggested that effectiveness might have the strong connection with the guidance contents, and vary from person to person.

Guided meditation is another popular theme of audio guidance all over the world. The main purpose of mindfulness meditation is encouraging people to concentrate to inner self and the environment. In one of the most popular phone applications, Headspace, there are many lessons teaching people how to do meditation appropriately for various purpose. For getting a better night sleep, the trainings begin with a simple introduction, then several simple steps. The length varies from 10 min to half an hour, and the light background music is throughout the whole process.

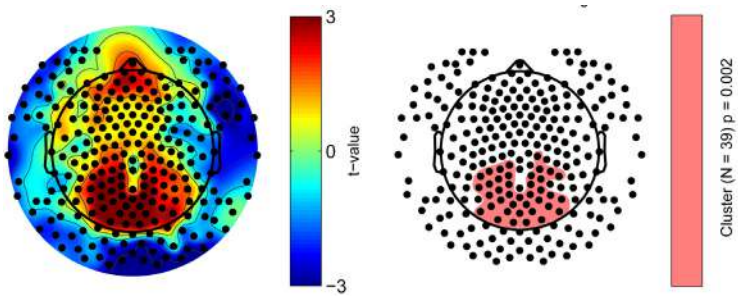


Figure 30. Long-term practitioners had higher NREM gamma power compared to meditation naives in a parietal-occipital region (Ferrarelli, et al., 2013).

Some studies demonstrated improvements of sleep quality, decrease of depression level and pressure, in insomnia patients after a heartfulness meditation training for eight weeks (Carlson and Garland, 2005; Zhou, et al., 2016; Thimmapuram, et al., 2020). They also explained the principles, the form of a regular habit, and being away from the distracted thoughts. The research also shows the positive impact of silent motion graphics of meditation guidance, on treatment for insomniacs who have dysaudia or who are more sensitive about sound.

Addition to these, the guided animation for small exercises are also used for people who have stress in body. It has been proved that moderate body movements under professional guidance are helpful to fall asleep faster, especially for the elderly (Myllymäki, et al., 2012; Kamrani, et al., 2014). Mentioned in Section 1.4, in-cabin exercises were introduced in a research flight for better rest. Passengers has higher comfort level after performing more guided exercises on seats. Bouwens, et al. (2018) tested an interactive seat for flight passengers, and it is indicated that participants prefer the interaction because it increase in-cabin comfort by significantly more body movement.

All these different kinds of guidance could also be applied to the in-flight sleep promotion. Even in the flight cabin, a public space, sleep is still a private activity for most passengers. However, the sleep guidance can be regarded as a professional companion, providing useful suggestion step by step. Also, from a psychological level, the feeling of being guided creates the mental security when people are frustrated. This might be another important reason explaining the effectiveness and acceptance of the guidance information, for those insomniacs.

2.8 Conclusion

In the research phase, I looked into different fields by using various approach, including literature review, interview, online survey, co-creation session. Serveral research questions are answered.

RQ 1: What is the general comfort level in the cabin perceived by passengers?

Many researchers have revealed the factors influencing the in-flight sleep, and several ***comfort models*** and ***design principles*** were developed for comfort design.

RQ 2: How do passengers sleep on other transportation?

There is relatively ***bigger space*** on other transportation for sleep, so sleeper berths sometimes are provided for comfort and privacy.

RQ 3: What are the differences between sleeping on other transportation and sleeping on an airplane?

Compared with other experiences of sleep in transit, in-cabin sleep has ***more challenges*** to deal with, such as ***jet lag, unstable environment, limited privacy***.

RQ 4: Is there any routine or pattern for LHF passengers to perform sleep in cabin?

There is a ***routine*** for in-flight sleep, including four phases:

1) Preparation before flight;

2) Adaption after boarding;

3) Cruise flight;

4) Refreshment before landing.

RQ 5&6: How and why do they feel during the LHF journey during separate phases?

Although the activities performed in different phases are various, there are some similarities in ***emotion and deeper requirements*** during separate phase.

1) Emotion during the ***preparation and adaption is relatively positive***, like enjoyable, excited, because passengers anticipate a new journey;

2) Emotion ***during cruise flight is more negative***, like annoyed, impatient, awkward, disappoint, due to the cycle of falling asleep, waking up, and transition activities;

3) Emotion ***before landing experience an upturn,*** like relief, refreshed, because they finally get to the destination.

RQ 7: Are these findings applicable for more LHF passengers?

RQ 8: Is there any other neglected factor influences in-flight sleep?

Addition to the seats or other physical environment, there are many ***intangible factors*** that influence the sleep being neglected, like ***neighbour and interaction with crew***.

RQ 9: What do passengers really need?

RQ 10: What is the relationship between these requirements and comfort model?

The activities performed, the vision of the ideal flight, and the related requirements reflect passengers' fundamental needs.

1) ***Autonomy***-passengers want to have more flexible choices, and the transition should be more initiate;

2) ***Security***-passengers want to be fully informed about the flight, the destination, the cabin environment and the self-condition, which makes them feel safe, certain, and confident;

3) ***Fitness***-passengers want to keep both mentally and physically healthy, and be energetic after a long journey.

RQ 11: How do people deal with insomnia when they are at home?

RQ 12&13: Are these methods helpful, and supported by more academic evidence?

Sleep-aid applications in phone have multiple functions, like music, guided meditation, monitoring, long-term track on habits. The effectiveness of these are not fully proved, but it is potential and needs more exploration.

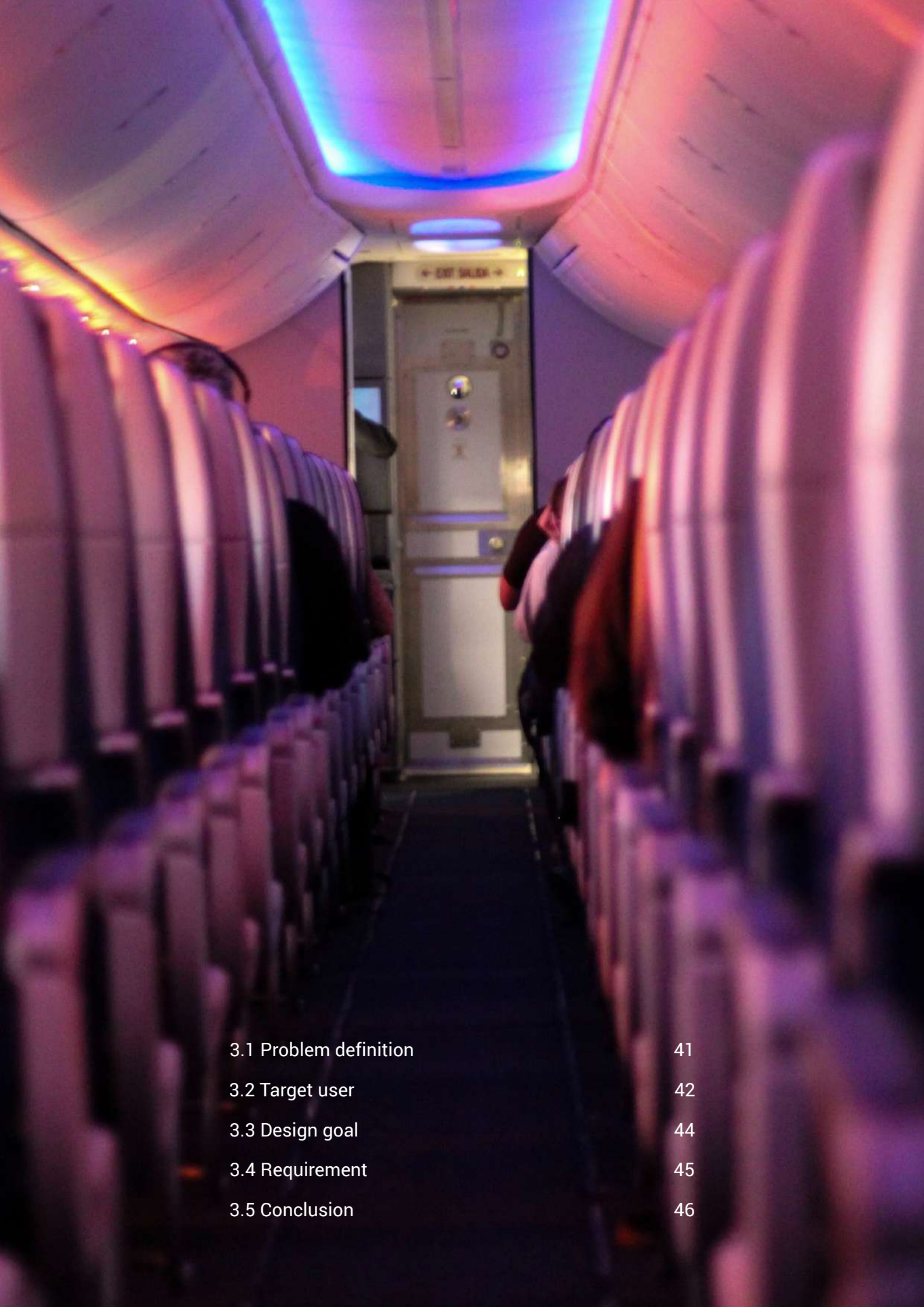
Relaxing music, peaceful video and some other multimedia materials are proved helpful to treat insomnia. Although the overuse of digital devices could influence the sleep quality negatively, ***multimedia tools*** can be used to combine text, image, audio, video to aid sleep.

The conclusion and insights are the fundamental base for the design. In the next chapter, the project would be further defined, with a clearer problem definition and design goal.

03 Project Redefinition

Introduction

After a series of research, the background and real context have been revealed. Also, the insights from the users indicated the design opportunity. In this chapter, a refined design brief would be explained. It is a condensed document that contains background and key information about a potential design project. More specifically, it includes an overview of the problem definition, target users, design goal, interaction vision and specific needs from users.



3.1 Problem Definition

The passenger journey of in-flight sleep has been explained and illustrated in the journey map in Section 2.4, showing a list of pain points during separate phases.

More specifically towards the activity of sleep, there are four directly related issues from passenger's perspective. These problems are mapped based on the timeline in Figure 31.

1. Have difficulty ***falling asleep*** after boarding;
2. Have difficulty ***staying asleep as long as desired***, easily be awakened during cruise flight;
3. Feel physically ***painful*** after sleep;
4. Feel ***continuous fatigue*** throughout the whole journey.

Many passengers would have some preparation to deal with such problems, but hardly anyone has a concrete solution to solve them. What's worse, there is no advice, service or help from flight attendant to improve the situation. So, passengers are still in a relatively passive position suffering from these issues.

In this project, I want to focus on the problem of ***"have difficulty falling asleep"*** and ***"easy to be awakened"***, which have more potential by improving the intangible services, system and environment. The other two problems are more ergonomics-related, requiring more hardware design or physiological intervention. However, they could also be evaluated criteria, since all complains are cognitively self-reported, which might be improved as well.

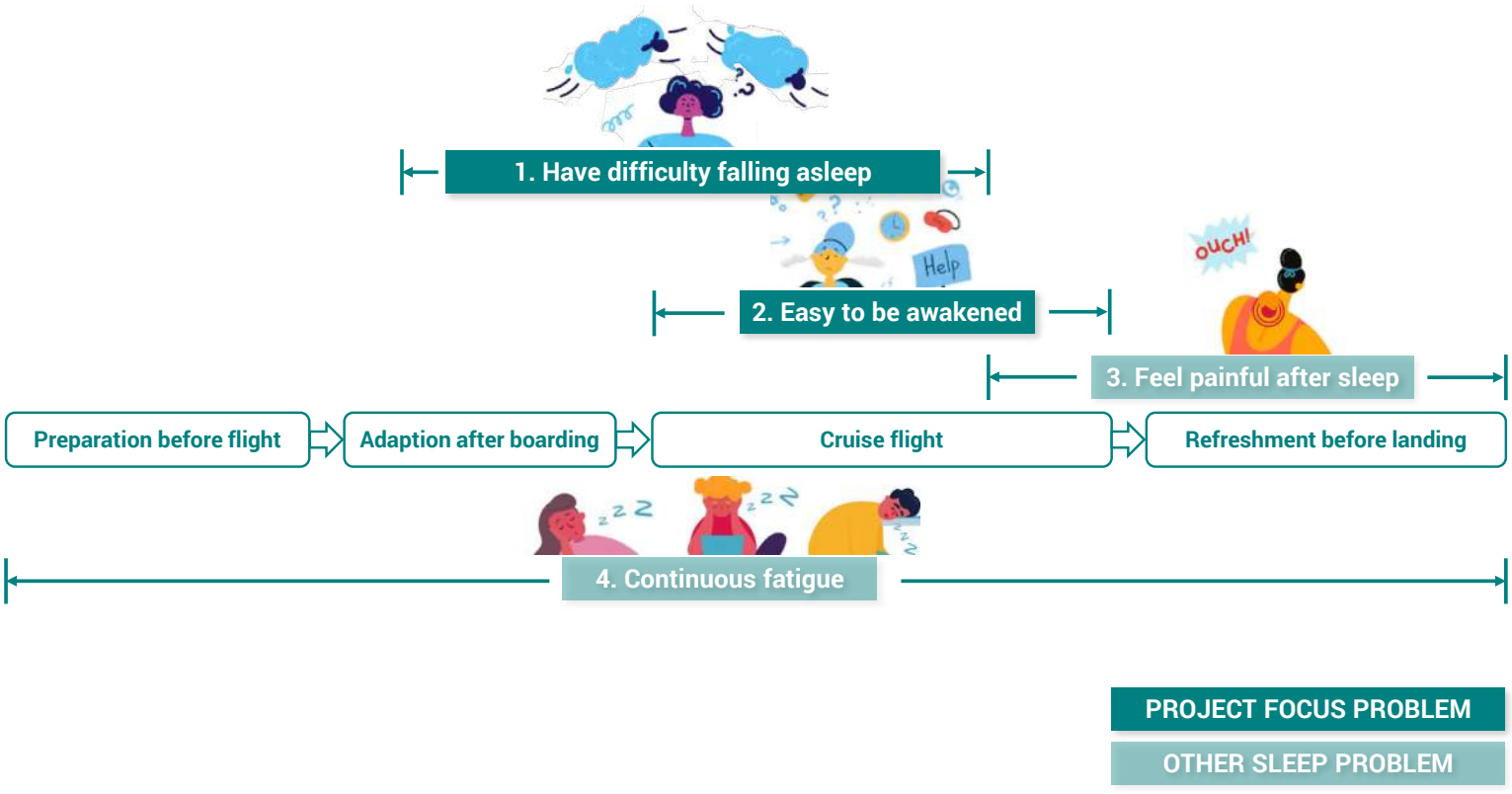


Figure 31. Four main problems directly related to sleep during the flight journey

3.2 Target User

In real life, not all these problems would be faced by individual, because various types of passengers have different scenarios. Even though they are in a shared space, their prioritised problems might differ widely according to personal demands. Therefore, target users were specified in a two-dimensional model, one is their experiences of taking the LHF, the other one is how busy their schedule is. Based on the insights acquired in the previous user research, these two dimensions are the most important factors, affecting the activities and emotions, further influencing the in-flight sleep.

According to these criteria, most passengers could be categorised into three groups. A persona map was used to visually explained the differences among these three target groups (see Figure 32).

What should be noted is that this way of categorizing might not cover all travelers. For example, some passengers might have tight schedule at the first time taking LHF. I did not build a separate persona for them, because they have both qualities of Group A and Group B, and account for smaller proportion of all passengers. On the other hand, there is no strict boundary among these groups, so passengers might have more definition and qualities in the practical situation.

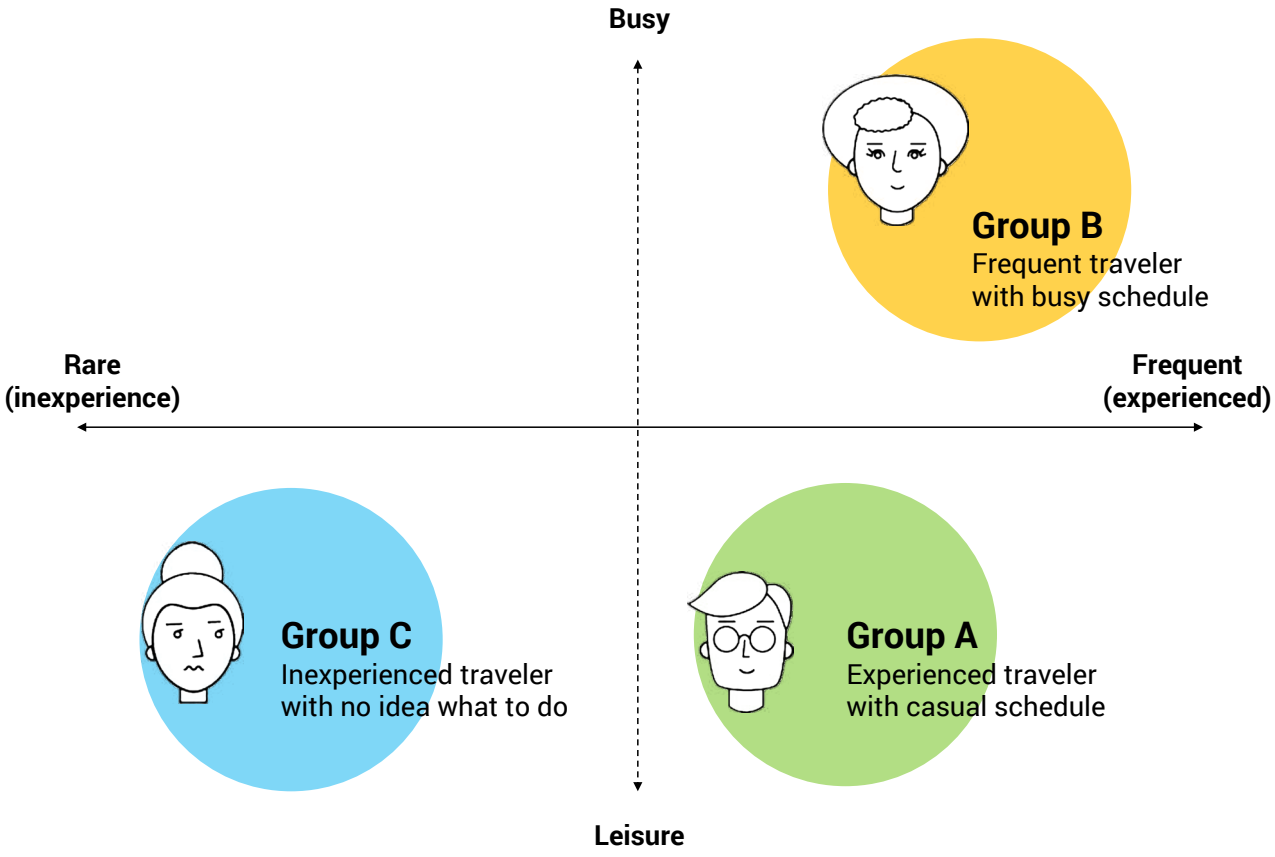


Figure 32. Persona on two-dimensional map (experience level, busy level)

To better define the design goal and achieve the requriments of different groups of passengers, the detailed characters and chllenges they might have are described in the Figure 33.

Target users	Character	Challenge
 **Group A** Experienced traveler with casual schedule • Holiday travel; • Study aboard; • Visit relatives.	• Would prepare some sleep-aid tools before the flight based on previous experiences; • Relatively clear about the flight journey, like in-flight service and facility; • Have curiosity to explore the most comfortable state.	• Try to find the most comfortable state within the limited space; • Need more options of in-flight activities; • Need communication with neighbours and air crew.
 **Group B** Frequent traveler with busy schedule • Business trip; • Academic trip.	• Have a relatively rigid and organised flight routine; • Concern about the upcoming activities after landing; • Have work to finish during the flight.	• Concern more about efficiency; • More privacy, less interruption; • Make sure everything is on schedule.
 **Group C** Inexperienced traveler with no idea what to do First time of • Holiday travel; • Study aboard; • Visit relatives.	• Don't have a flight routine; • Don't know much about the journey; • Would do research before the flight to be prepared; • Need extra help.	• Need guidance and help when they feel lost; • Need more information of the whole flight; • Need mental security because they are easily get nervous and embarrassed.

Figure 33. Detailed characters and challenges of different target groups

3.3 Design Goal

In Section 2.5, three main fundamental needs of passengers have been described, ***autonomy***, ***security and fitness***.

These requirements cannot be fully satisfied by merely improving in-cabin hardware, like providing spacious leg space or flat bed. There is a need to provide more comfortable environment, but it is more important to increase the feeling of security in an unstable space. If passengers feel more confident about their current and upcoming situation, they would know what to do, and then possibly be more tolerant and patient to deal with the discomfort.

Therefore, the design goal is

"Feel in control" is a relatively abstract vision, so I tried to make it more concrete by splitting it. Three key words were chosen as the interaction vision, ***secure***, ***flexible*** and ***serene***. This feeling is not purely negative or positive emotion, but more like a neutral state (see Figure 34).

Secure: feelings that your conditions and environment keep you safe from harm and threats;

Flexible: feelings that you have free choices and are able to do what you want without hesitation;

Serene: feelings that all your expectations are fulfilled, everything is well and there is nothing urgent to do.

"to make passengers who want to have a nice sleep feel more in control during different phases in LHF".

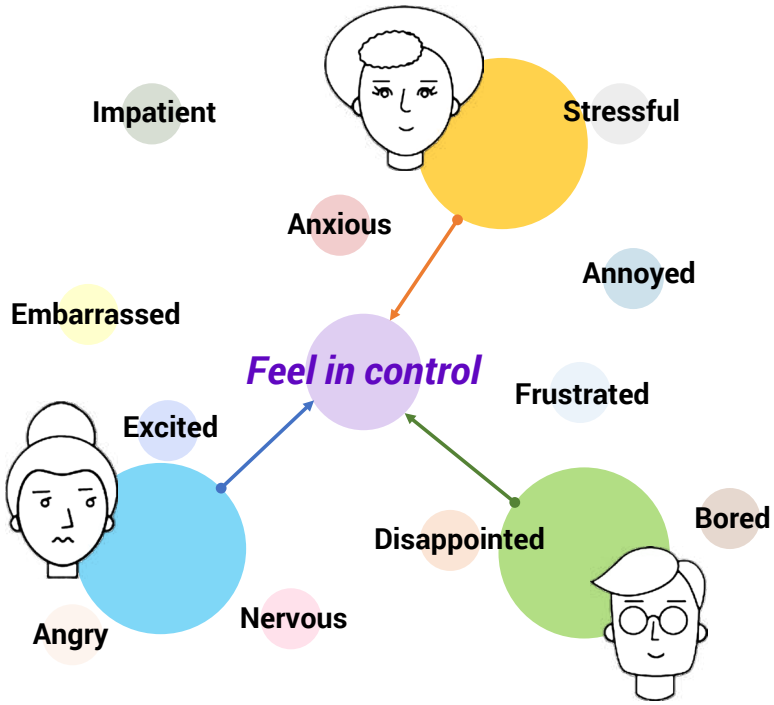


Figure 34. The design goal of "feeling in control" from other mental states

3.4 Requirement

In order to explain interaction vision in a real situation, more detailed requirements have been listed. In the next chapter, these requirements are used as evaluation criteria to select the best concept, which would be further developed.

1. Secure

1.1 Be informed of the updated current environment;

1.2 Be informed of the upcoming event;

1.3 Be informed of the whole schedule;

1.4 Be aware of updated self-condition;

1.5 Be aware of neighbour's condition;

1.6 Have reasonable expectation;

1.7 Know how to deal with unforeseen circumstances;

1.8 Trust on flight crew and airlines;

2. Flexible

2.1 Have controllable personal bubble (sound volume, light, etc.);

2.2 Have multiple choices of in-flight activities in different phases;

2.3 Feel free to perform individual activities;

2.4 Feel free to switch among flexible choices;

3. Serene

3.1 Be clear about what to do, instead of feeling bored or frustrated;

3.2 Feel calm and peaceful;

3.3 Believe everything is in the reasonable arrangement;

3.4 There is nothing should be worried about.

3.5 Conclusion

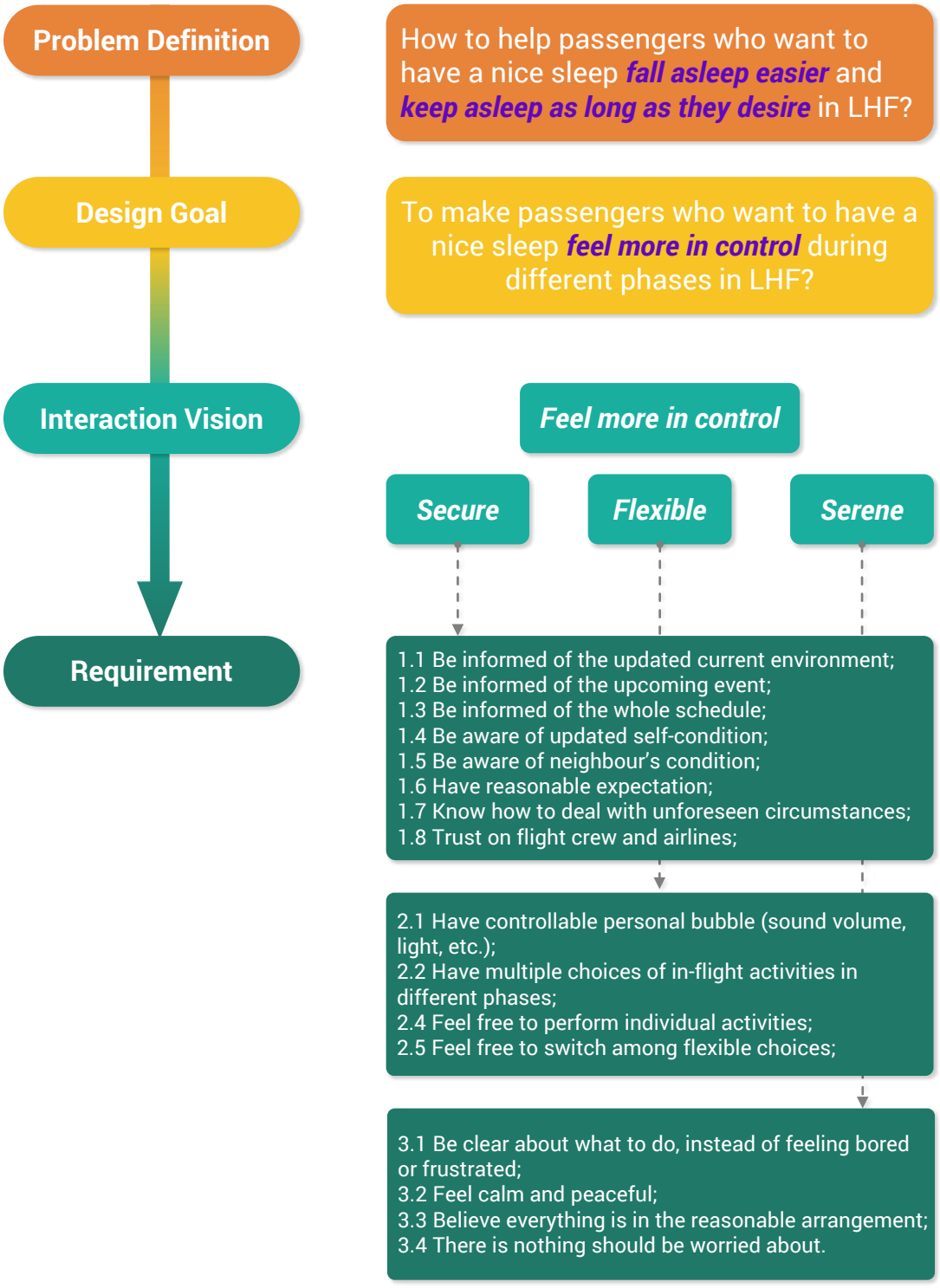


Figure 35. Overview of the redefined design brief

04 Conceptualisation

Introduction

The previous chapters explained the analysis phase that concluded with the design brief, which is the basis for following steps taken in the design process. This chapter covers the idea generation process and how those ideas converged into three concepts, which were evaluated by design requirements, tested and served to build a redesign proposal of the in-flight sleep promotor.

4.1 Ideation

The idea generation started with a creative facilitation session, based on the previous analysis. In order to avoid the constrains from the project owner, this session was hosted by another design student, who received relevant training and is experienced with such an generative group session.

After that, a brainstorming session was done by diverging and creating a number of ideas that were then converged into concepts (see Chapter 4.2), aiming to explore the scope in terms of depth and breadth. The ideas generated were used as inspiration and input for new concepts. The session consisted of four phases, introduction, problem finding, idea finding and recapitulation. The complete procedure and the details are explained in Appendix C.

One of the main outcomes of the session is a new design goal, which is in a higher level, "***trigger passenger's awareness of pleasure during different phases in LHF***". This goal was defined by all 6 participants, including me as the project owner.

The happiness is one of the most important in the "aesthetic-economical model" which is mentioned in section 3.3. So, it made me realise that the design should be positive and attractive, especially in such an unsatisfactory context. The needs for joy should also be paid attention to, instead of being put in the second place after the vision of "feeling in control".

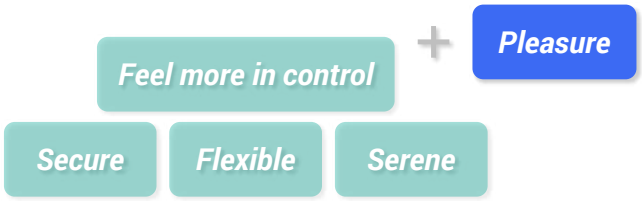


Figure 37. Additional goal generated during the session

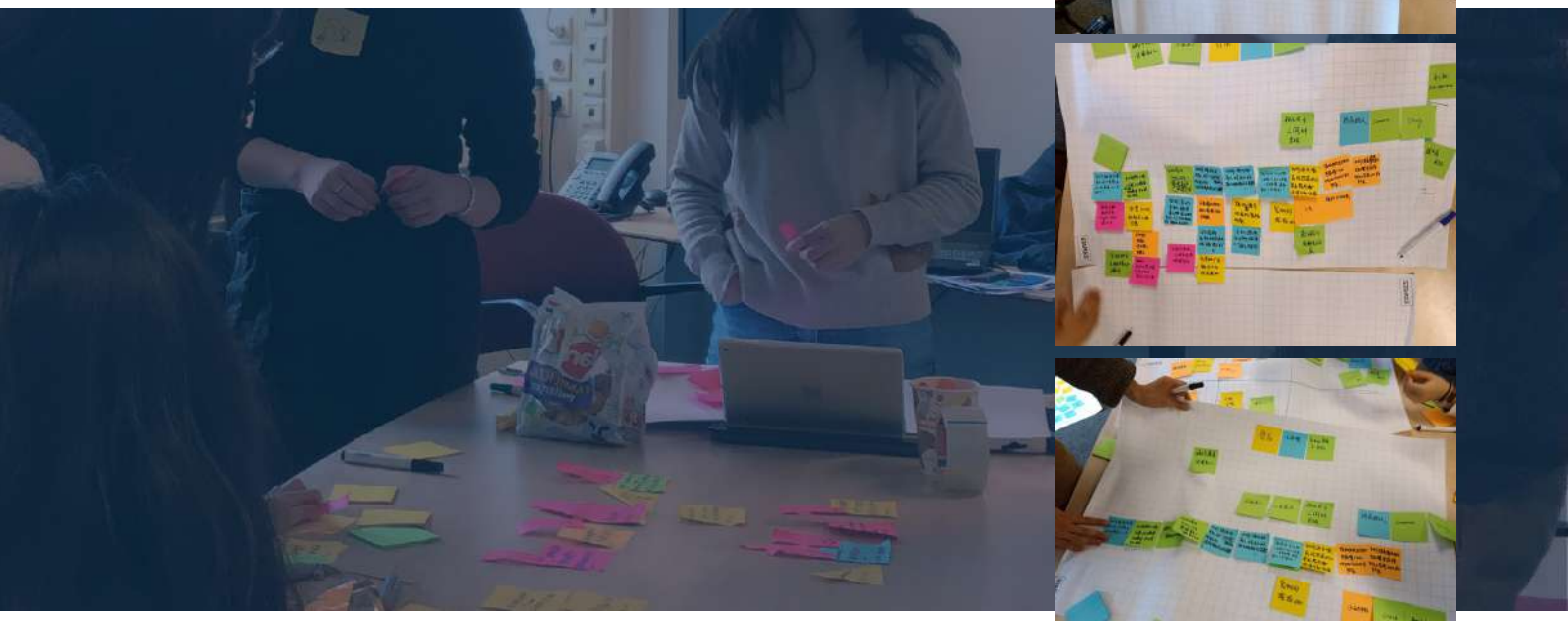


Figure 36. Creative facilitation session

Feedback	Social conversation	Information acquisition	Choice
H2 to enable passengers to input and have an impact	H2 trigger conversations; H2 show othes my preferrence; H2 to enhance the interaction between passenger & assistant; H2 trigger conversation when it is necessary; H2 find something to do for the idle passengers	H2 get passenger choose what information to receive; H2 to verify information;How to playback; H2 know what happens in the past journey; H2 provide more information about the journey	H2 select the seat environment through VR; H2 provide more choices without passenger getting lost; H2 provide multiple choices; H2 choose a neighbour; H2 know more about the whole journey

Personal Space	Emotion	Ownership	Flight attendant
H2 stay alone; H2 keep passengers who want to sleep undisturbed; H2 be independent & private in the community; H2 create a space according to passenger's personal needs; H2 ensure independent on-board experience	H2 make passenger maintain stable emotion; H2 keep a good mood; H2 create superiority	H2 expand the scope of passengers' responsibilities; H2 make passengers feel like they are a community; How can a passenger offer another passenger a free opportunity	H2 make flight attendants care about passengers; H2 do flight attendants connect

How might we raise the customers' awareness of the pleasures in the cruise experience?

Figure 38. Outcomes from "Problem Finding"

Figure 39. Outcomes from "Idea Finding"

4.2 Initial Concept

Concept 1 - Master My Flight

Personalisation and info-visualisation is the core of Master My Flight (see Figure 40), which provides a personal database from the previous personal flight experiences. All personal data will be accessible for passengers, and used to generate better journey mode.

The *overview of the journey* would display on the phone of passenger with *personal tips*, reminding user to prepare better for a good in-flight sleep before boarding. The in-cabin *climate is controllable*, including the volume of broadcast, the humidity, the lighting system. *Real-time updated flight information* and *destination information* is available, which make passengers feel secure. The detected *physiological data* would be gathered for the improvement of the related design, like the optimised resources distribution, friendly seat design. And passengers would receive *positive feedback* on their contribution after landing or in the next flight.

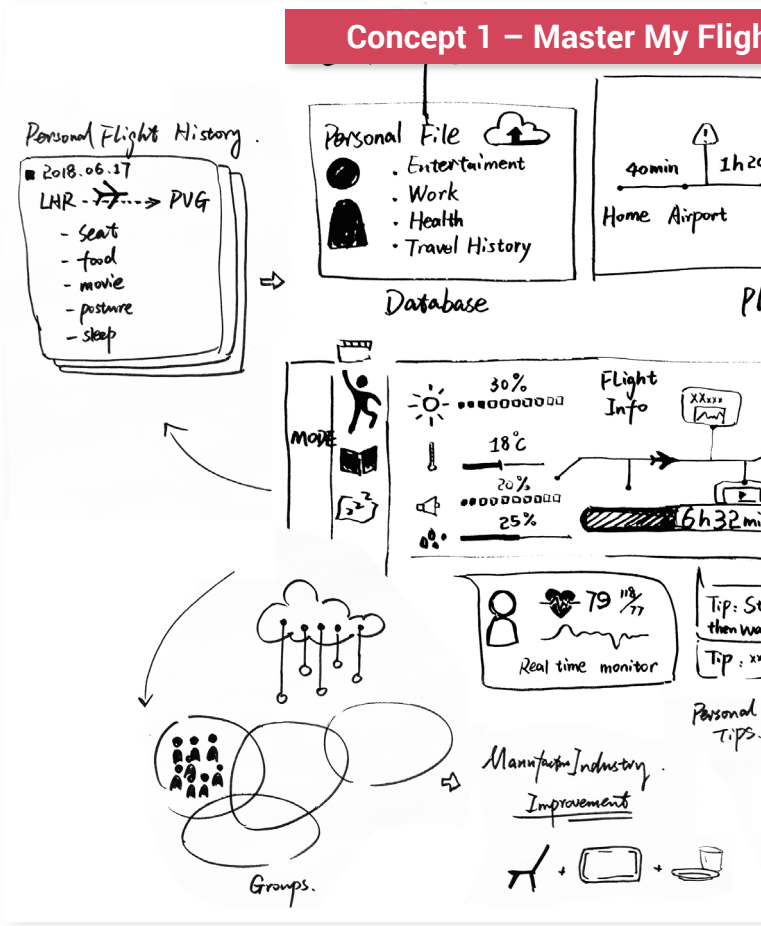


Figure 40. Sketch of Concept 1 - Master My Flight

Concept 2 - Perfect Match

Matching before boarding is the primary idea of Perfect Match (see Figure 41), which provides an optimised seating arrangement. After analysing the personal information, like mood, habit, flight purpose, passengers would get a better matched seat with their neighbour.

The main purpose is *reducing the conflict of interaction with neighbours* during the flight. Passengers who share the similarities might get support from each other and have better communication, so they would feel the belongings and safety. These all contribute to a relaxing atmosphere for passengers to perform a good in-flight sleep.

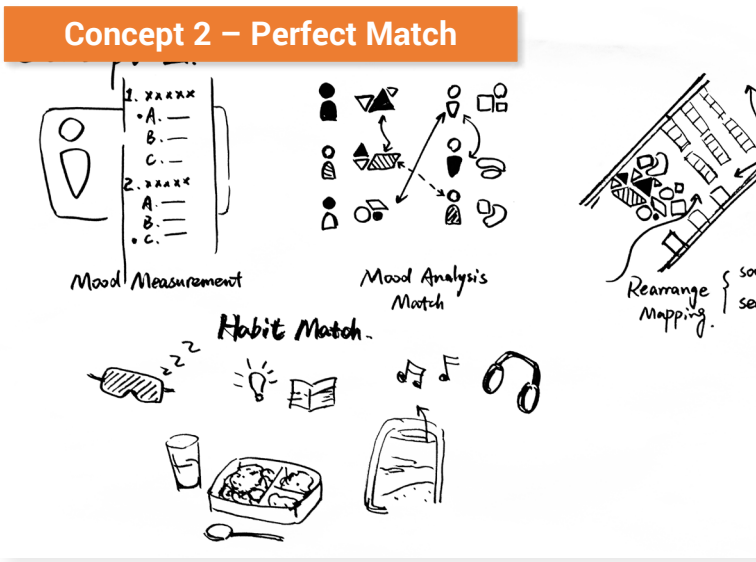
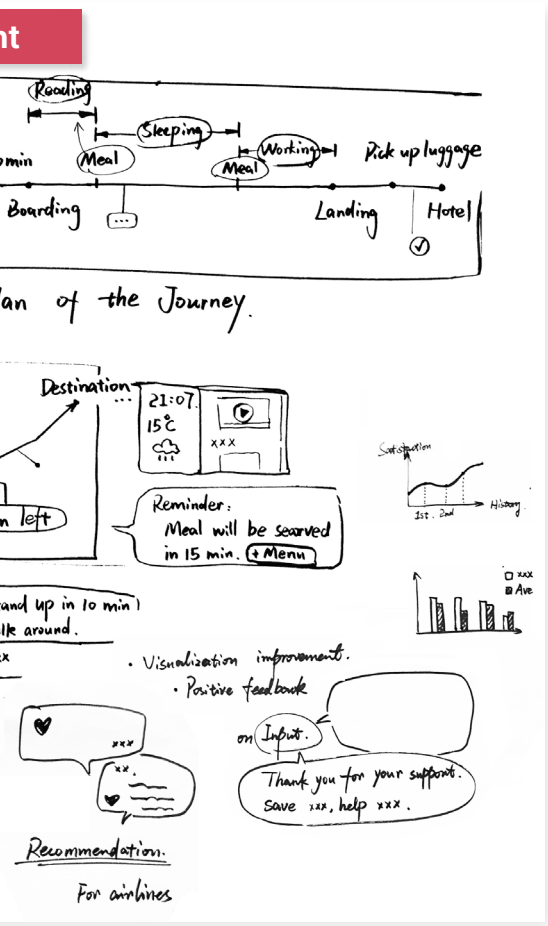


Figure 41. Sketch of Concept 2 - Perfect Match



Concept 3 - Shared Adventure

Taking the flight as ***an interesting adventure with all passengers*** is the main idea of this concept (see Figure 42), which provides a gamified cabin environment. All passengers are in one community with individual role, unique characteristics, and share the same goal.

For example, passengers would have the task to keep as quiet as possible during the cruise flight to hide from "the enemy". This enriches the long journey, making everyone have a ***feeling of responsibility, engagement and empathy***. Different from the other two concepts, gamification concept does not directly enhance the sleep experience, but giving those passengers ***more possibility to perform activities as a whole***.

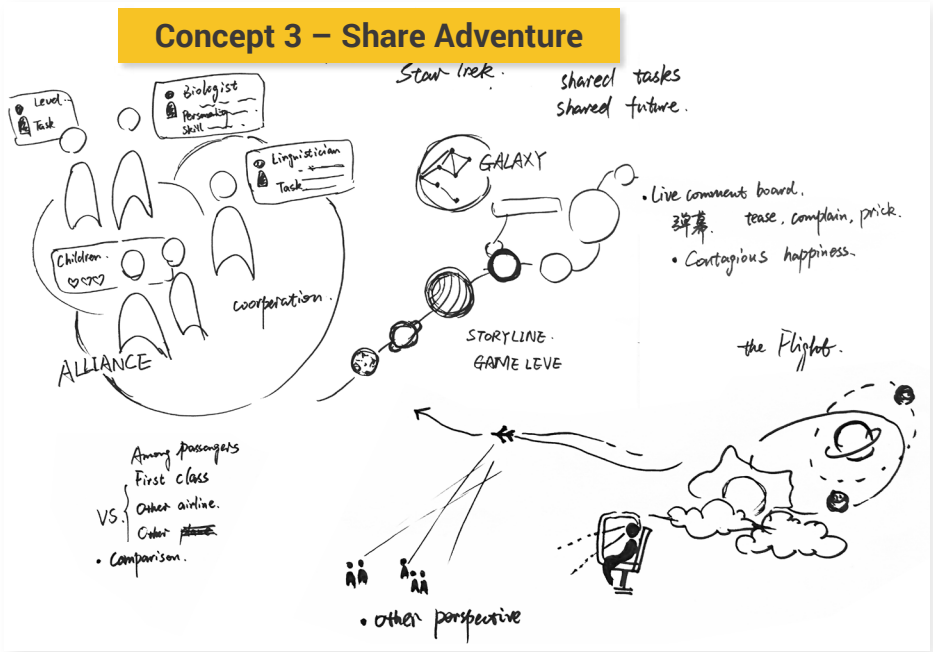


Figure 42. Sketch of Concept 3 - Shared Adventure

4.3 Concept Evaluation

Timeline-Based Evaluation

In this evaluation phase, a timeline-based evaluation map was drawn first for showing the intervention and impact of these three initial concepts (see Figure 43).

The map shows the evaluation result of how long and when the intervention would be, and how long the impact would last for. The concept 1 has the longest intervention and impact, which potentially creates the strongest feeling of being control. The concept 2 has the smallest intervention, which is set before boarding, but with relatively longer impact. The concept 3 has the shortest intervention and impact, mainly appearing during the cruise.

Although the quality of these intervention and impacts of these concepts are not shown in this map, it still suggests that the concept 1 fits the design goal "in control" the best.

Quality-Based Evaluation

After that, a qualitative method was used to do further evaluation. I used a 2 x 2 matrix to generate an evaluation overview of three concepts (see Figure 44).

Two axes are determined according to the in-cabin comfort models described in Section 2.2, and the requirements listed in Section 3.4. The two direction in one axis are not totally contradictory, like the basic requirement of feeling in control is not opposite with the higher requirement of awareness of happiness. Also, when check the requirement in section 4.5, most requirements are located in the red dashed circle. It is efficient to evaluate these initial concepts in the map.

The results indicate the concept 1 meets more basic requirements (feel in control) and is more suitable for individual passengers. The concept 3 meets more advanced requirements (aware of happiness) and the sharing quality means it would be more popular among group passengers. The concept 2 covers both two directions, suitable for diversed target users.

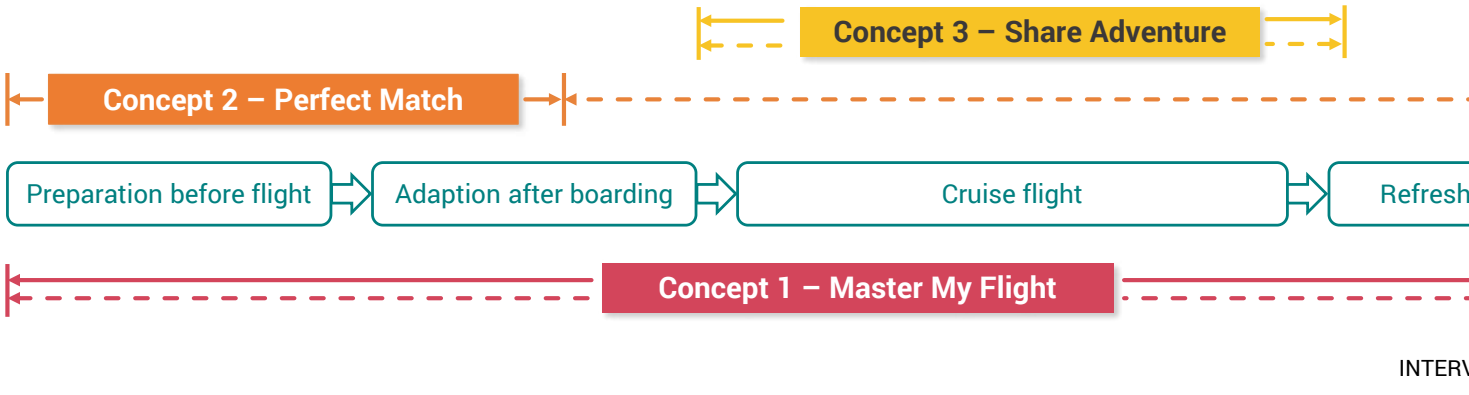


Figure 43. Intervention and impact timeline of the concepts during the passenger journey

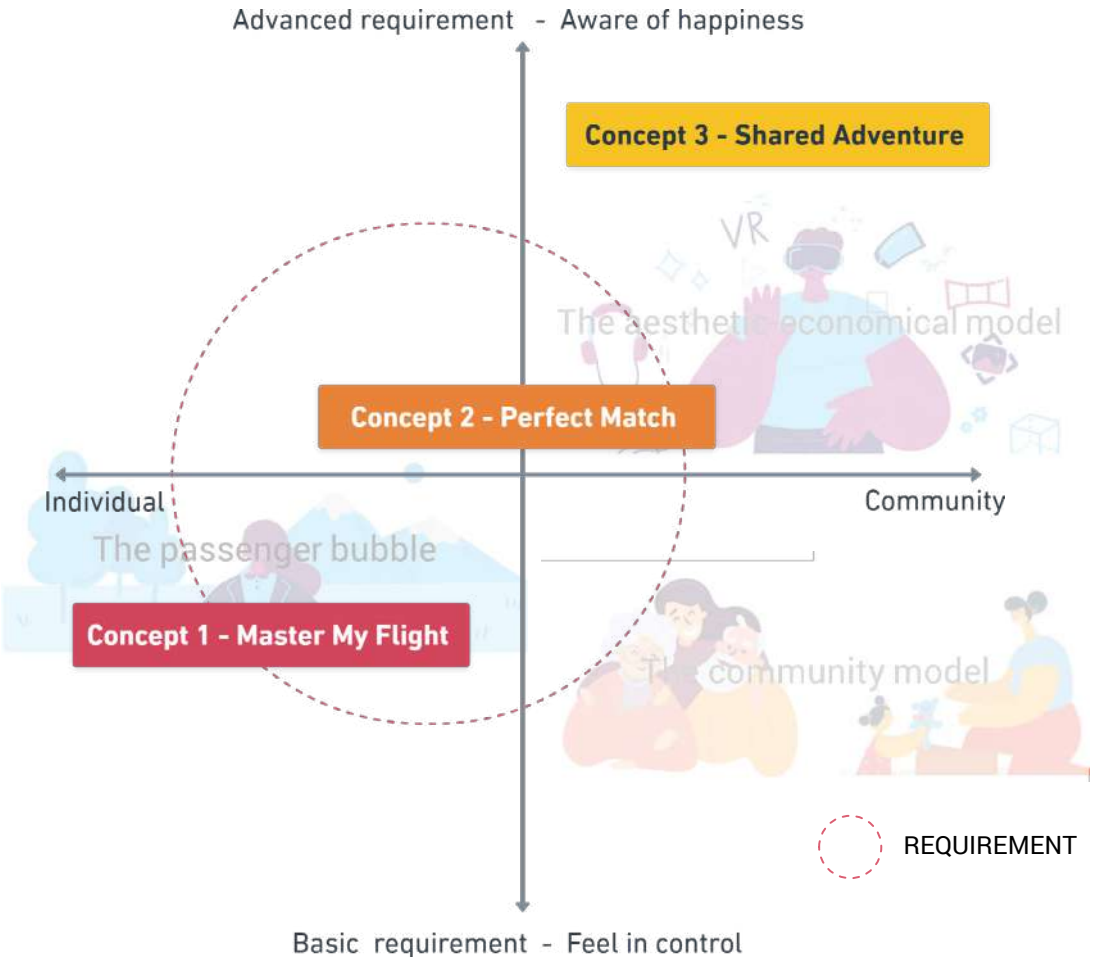
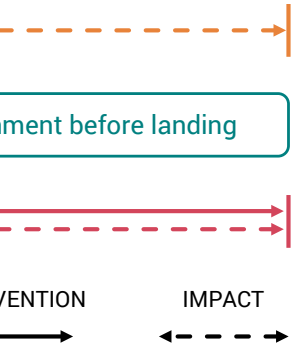


Figure 44. 2 x 2 Matrix evaluation map



Conclusion

As a result, the concept 1 was chosen to be the base of the final concept, because it covers different phases and meet most of the requirements. At the same time, the design highlight from the other two concepts will be integrated into the final concept, to make it attractive and more acceptable.

4.4 Concept Refinement

4.4.1 Overview Flow

In order to achieve most requirements and better comprehension, an overall flow path is developed. Since most passengers would shift the usage of equipment after taking off, the system is applied in both phone and IFE.

4.4.2 Highlights

There are some detailed design highlights that are corresponding to the design goal, from three aspects of interaction vision, security, flexibility, and serenity (see Figure 46).

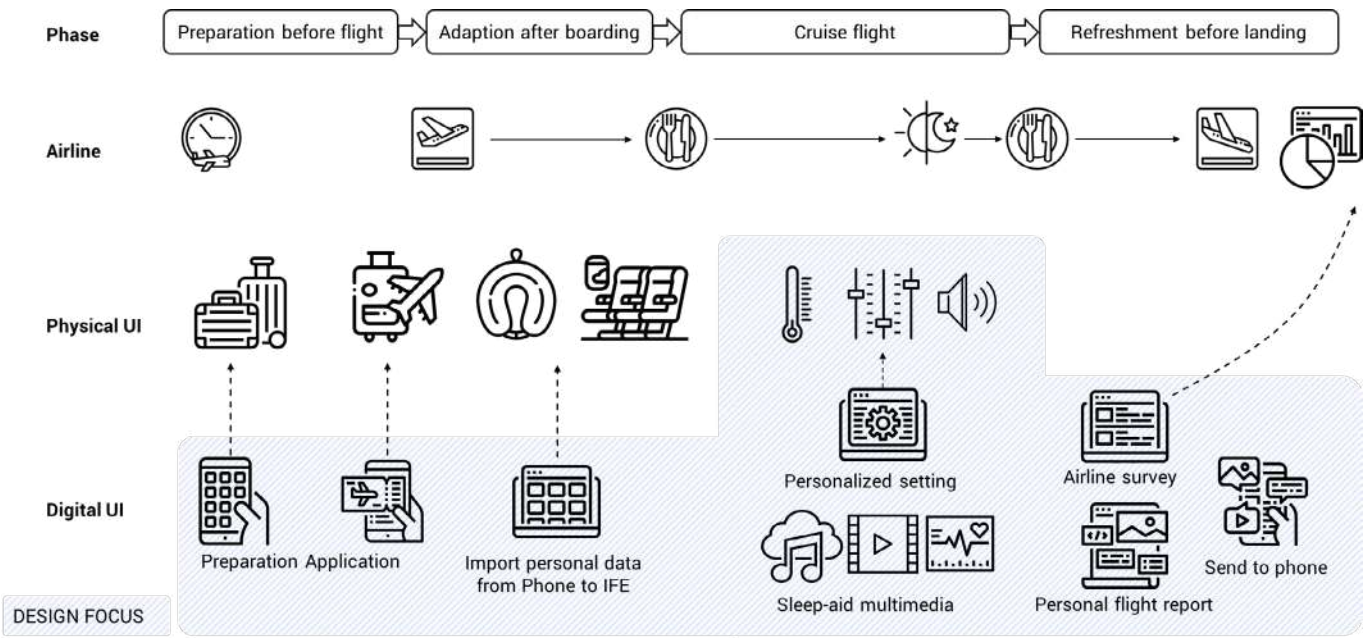


Figure 45. Overview flow of the refined concept with design focus on phone application and IFE

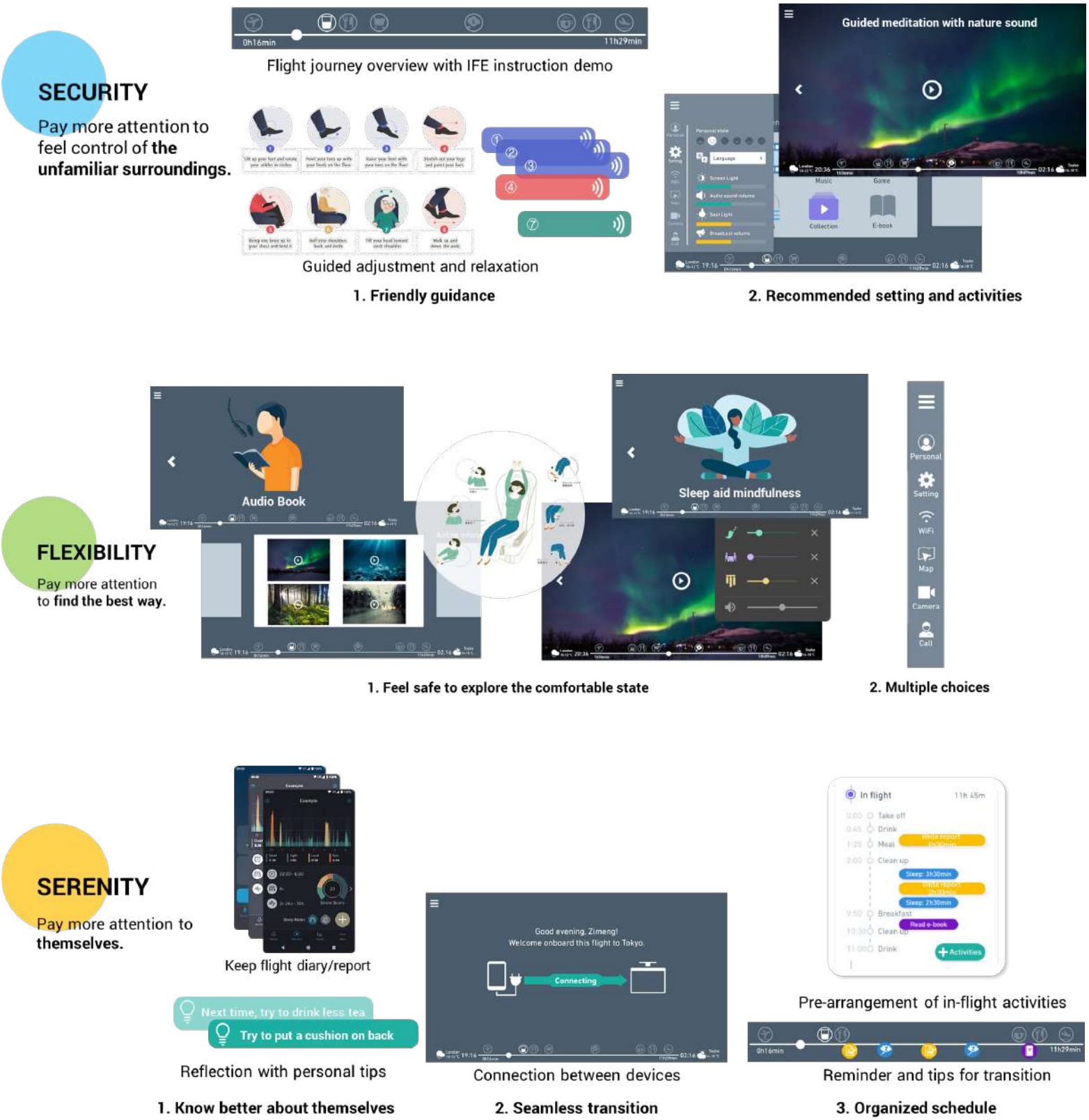
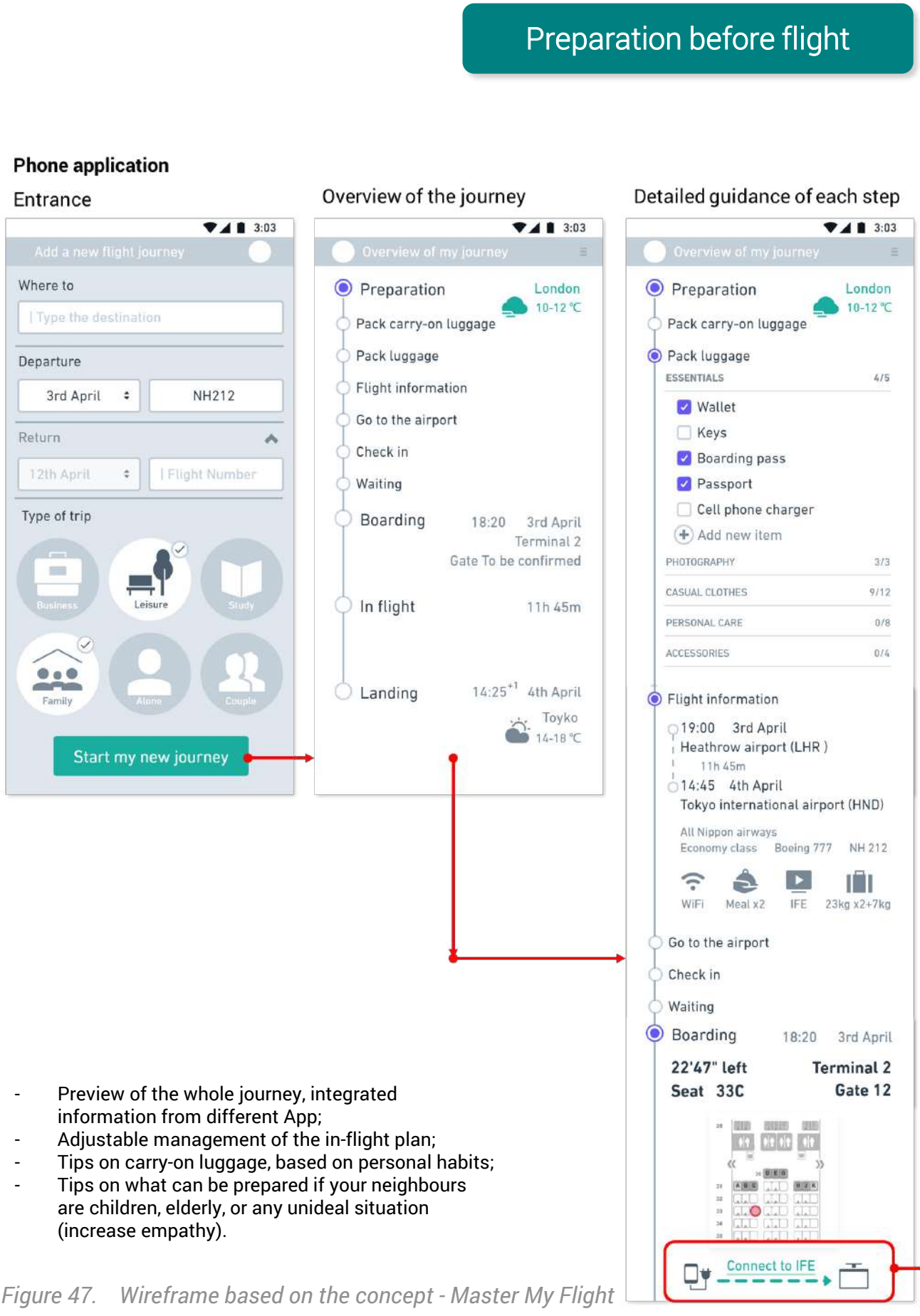


Figure 46. Highlighted functions corresponding to three qualities of design goal

4.4.3 Wireframe

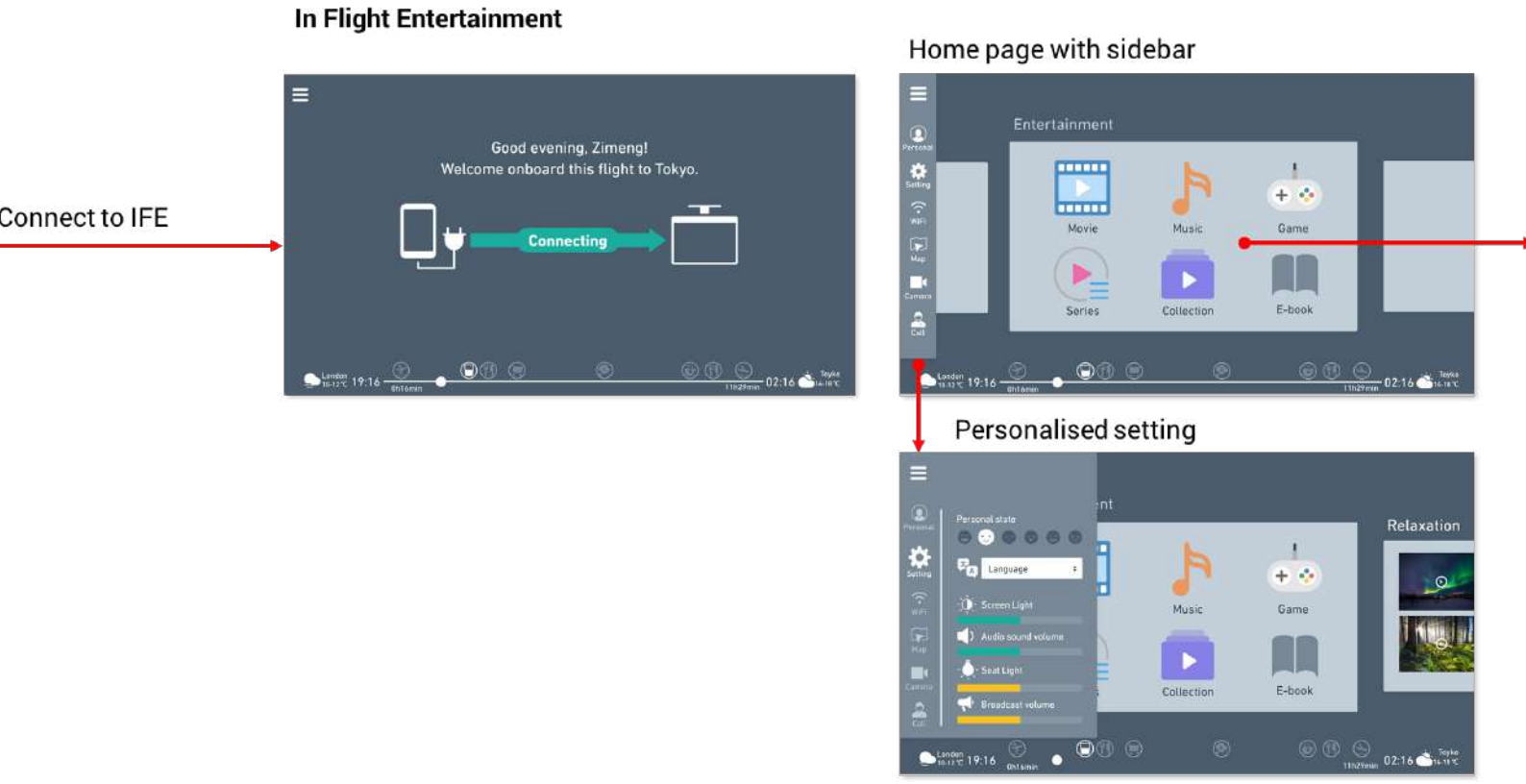


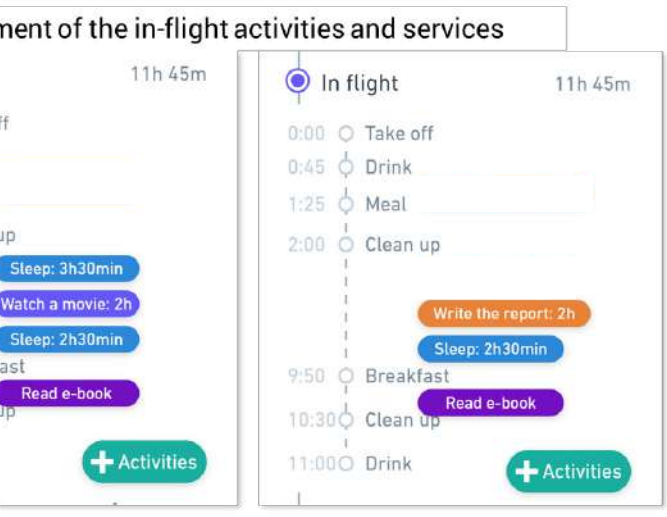
- Preview of the whole journey, integrated information from different App;
- Adjustable management of the in-flight plan;
- Tips on carry-on luggage, based on personal habits;
- Tips on what can be prepared if your neighbours are children, elderly, or any unideal situation (increase empathy).

Figure 47. Wireframe based on the concept - Master My Flight

Conceptu

Adaption after boarding

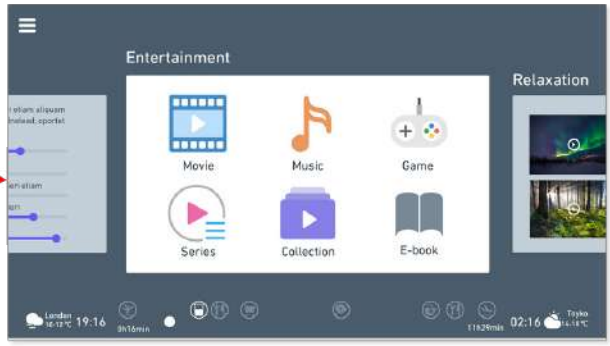




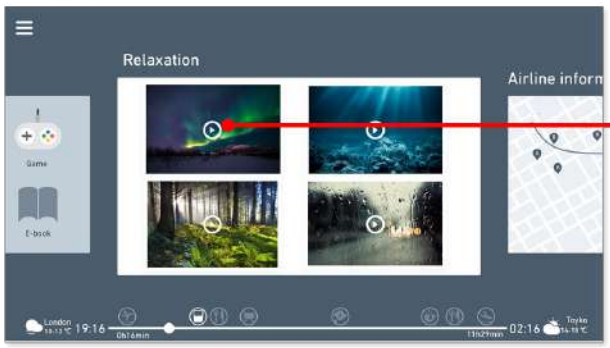
- Import preview of journey from phone to IFE;
- Real-time updated flight information;
- Real-time updated passengers information (personal data, how many passengers have onboard);
- Adjustable climate (lighting, sound, personal state);
- Relaxation mode options for deep sleep, small nap, focus (guided meditation, music, image, video, nature sound).

Cruise flight

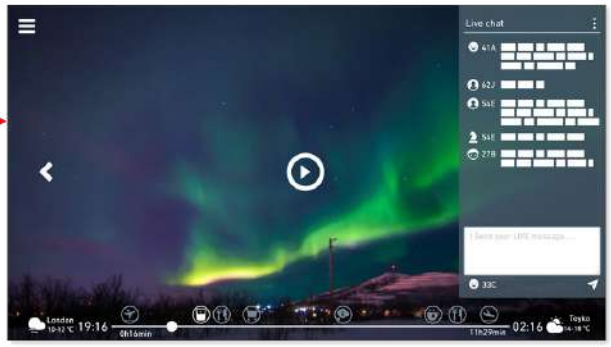
Entertainment



Relaxation



Live video with soft music



Flight map

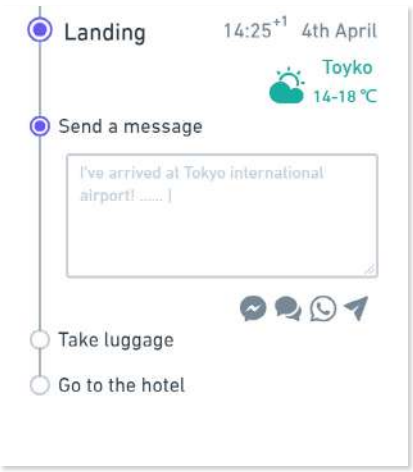
Updated flight information

- Mood board to show the real status of passengers (show to the others, on physical folded board, or holographic projection, breathing light, etc.);
- Live chat board for interaction with crew, neighbours;
- Real-time updated flying map;
- Real-time updated passengers information (personal data, how many passengers are awake, how many are asleep);
- Tips for anxiety, frustration(stretch arms and legs, meditation, food and drink);

Refreshment before landing

Feedback to airline

Personal flight report



- Leave feedback on the flight for airlines;
- Keep diary for themselves;
- Show appreciation to others (crew, neighbours).

4.4.4 Cognitive Walkthrough

Method

Cognitive walkthrough is an evaluation technique for design of a user interface, with attention on how user exploratory learning the interface. This theory-based method has been proven useful in designing applications and webs that support users' navigation and information search tasks (Blackmon, et al., 2002; Lewis, et al.,1990). The evaluators are often the peers and fellow team members who are guided by the designer to gather feedback and reach a consensus.

Gathering insights from the professionals is more valuable and efficient at this stage. Also, this is helpful for designer to avoid fundamental problems in the beginning.

Though this is an individual project, I used a simplified version of cognitive walkthrough to test the whole workflow with 3 students who also study Design for Interaction in Delft University of Technology.

Research Question

1. Is the system and the flow ***understandable, logic, easy to follow?***

2. Is there any page or button ***causing misunderstanding***, easily leading to fault?

Procedure

Participants were briefly introduced the background, including the target user, the design goal, the interaction vision, and the usage scenario.

Participants went through the whole process to experience the system without instruction.

Participants answered the research questions, evaluated the system and gave feedbacks.

Insight

1. Entrance is confusing, could show the main function as a ***brief introduction***;

2. The timeline is clear, but list is too long. Overloaded information would cause ***pressure***, conflicting with the interaction vision "feeling of control";

3. The connection of two systems is not strong enough, could link them in a loop, which might create more engagement and ***long-term impact***.

Improvement

1. The format of the timeline is transformed from long list to ***list to sub-pages***;

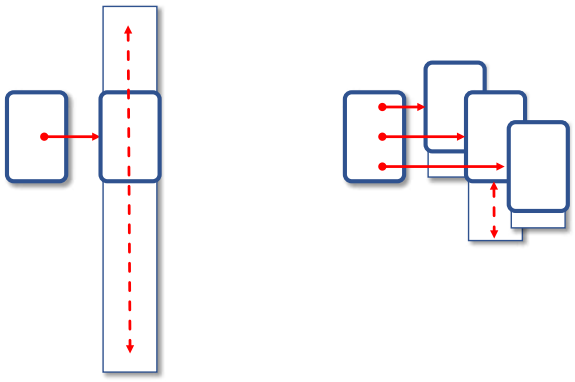


Figure 48. Transformated timeline from long list to sub-pages

2. The connection between these two systems is strengthened by adding the function of files transferring, including in-flight schedule and personal flight report (see Figure 48).

Figure 49. Strengthened connection between two systems by transferring personal schedule and reports

4.5 Conclusion

The goal of the conceptualisation phase is to come up with different concepts, evaluate them and explore different interactions and select the one that had the highest usability and satisfied most requirements. The main insight from this phase is that all three concepts have strengths and weaknesses. During the evaluation, it is found that most requirements could be achieved by Concept 1- Master My Flight, which also has a comprehensive impact throughout the whole passenger journey. Additionally, Concept 1 has the highest feasibility and more practical to build an interactive prototype for the following verification and evaluation.

Therefore, an integrated refinement based on that was used as a starting point for the following steps. A low-fidelity wireframe was made to test the basic flow by walkthrough, and the main insight is to simplified each step and connect two parts in one system for better engagement of passengers. These provide a solid foundation for the next verification phase.

05 Verification

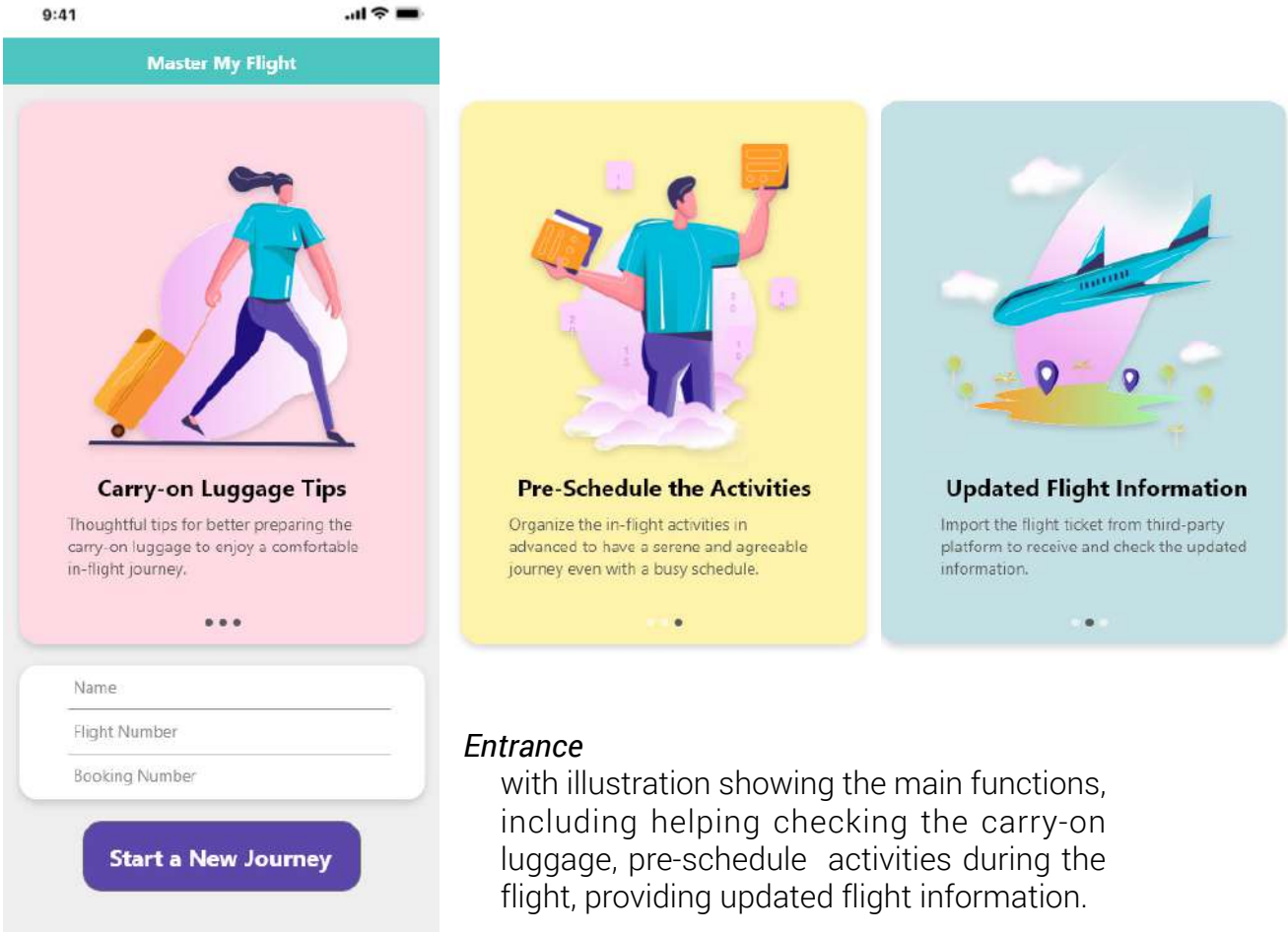
Introduction

This chapter gives an overview of all the steps taken from the refined concept until it was improved and fully defined. It also shows how the high-fidelity prototype is tested and evaluated. The results from the user tests are also presented in this chapter, and used later to come up with recommendation for the future improvement.

5.1 Final Prototype

As shown in the previous chapter, the design consists of two parts, phone application and in-flight entertainment system. The user interface (UI) of final prototype was developed in Adobe XD based on the wireframe. In this section, the main UI pages are shown with short explanation (see Figure 50&52).

And the interactive animation and pages transition was made in ProtoPie with accessible links and QR code (see Figure 51&53). Although not fully functional, like the data transferring function, the prototype were used for the evaluation tests (see Chapter 5.2).



Entrance

with illustration showing the main functions, including helping checking the carry-on luggage, pre-schedule activities during the flight, providing updated flight information.

Figure 50. Final prototype UI of Master My Flight in phone application

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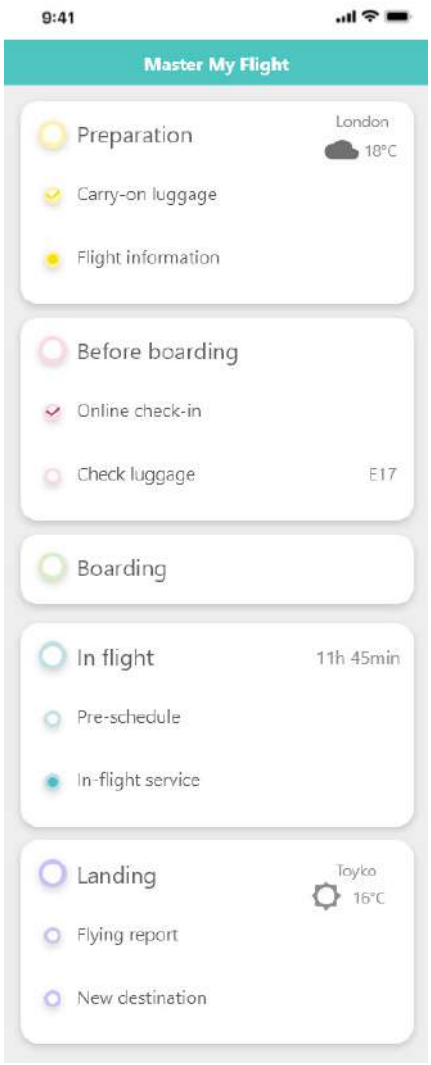
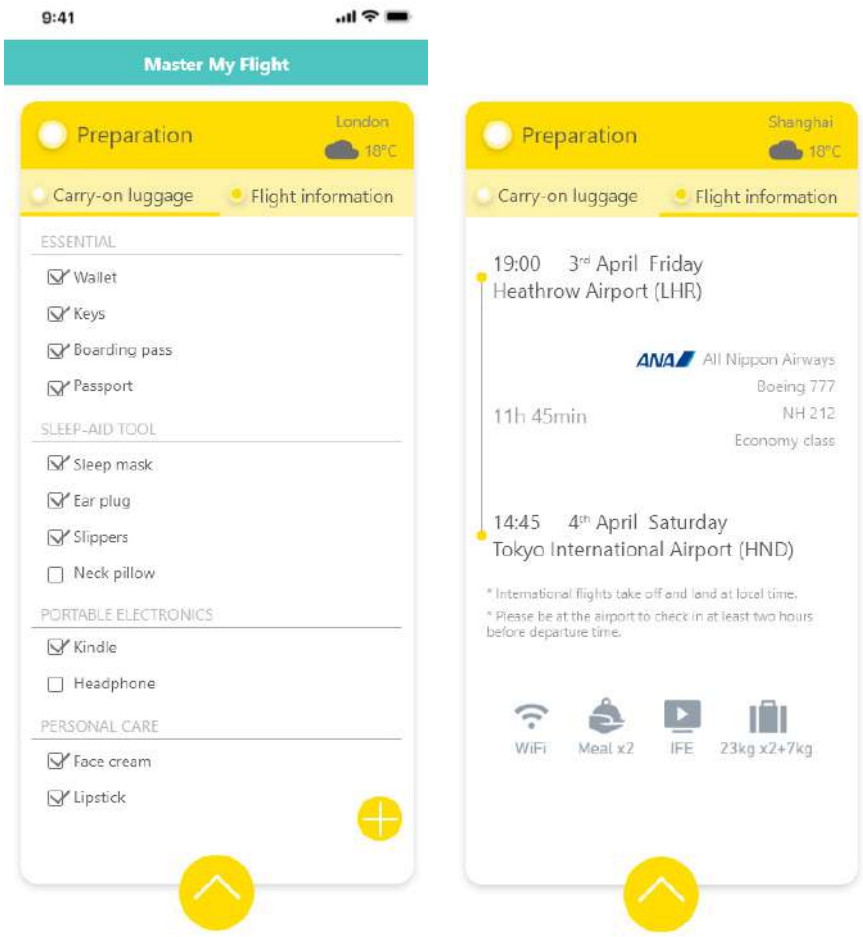
Figure 51. QuickMark code of the final interactive prototype (phone application)

Verifi



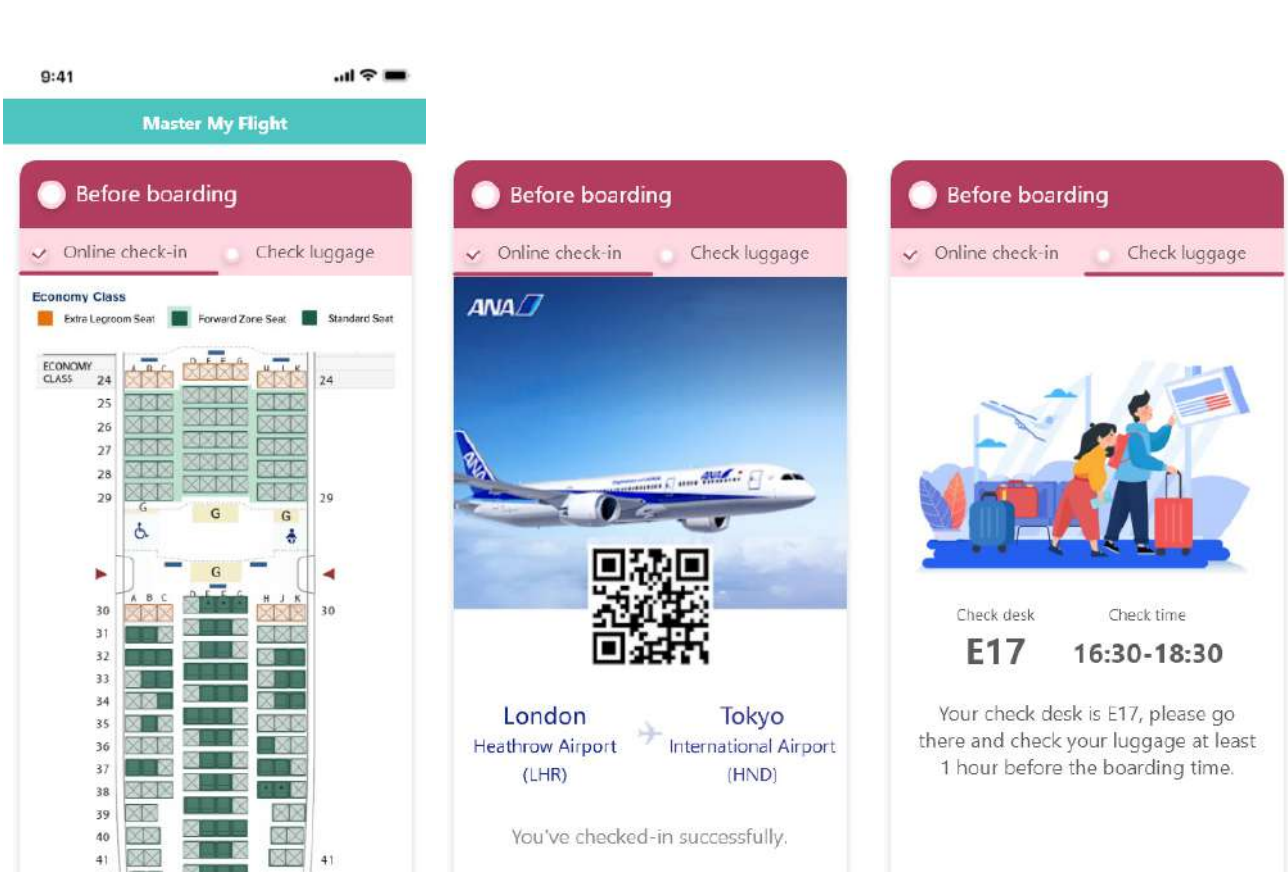
Overview of journey

showing different phases, with reminder of the tasks, updated information.



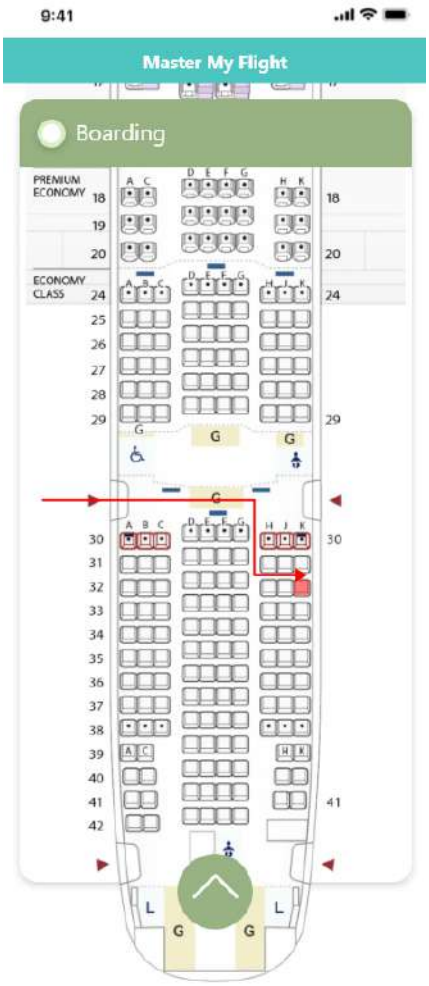
Preparation phase

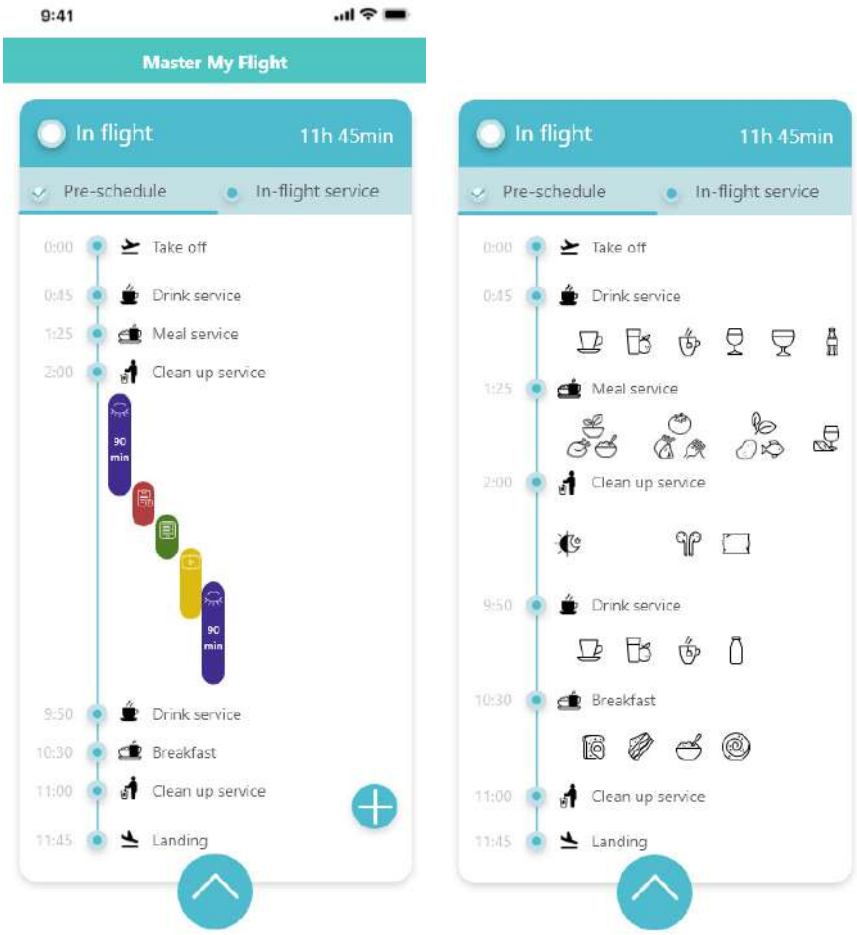
providing a check list of curry-on luggage, including sleep-aid tool; providing basic flight information and special rules of airline.



Before boarding phase

providing a seat booking service, with leg room information;
providing online checking service with QR code for boarding;
providing updated information of luggage check-in.



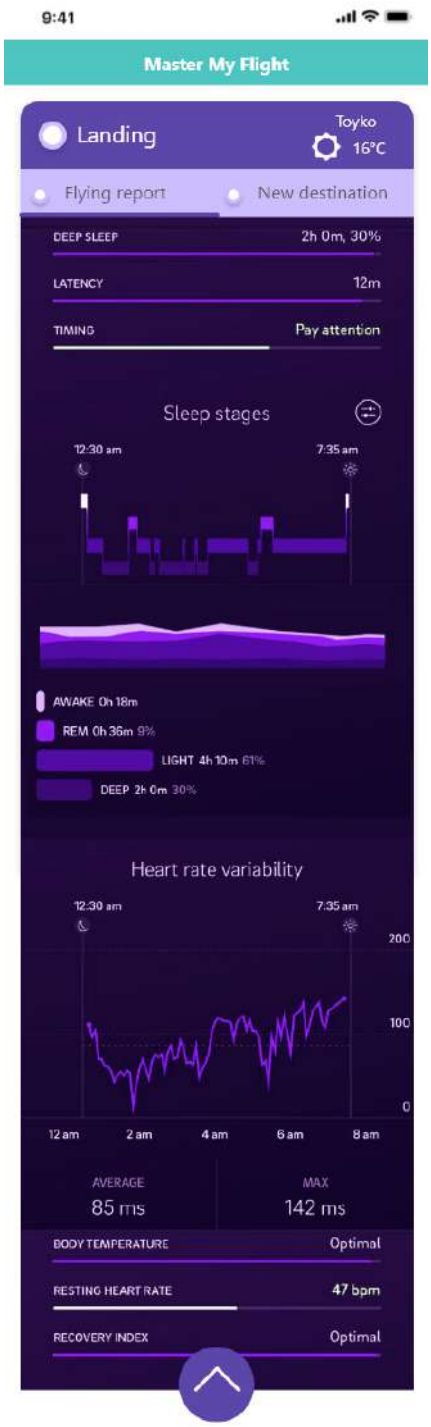


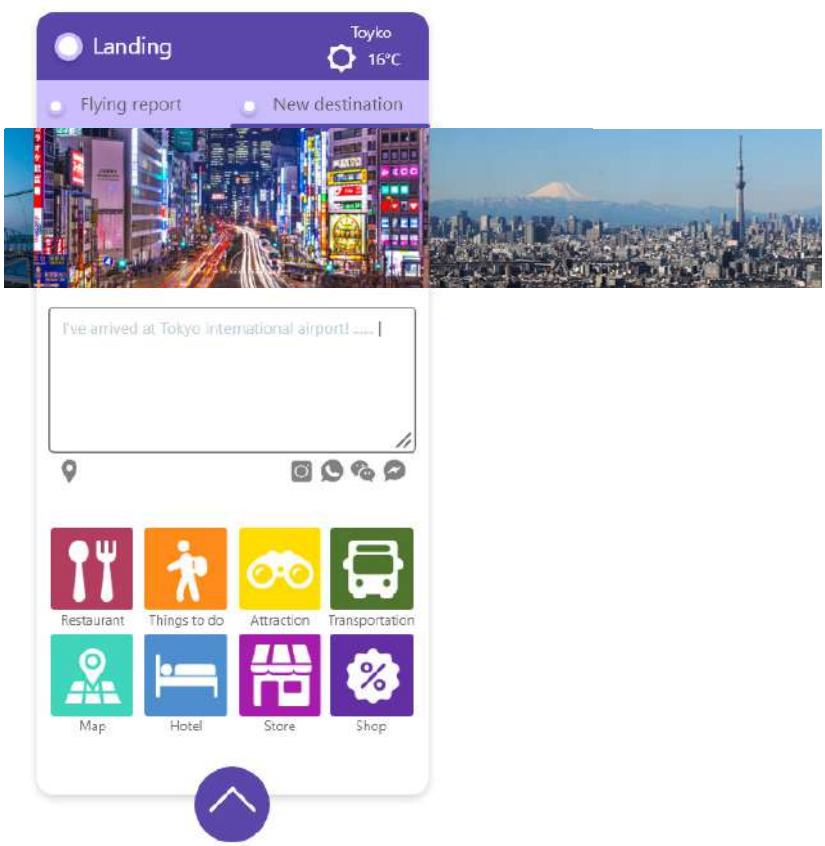
Boarding phase

providing a cabin map and the boarding route.

Inflight phase

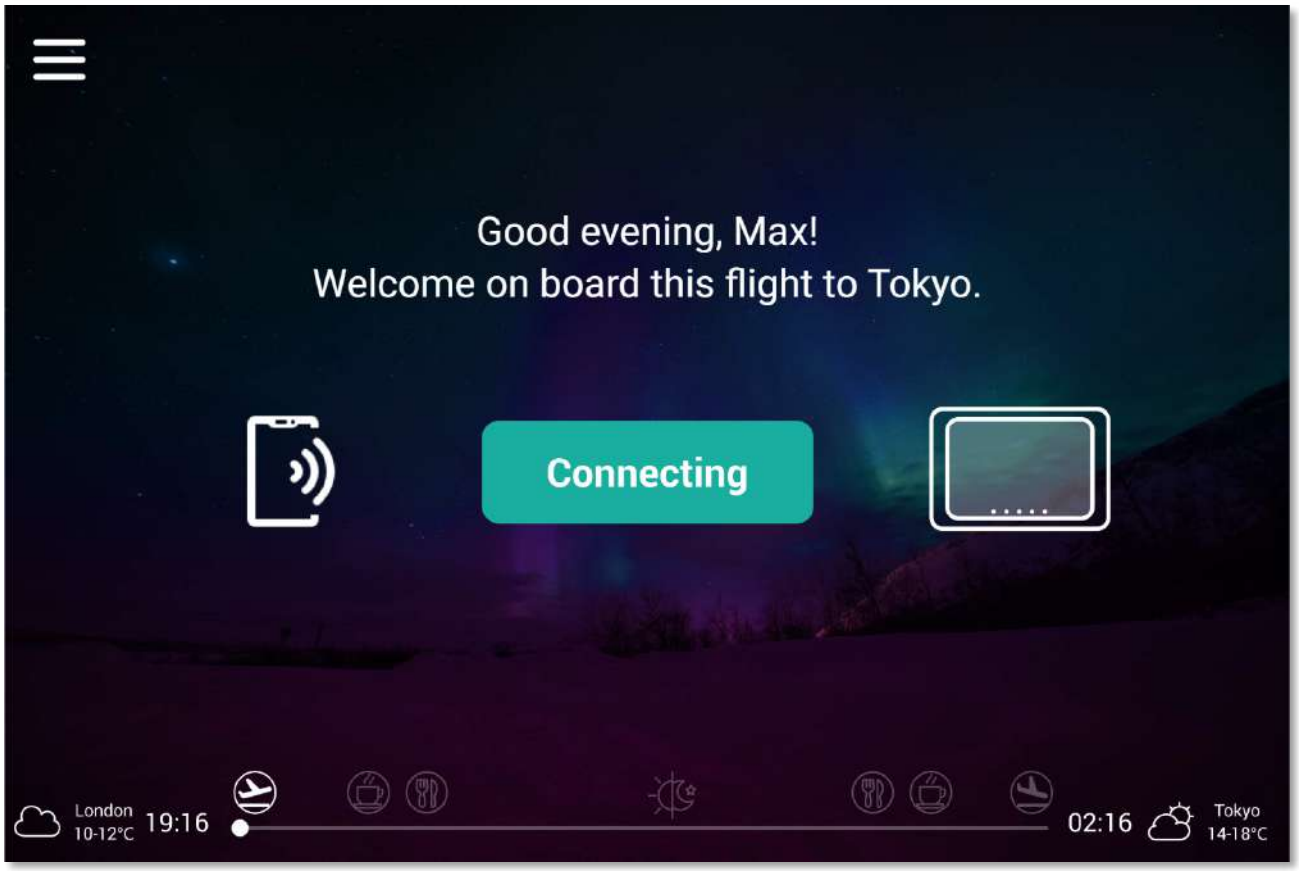
providing pre-schedule function for better arranging the in-flight activities; providing overview of the in-flight services and timeline provided by airlines.





After landing phase

providing the personal health report during the flight from the IFE; providing integrated social platform for sending massage and sharing the location;providing information of destination from other third-party platforms.



Entrance and dynamic timeline
providing the connection option between phone and IFE; providing the timeline with the in-flight services, local time in both time zones, and the updated weather condition.

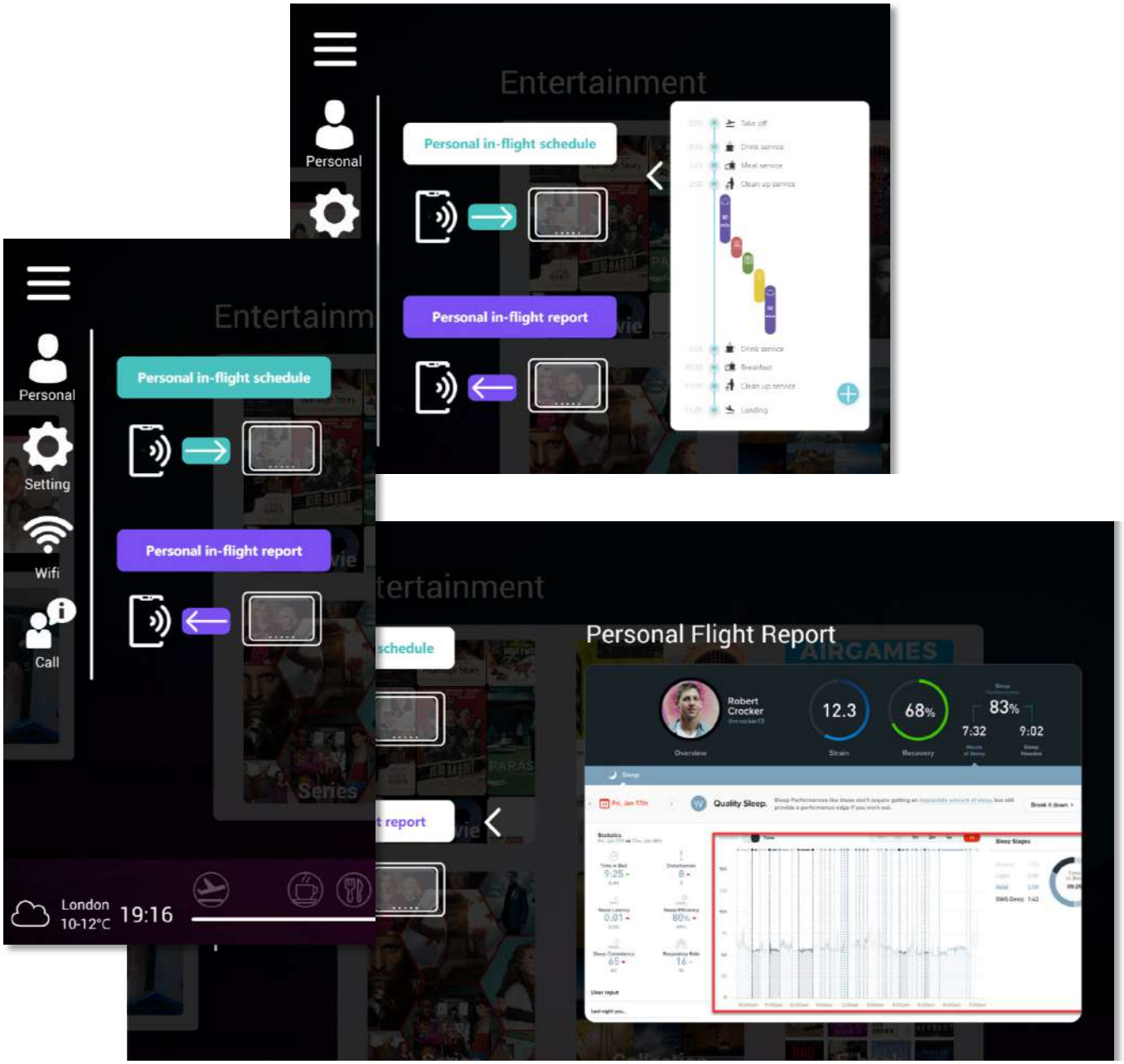
Figure 52. Final prototype UI of Master My Flight in IFE

EN 中文

Figure 53. QuickMark code of the final interactive prototype (IFE)

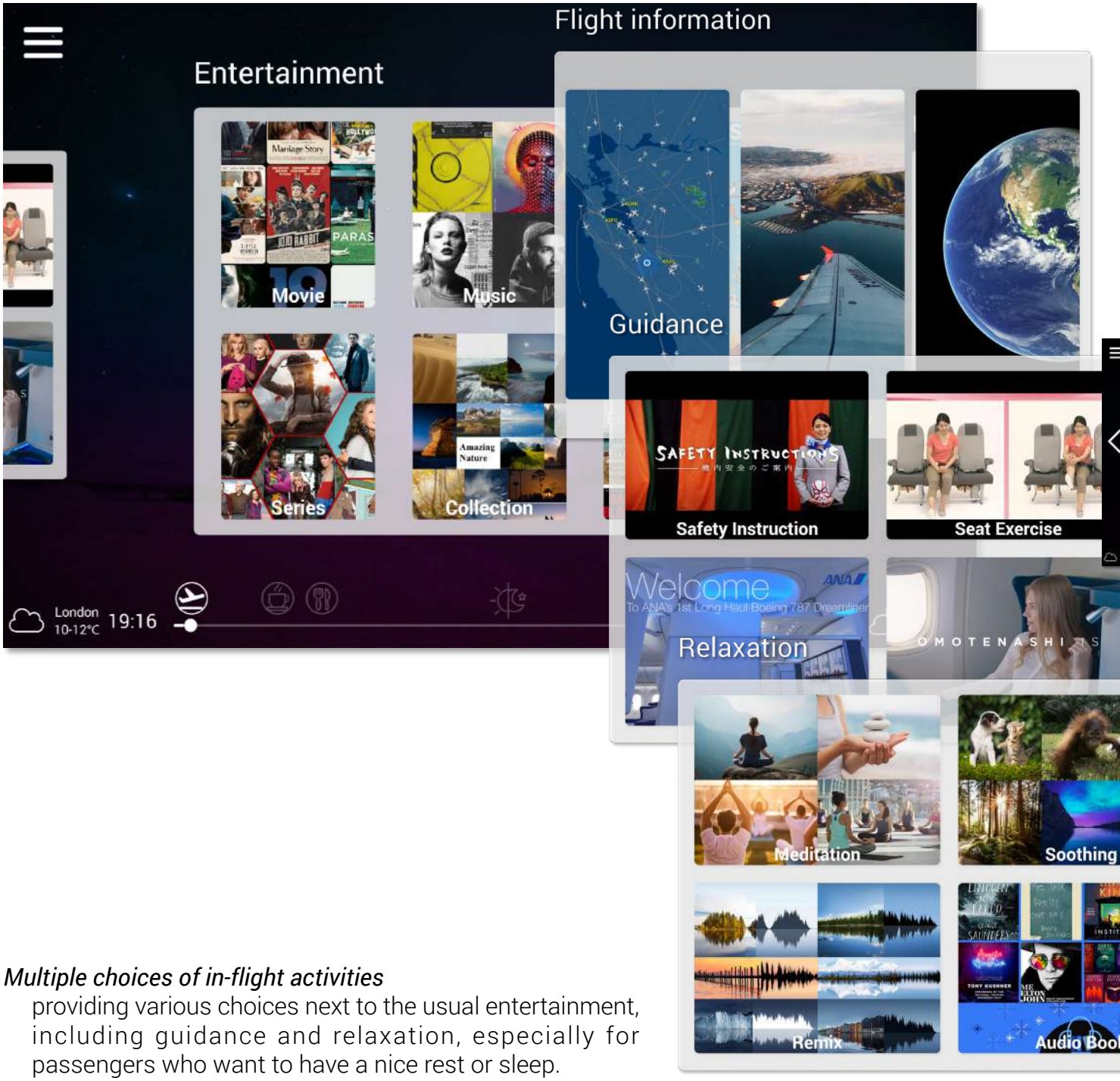
Personalised setting sidebar

providing different modes of setting profiles with recommended setting of screen light, reading light, IFE system sound volume and broadcast sound volume.

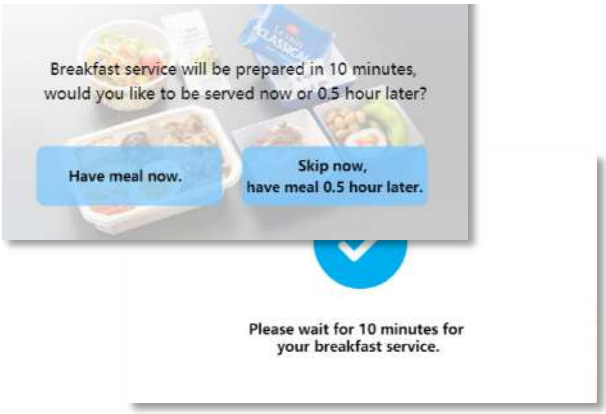


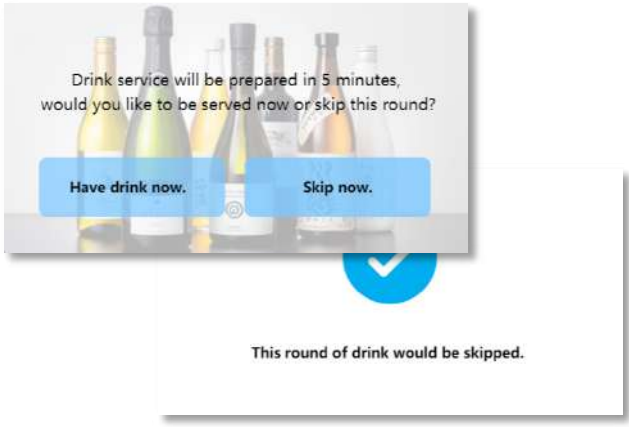
Personal file transfer

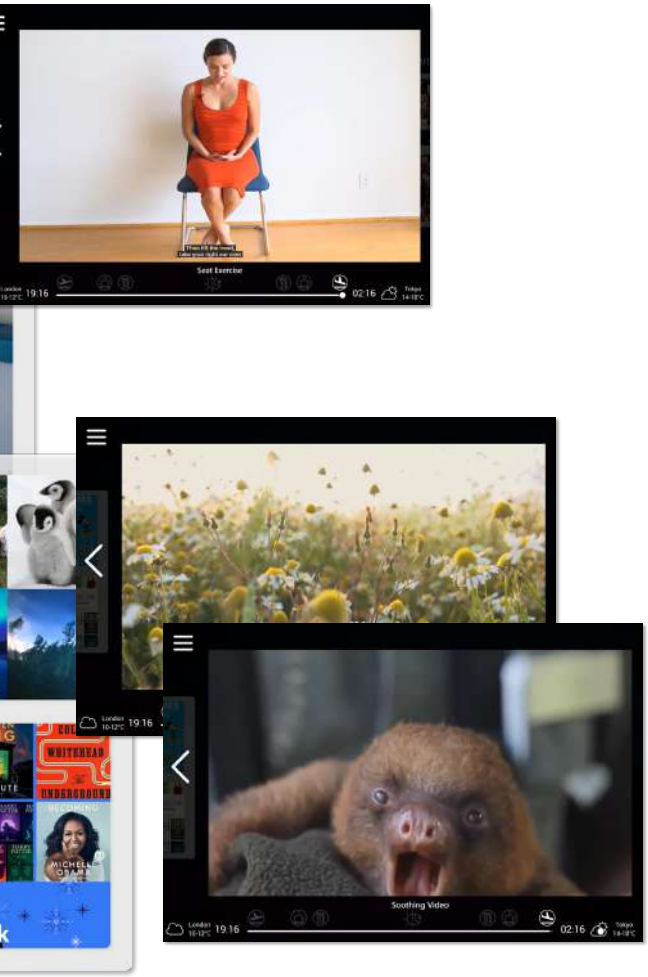
providing checking and transferring fuction of personal data, including importing schedule and exporting flight report to phone.



Multiple choices of in-flight activities
providing various choices next to the usual entertainment, including guidance and relaxation, especially for passengers who want to have a nice rest or sleep.







Flexible choices with pop-up reminder
providing relatively flexible service time; providing reminder of seat exercises after sitting for a long time.

5.2 Evaluation Test

This section introduces the evaluation process, the obtained results. Last, limitations and recommendation are also given in the discussion.

After building the interactive high-fidelity prototype, the evaluation test was held with 10 participants individually. Due to the restriction of the social environment, 7 participants took part in the online tests, other 3 participated offline.

The research goals of the test are:

1. To assess how well the final design could meet the design goal "to make passenger feel more in control";
2. To evaluate the usability of the final design for different types of users when performing common tasks;
3. To evaluate the qualities of the final design by scoring users experience on "security, flexibility, serenity";
4. To identify user's obstacles on completing the tasks;
5. To determine the design guidelines for improving the design in the next step.

5.2.1 Test Set-up

Due to the restriction of the social environment, seven participants took part in the online tests, other three participated offline. Each round lasted for approximate one hour. Because the final design consists of two system, phone application and IFE system, the tests were divided into two parts. After going through all tasks, participants were asked to fill the evaluation forms for two systems separately.

Participant

Ten participants were recruited for the tests, and one tester participated the pilot test. They have different backgrounds, and their experiences of taking LHF are various (see Figure 54).

They went through the same test procedure, and filled the same evaluation forms, but they were given different scenario settings, based on their previous relevant experiences. This made it easier for them to put themselves in the real situation.

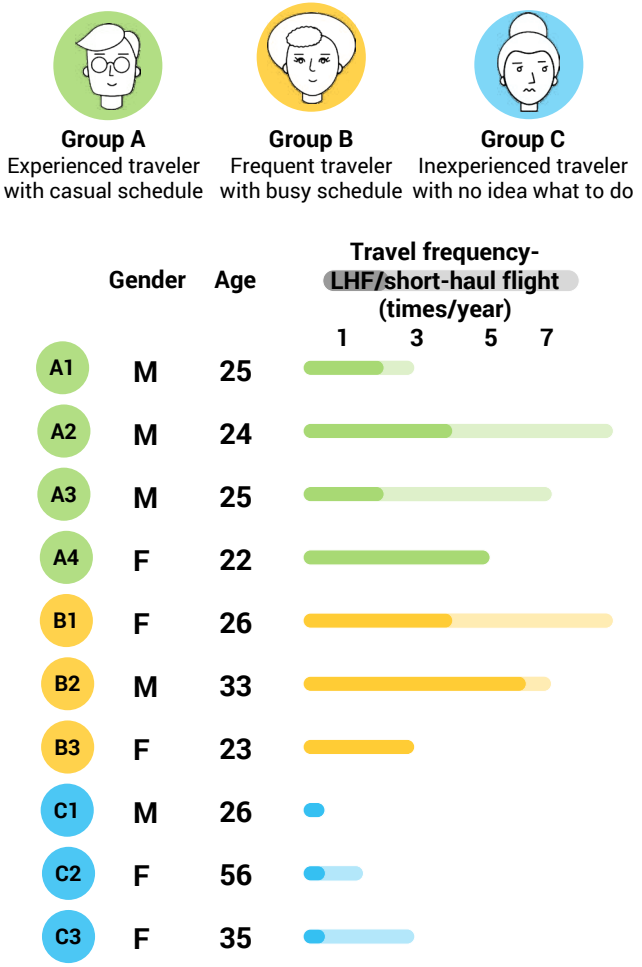


Figure 54. Participants groups

Material

Two sets of evaluation forms were designed for phone application and IFE system, powered by Microsoft Forms.

The System Usability Scale (SUS) (Brooke, 1996) was used to evaluate the learnability and usability. AttrakDiff scale consists of several pairs of description words, measuring different qualities about the design. Additionally, the user experience were evaluated by comparing with the previous experiences without using the system.

As the questionnaire prepared for the test used a seven-point Likert scale, the scores transferred to centesimal scale or ten-scale for final score calculating.

Due to the different background of participants, the tests were conducted in both English and Mandarin. All test materials (see Appendix D), including script, evaluation form, task list are bilingual, for minimum error deviation caused by semantic misunderstanding.

Procedure

1. Welcome and brief introduce the test;
2. Interview participants about their relevant flying experiences;
3. Give the task list and the basic scenario to participant;
4. Participant starts experiencing the phone application and trying to perform the tasks, meanwhile thinking out loud;
5. Observe and record participant's action and thoughts, providing guidance when necessary;
6. Short interview about the overall experience;
7. Help participant finish the usability evaluation form and ask for reasons;
8. Repeat step 3 to 7 for testing the IFE system.

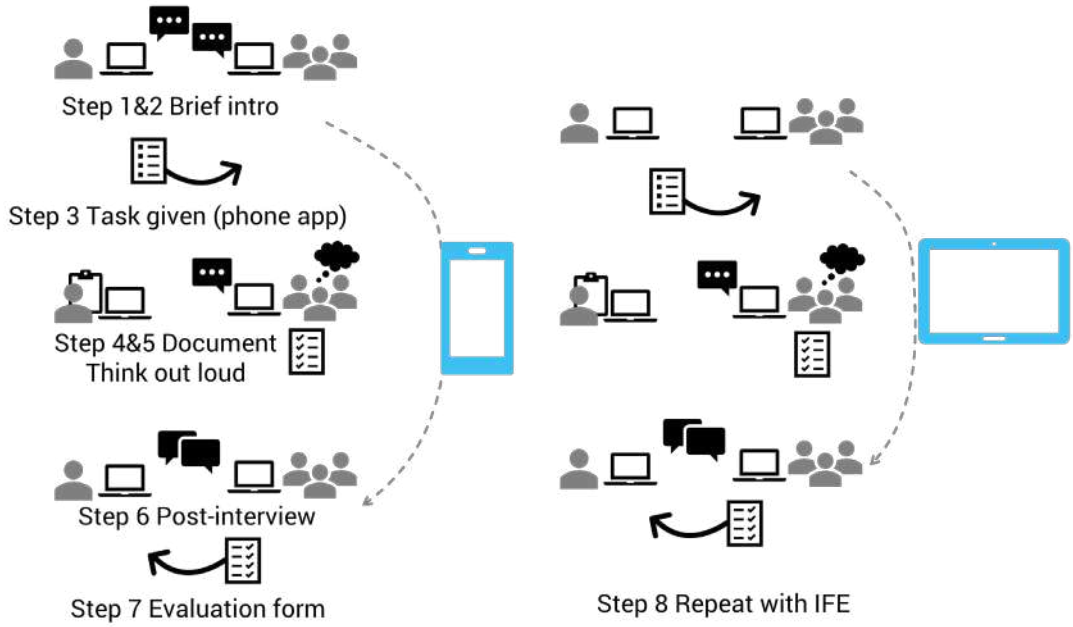


Figure 55. Test procedure

5.2.2 Evaluation Result

Through filling the post-test survey, the experience of using the system was scaled. The quantitative results of two parts from evaluation scales are explained and presented in diagrams separately.

Then the qualitative feedbacks including common obstacles, appreciated advantages, and insights are shown in the infographics. These feedbacks were concluded by analysing the transcripts, and served as the valuable guidance for the future design.

SUS Score

The five options of attitude towards the questions represents a certain score. The SUS score was calculated and transferred into centesimal system in Microsoft ExcelIfl. The phone application got a total score of 75.2, and IFE system got 79.4.

According to research of Bangor (2008), the score between 68 to 83 represents the usability is *'Acceptable'* and *'Good'* for users. Therefore, the both parts have high usability, which means easy to accept, learn and use.

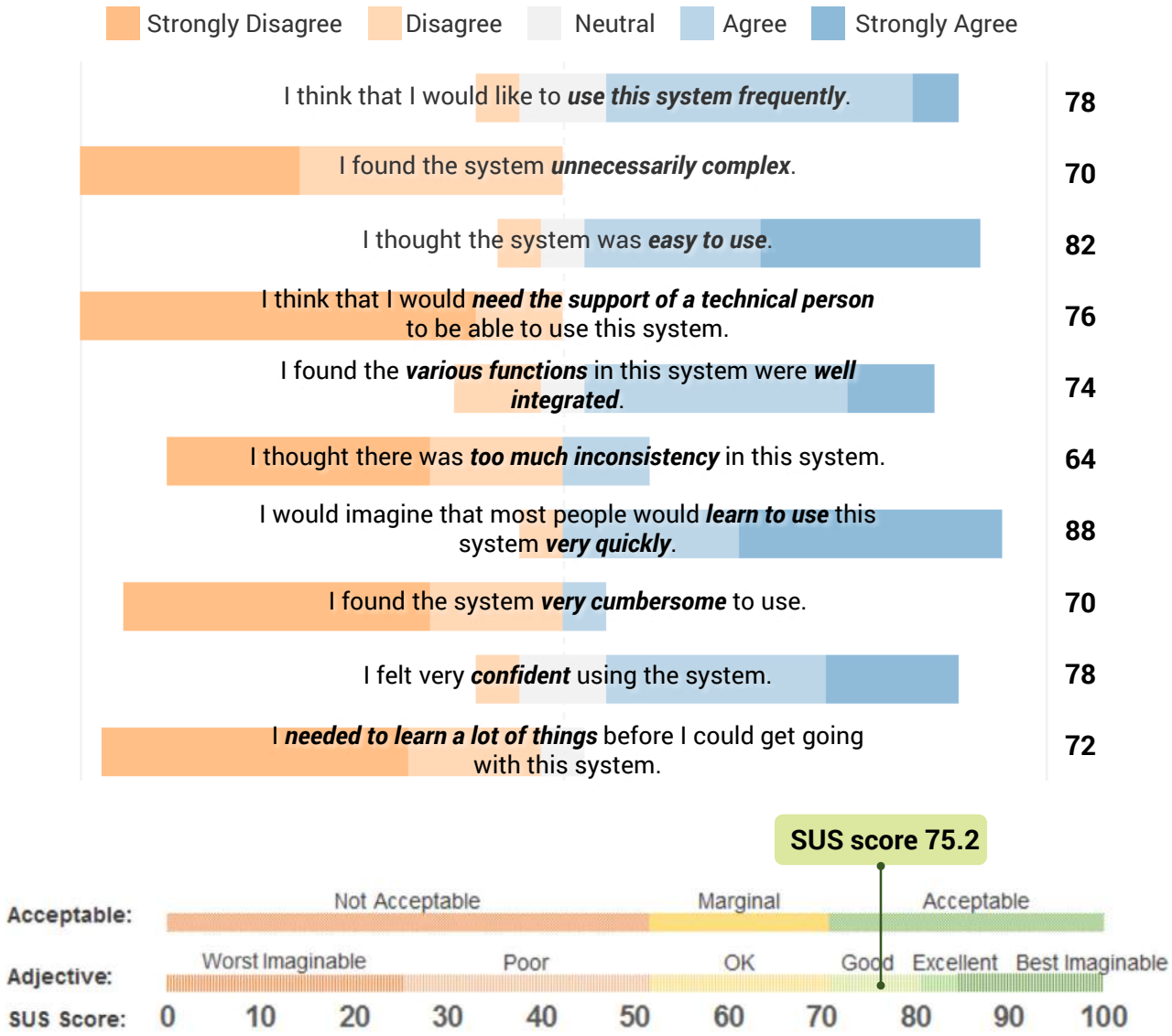


Figure 56. SUS score of phone application

When looking into the detailed questions, there are still some difference existed between attitudes towards these two systems. The results of phone application has higher dispersion level, especially on functional integration, and user confidence. This means there are big cognitive differences among different groups. The IFE system has slightly higher scores on several criteria, like it would be more frequently used, and with more confidence.

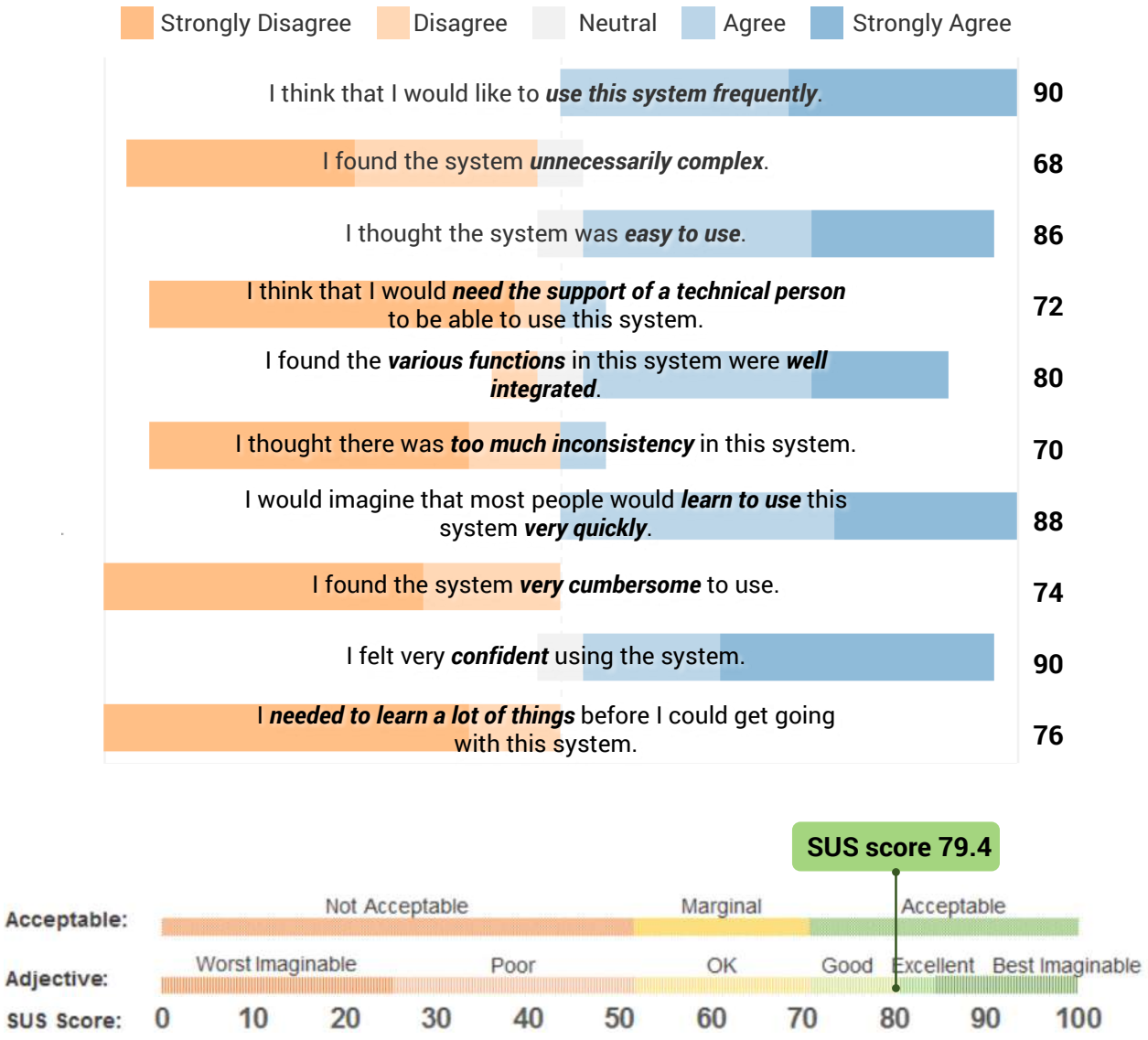


Figure 57. SUS score of IFE system

AttrakDiff Scale

AttrakDiff scale described by Hassenzahl (2003) as an effective tool, consisting of dozens of description word, measuring the quality of a system on different dimensions. Here, a few pairs of words were selected, making up a short version of AttrakDiff scale. It should be noted that these word pairs are not all extremely positive or negative, just represent the characteristics of the system.

As shown in Figure 58&59, the results are similar, like they are both clearly structured, practical, undemanding, and inviting, which also indicates the consistency of two systems.

The results also give a hint on what characteristics are particularly critical or particularly well-defined. For example, these systems are more individual-oriented, because there is not much quality of conncetion.

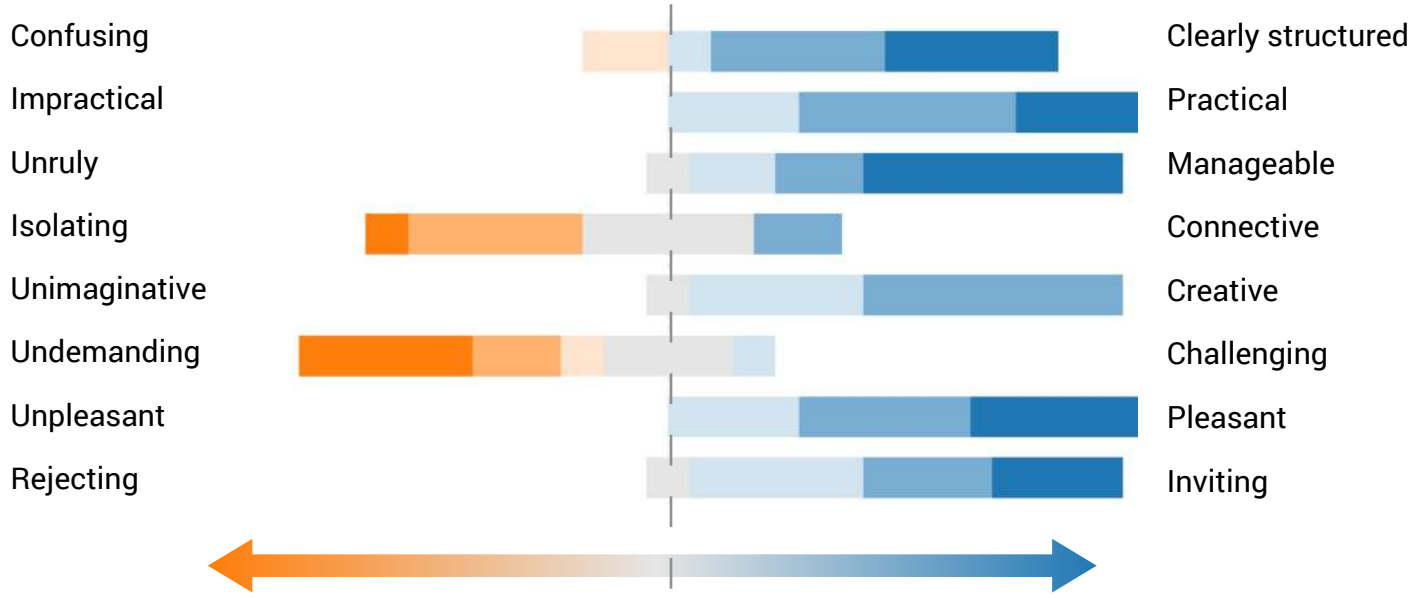


Figure 58. AttrackDiff Scale of phone application

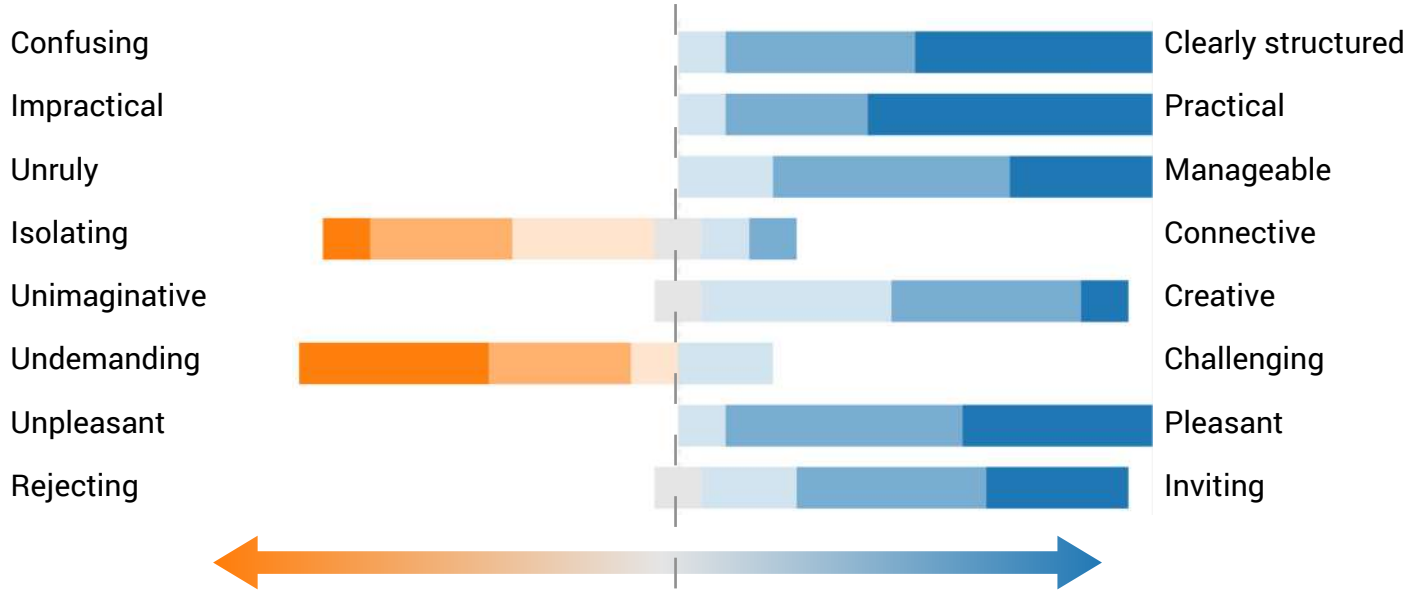


Figure 59. AttrackDiff Scale of IFE system

UX Quality Scale

In order to assess how well the final design could meet the design goal "to make passenger feel more in control", participants were also asked to score their experience on a few more questions.

"Compared with your previous experience or the experience of using other similar applications, ***do you feel more*** …… by using this application? "

UX quality scores of ***security, autonomy, flexibility, relaxation-promotion, preparation-aid, reflectiveness*** are shown in the Figure 60&61.

The scores were gathered with a seven-point Likert scale, then transferred to ten-point scale for final score calculating.

Scores were highest in helping to prepare on both systems, but relatively lower in autonomy on phone application, and lower in security in IFE system. The rest of the measured qualities got the similar scores and were quite appreciated by participants.

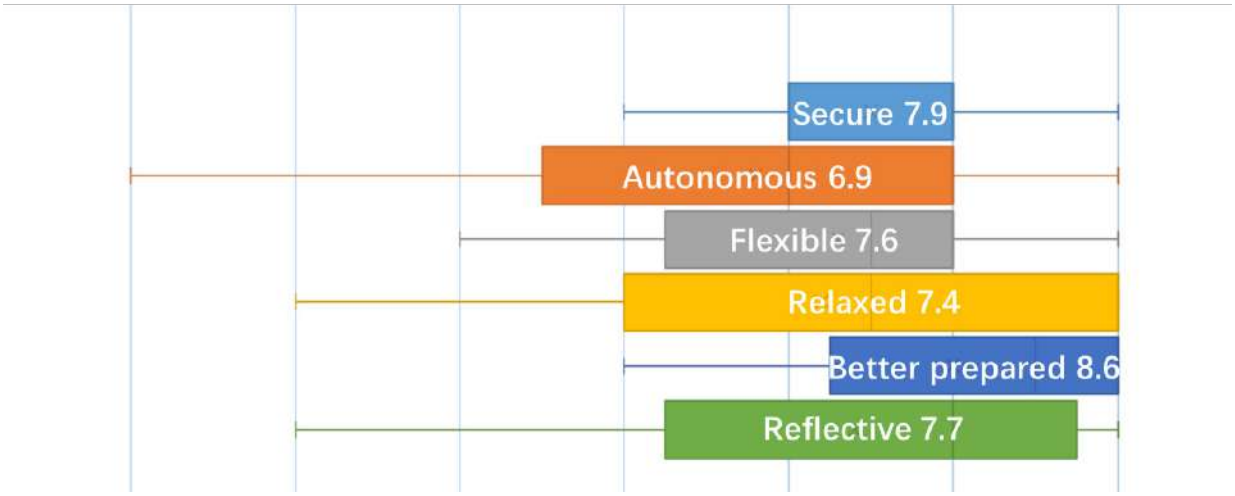


Figure 60. UX quality score of phone application

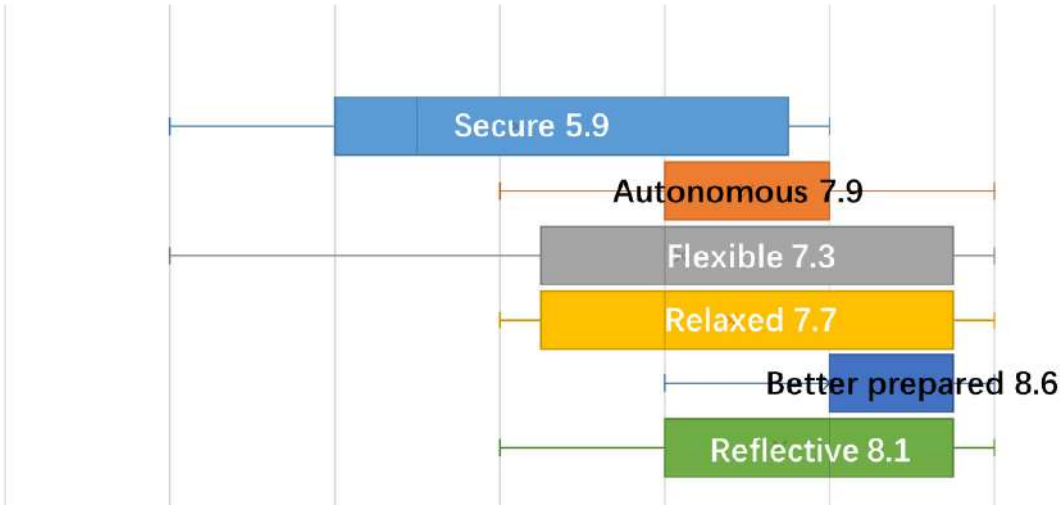


Figure 61. UX quality score of IFE system

Qualatitive Result

Aiming at "identifying user's obstacles on completing the tasks" and "determining the design guidelines for improving the design in the next step", the qualitative feedbacks on UI and UX were also analysed. The results were categorised into three types, positive, negative and inspiring.

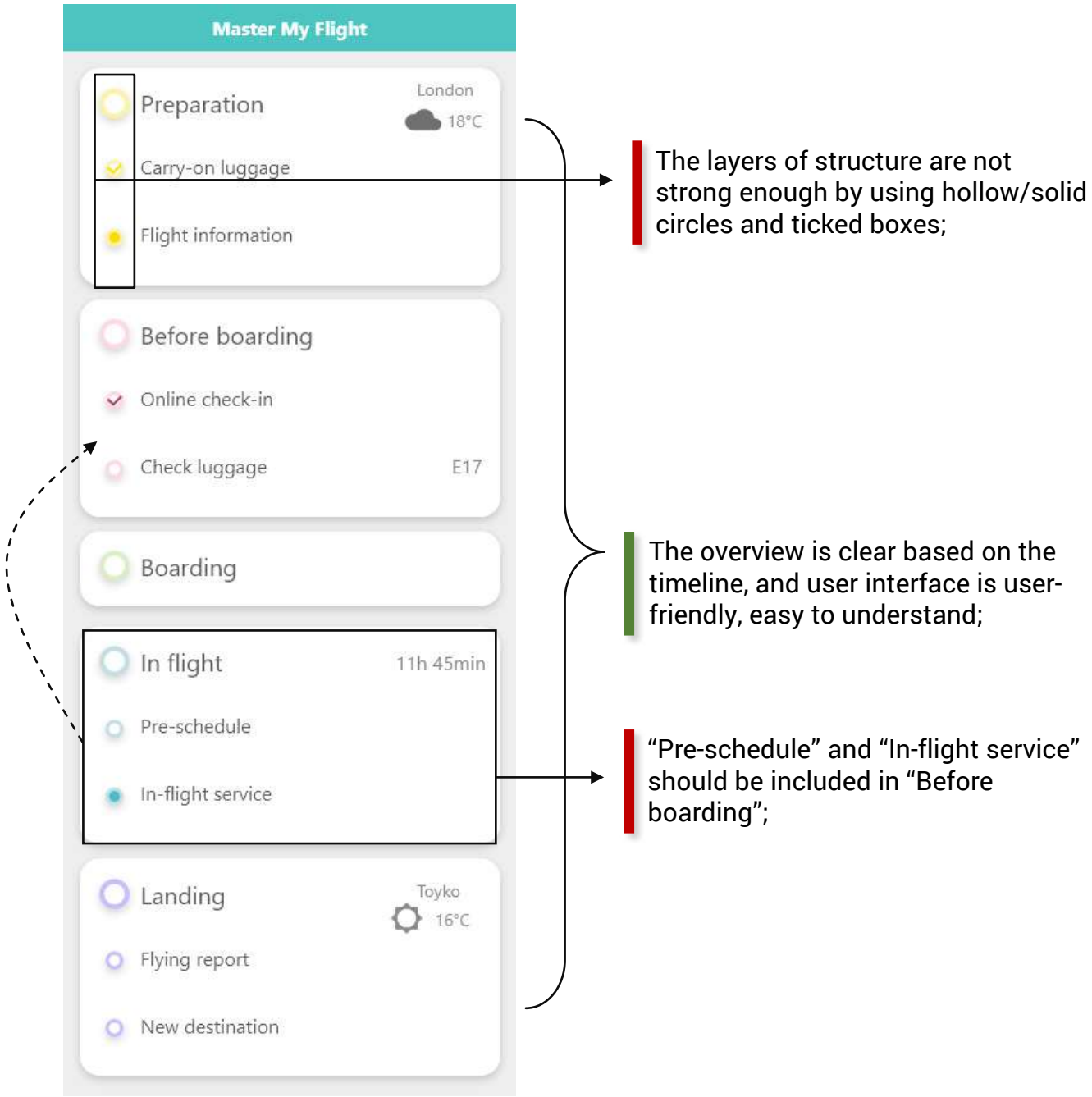


Figure 62. Qualatitive results of overview timeline page in phone application

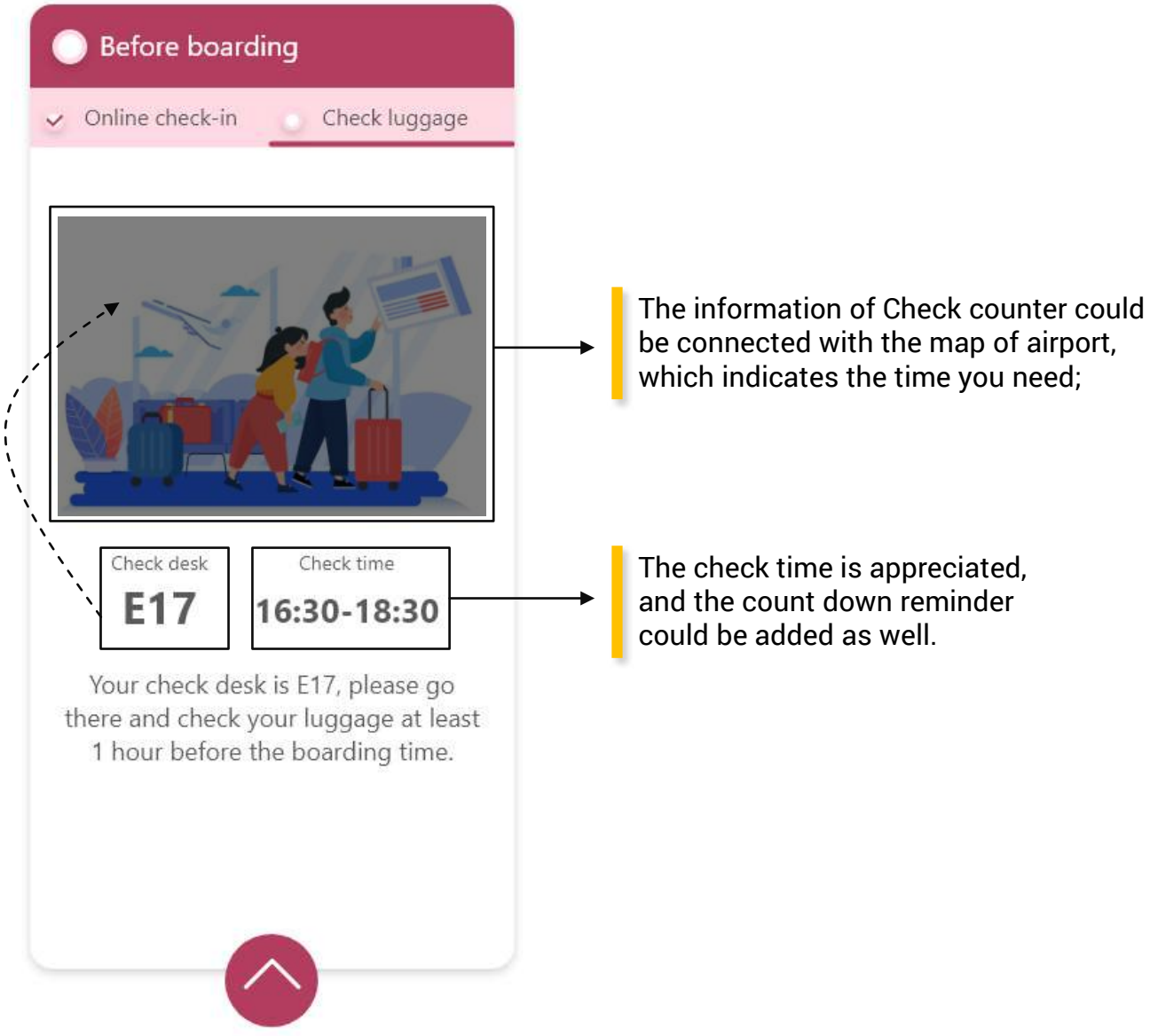


Figure 63. Qualatitive results of preparation phase in phone application

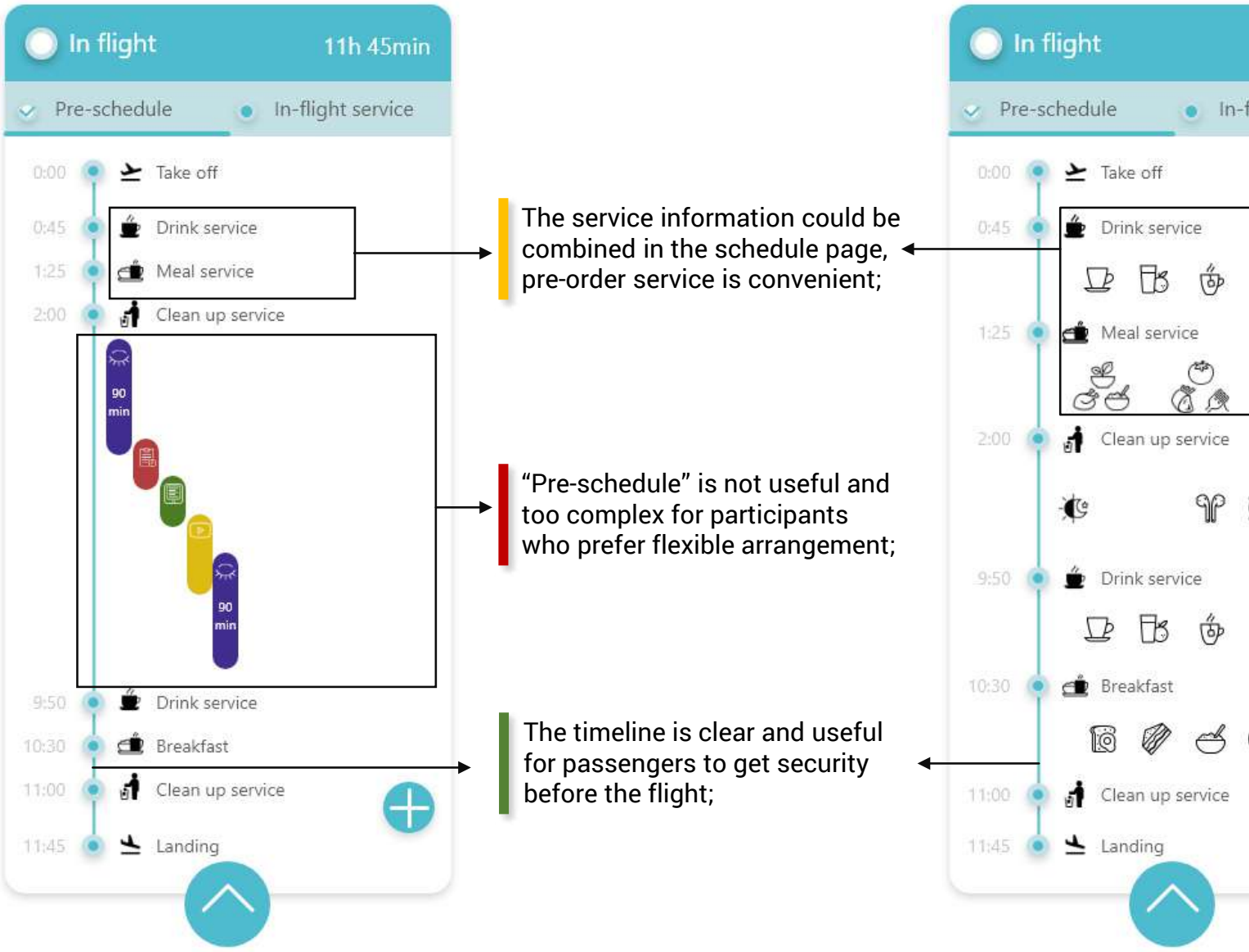


Figure 64. Qualatitive results of in-flight phase in phone application

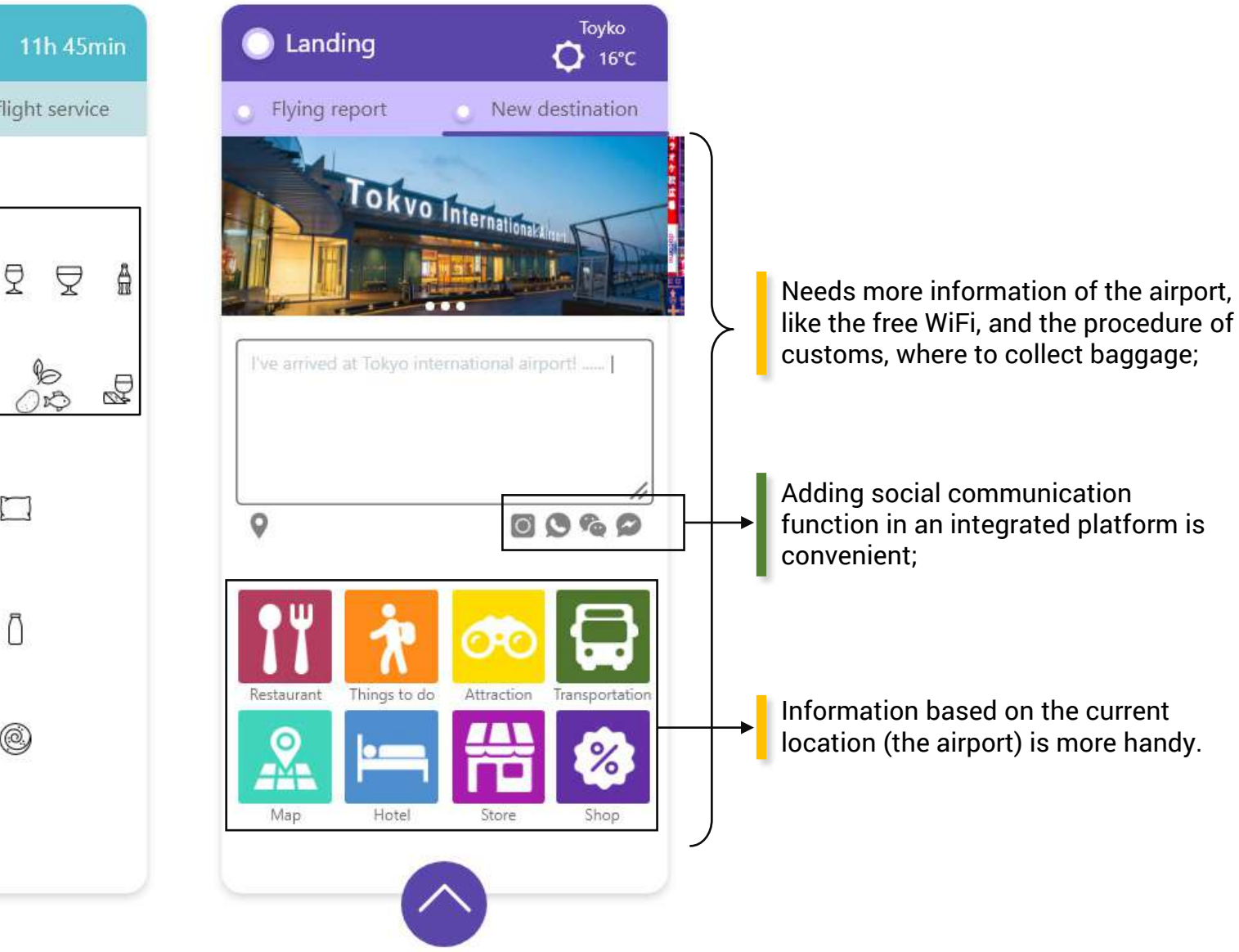


Figure 65. Qualatitive results of landing phase in phone application

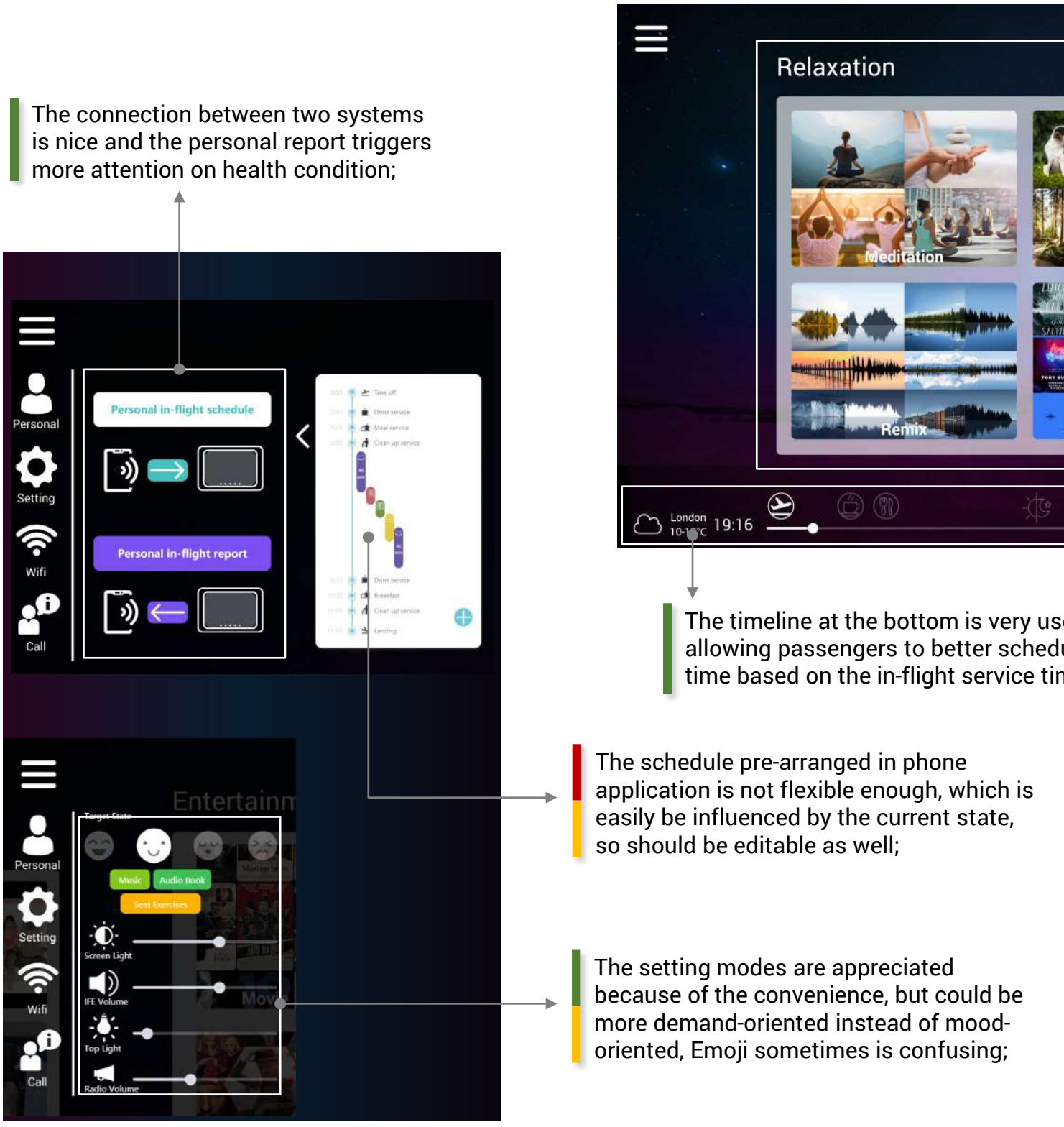
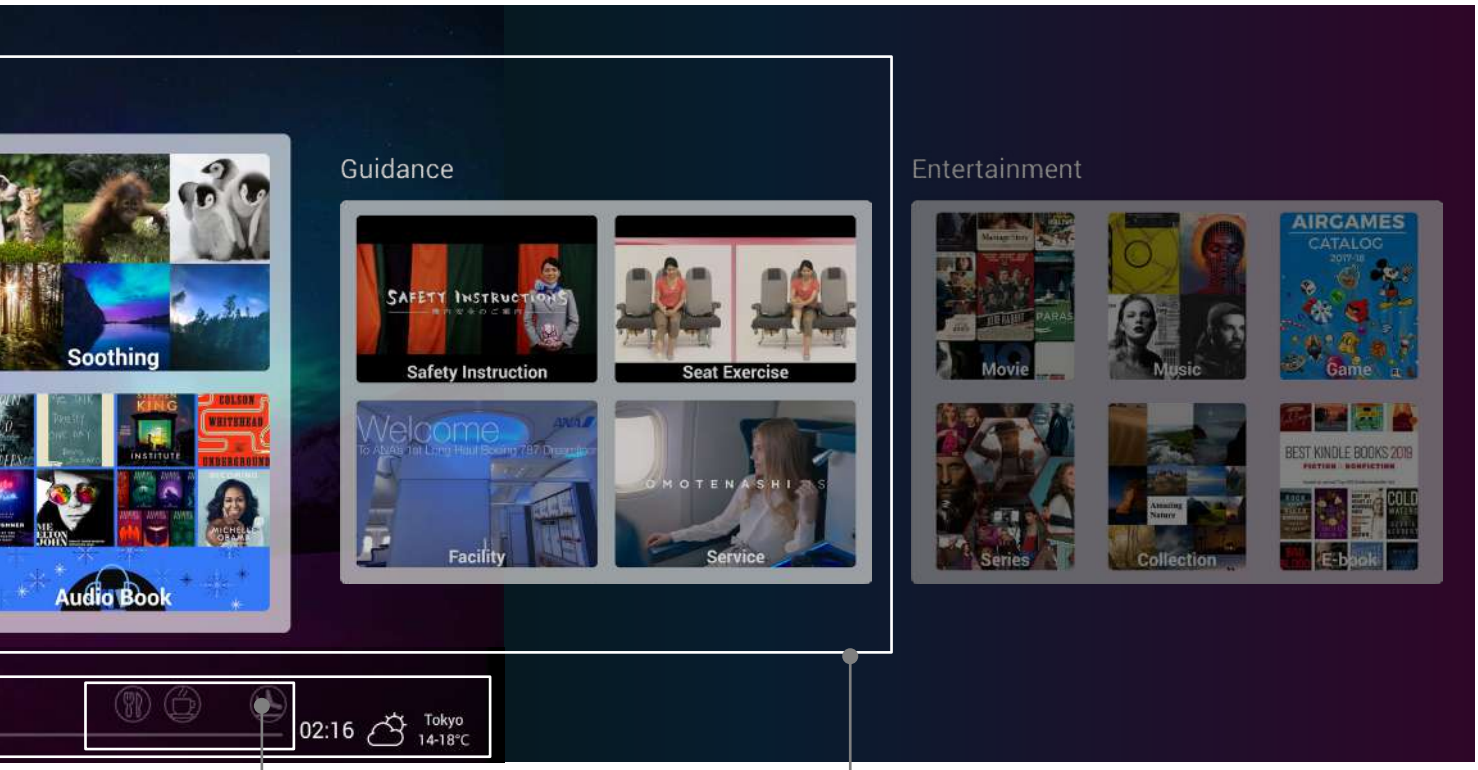


Figure 66. Qualatitive results of IFE system

Verifi



eful,
ule the
me;

Each phase could have some interactive information, like preview, cancel, ask for help;

Separate function of relaxation and guidance is helpful and necessary, providing more activity choices, especially before and after sleep;

The pop-up reminders sometimes are annoying or neglected, when passengers are not interested in, or busy with other activities.

Positive
Negative
Inspiring

5.2.3 Discussion

The evaluation results have been shown in the last section. Overall, the design of two systems meets the design goal quite well in terms of the feeling of control. But there are also some differences in the measured evaluation of two parts.

Compared with other existing travel or airline applications, the phone application is more radical from scratch. Multiple function is integrated in one application, which is relatively convenient, reducing the time spent on filtering necessary information from different platforms. But on the other hand, it needs more efforts to learn how to use and perform tasks, especially for inexperienced users. There are some polarised feedbacks from participants, like confusion or like of the function of pre-schedule. Negative opinions appear more often on participants who do not have the demand of better time management during LHF. But still two participants appreciated this function as an effective tool of scheduling the activities. The reason of polarised feedbacks towards this new function might be the habit of time management.

The IFE system was designed based on the current product, so the acceptance is relatively higher, and the interactive UI is user-friendly. Two new functions, pre-schedule and export personal health report, have been learned in the test of the phone application. Therefore, almost all participants are able to understand and complete the tasks without extra guidance.

The airport information was negalected, but is necessary to be provided in both systems to increase the feeling of control. But on the hand, the involvement of airport might add complexity due to more stakeholders in the system.

5.2.4 Limitation

Test Environment

There are some restrictions on the test condition, like the time span is too short compared with the real situation. The accelerated simulation might influence the reaction from participants, because they do not have enough time to think before making a real reaction.

Internet Restriction

Due to the internet connection issue, there was delay and interruption during the tests. Two participants finished the tests in two days, which might cause inconsistency in the feedbacks.

Technique Limitation

Due to the personal technique limitation, the fidelity of the final prototype is not fully achieved as proposed in the final design. Like the link to the third-party platform, and the real-time updated information. This caused some misunderstanding and was explained during the test.

Participant

The recruited participants are relatively young, so their acceptance of new design is higher than the elderly, who are not tested in this phase. Most participants are students and researcher, so people from other fields should be taken into account as well in the future study.

5.3 Conclusion

In this final stage of the project, verification and evaluation has been conducted. The final interactive prototype was built and tested with ten participants online and offline.

Valuable feedbacks were gathered and analysed. Overall, the design has high system usability scores in SUS, AttrackDiff and quality evaluation.

Although there are some limitations, it can be concluded based on the evaluation results that both systems meet the design goal quite well in terms of the feeling of control. Also the sub-goals of feeling more secured, more flexible, and more serene are achieved.

The flight information and in-flight service provided in advance helps passengers have better preparation. The function of pre-schedule received positive feedbacks from passengers who purchase higher efficiency during the flight time. The relaxion programmes and guidance for seat exercises in IFE system are appreciated, providing more options than the normal entertainment.

The qualitative feedbacks that are positive, negative, and inspiring would be the evidence to make the recommendatio for the future improvement of the design.

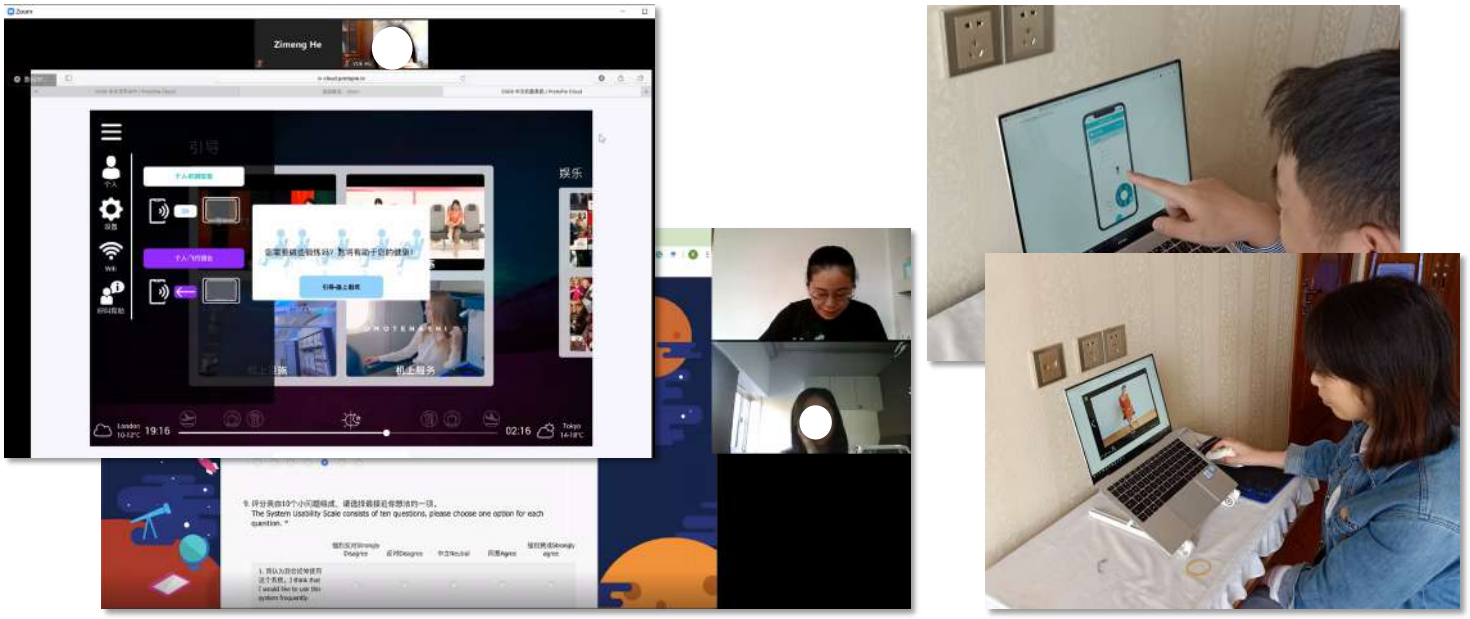


Figure 67. Online and offline scene of evaluation test

REFLECTION

Imagination of Futuristic Vision

This assignment is based on the Flying-V scenario in 2040-2050, but the final concept is still largely developed on the current technologies. Only the technology of personal health data collection would rely on the cutting-edge technologies. Will there be more possibilities to present the concept next to the phone and IFE system? Will there be innovative flight journey for passengers on board? The answer is far more beyond individual imagination, needs more research and verification.

Broad Scope

This project started from an explorative research project, so the scope at the beginning was quite broad. It is beneficial to acquire a comprehensive overview of the context and the whole journey, not only focusing on the in-flight sleep. But on the other hand, the focus was transferred from direct intervention in the flight to the before and after phases.

The outcomes of literature research might not be convincing enough to explain the relationship between these phases and the sleep quality. And the evaluation test was not directly related to the sleep, but to the design goal of "feeling in control", which might lead to the confusion if readers haven't gone through the previous research phases.

Neutral State

Although the test result shows that the design is inviting and it is pleasant to use it, the neutral state of "feeling in control" is largely based on subjective judgment, with no strong emotion or obvious reaction. As a result, it is difficult to capture this feeling during the experience process. The pleasure of using the system could be further developed, in order to encourage people from a higher demand level.

Lack of Iteration

In conceptualisation phase, the initial concepts contain many small elements and qualities, which could have been evaluated by fast prototype. Due to the quarantine in this phase, rapid iteration process was not practical as proposed.

Therefore, only literature models were used at the first evaluation stage. And then cognitive walkthrough on the wireframe was conducted as a replacement, but relatively less convincing and efficient.

Lack of Physical Interaction

The final design is mostly digitalised, but in the reality, lots on physical interaction would be triggered through a series intervention. Because of the constrains of test condition during verification phase, the physical interaction was not tested. The improvement could be done from body movement, in-seat posture, and other close- related aspects.

Opinion from Expertise

The aviation field is quite broad, including many different stakeholders, much more than passengers. But due to social environment constrains, the connection with expertise, like flight attendants, ground crew of airport, airlines employees, was missing. It could be helpful to get professional opinion from their perspective as well.

ACKNOWLEDGEMENT

At the end of the graduation project journey, I would like to express my gratitude to all who support me throughout the process. Without the help from my supervisors, families, friends, and all participants, it is not possible for me to accomplish this unusual but meaningful and fruitful journey.

Supervisory Team

First of all, a lot thanks to my chair, Peter, and my mentor, Haian, who have walked me through all stages even before the project starts. Although at the second half of the project, we were only allowed to work from home and are in different time zones, we still kept efficient communication. You are always positive towards what I am working on, and provide me professional guidance with patience.

Family

Secondly, thanks to my parents and my grandma, who support me to make up my mind to continue working on the project at home through these unusual days. You shaped me into the designer and the person today.

Friend

Moreover, I want to express my appreciation to my friends, who gave me inspiration during research phase, who hosted the ideation session during conceptualisation phase, who participated as the pilot tester during evaluation phase, who provided design suggestion and gave me encouragement all the time.

Participant

Lastly, I would like to show my gratitude to all participants, who gave help, spent time and patience to this project. Especially during the difficult time, there were lots of difficulties for every one, so the generous support was really precious. The kind sharing of your thoughts and experiences is one part of the most valuable inputs.

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Appendix

A. Generative Co-Creation Session

Generative Session

In order to do a creative survey investigating people of “current and desirable long-haul flight”, 3 round generative session have been done with IDE students who have the long-haul flight experience.

a) Setting

The generative session was conducted in a studio at IDE of technology university of Delft. Each round lasted for approximate 60 minutes, involving 4-5 participants and 1 moderator. For minimum error deviation, the moderator, materials, and the discussion time are the same.

b) Participants

All participants are master students from different programs (Design for Interaction, Integrated Product Design, Strategic Product Design) in IDE faculty. They are aged from 21 to 28 years old. As design students, they are familiar with co-creation process and have experience to do similar session.

c) Material

i. Sensitizing materials are prepared for scenario immersion, which is consisted of background white noise and clipped videos of long-haul flight from internet;
ii. PrEmo is displayed on the digital screen, indicating seven common negative emotions and seven common positive emotions;
iii. Paper form with a general timeline is provided, where colour-coded stickers, texts, drawings are encouraged for filling in;
iv. Consent forms.

d) Procedure

i. Welcome participants and ask them to read and sign the consent form;
ii. Brief introduction of the topic is given to all participants;
iii. Sensitizing materials like immersive video, background white noise and pictures are used to help participants recall their most recent sleeping experience in long-haul flights;
iv. Participants are asked to finish some tasks:
    1) draw or write down their experience based on the timeline or physical elements;
    2) Highlight their emotions (indicated by PrEmo or neutral) and reasons on colour-coded stickers;
    3) Indicate the emotion/comfort line;
    4) Indicate the duration and context of the activities;
    5) Discuss and explain their individual experiences;
v. Ask participants draw or write down their desired experiences (can be based on the current situation or in 20-30 years), then discuss within the group.

e) Data collection

Transcript from audio recording is clustered by high-frequency words;
Filled paper forms are collected

Consent Form

Please tick the appropriate boxes	Yes	No
Taking part in the study		
I have read and understood the study information dated 03/12/2019, or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	○	○
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	○	○
I understand that taking part in the study involves an anonymous group discussion with photos, filled forms, written notes and audio recorded interview that will be transcribed as text and destroyed once the research is finished.	○	○
Use of the information in the study		
I understand that information I provide will be used for reports or publications.	○	○
I understand that personal information collected about me that can identify me, such as [e.g. my face, my name or where I live], will not be shared beyond the study team.	○	○
I agree that my information can be quoted in research outputs.	○	○
I agree to joint copyright of the drawing or written information (03/12/2019) to Zimeng He.	○	○

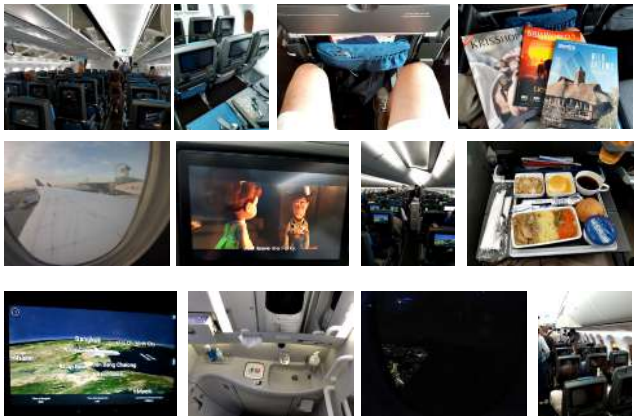
Signatures

_____	_____	_____
Name of participant	Signature	Date

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

_____	_____	_____
Researcher name	Signature	Date

Sensitising Material



Journey Map

1. Before the flight

a. Entertainment preparation
(download movie/music/e-book, etc.)

b. Pack up the carry-on luggage
- **Digital devices** (kindle, iPad, headset, etc.)
- **Sleeping suit** (earplugs, sleep mask, slippers, neck pillow, pajamas, etc.)
- **Food and water** (snacks, water bottle, etc.)

- ***Anticipate for a satisfied journey***
- ***New experience***
- ***Choose for preferred seats***

c. Choose preferred airline, seat, and check-in ⇌ **Interact with airline system**

2. Boarding→Stowing Hand Luggage → Waiting → Taxing → Take-Off → Just after Take-Off

a. Adjust the posture on the seat
(angle of the seat back, leg space, etc.)

b. Unpack the carry-on luggage
(put stuff in safe & accessible place)

- ***Anticipate for a satisfied journey***
- ***Satisfied with entertainment***
- ***Comfortable and secured after long-time waiting***

c. Change dresses
(take off shoes and thick coat, put on slippers and pajamas, ask for blanket, etc.)

⇌ **Interact with crew**

d. Explore entertainment equipment
(magazine, movie, game, music, etc.)

e. Create an isolated environment

- ***Tired and sleepy***
- ***Narrow space***
- ***Impatient with broadcast***

- For falling asleep faster **- Wait for the first meal/drink**

3. In Cruise

Interact with crew

a. Catering service
(drink, snack, meal, etc.)

b. Entertainment activities
(music, movie, game, read, skin-care, etc.)

- ***Relaxed***
- ***Enjoyable***

- ***Sleepy and bored***

(Repeat for several times)

c. Sleep
(rem sleep, light sleep, moderate sleep, deep sleep)

- ***Feel in control to see updated information***
- ***Small body movement improves comfort level***

- ***Awkward and embarrassed to disturb others***
- ***Hesitate if it is good time to go to the bathroom***
- ***Discomfort of keeping one posture, bad environment***
- ***Disappointment of short and light sleeping***

d. Awake
(disturbed by others, discomfort of pain, lighting awaken)
- **Check time and map**
- **Go to the bathroom**
- **Move the body, small exercise**
- **Adjust posture on the seat**
- **Look outside the window**
- **Eat/drink**

(Most activities are performed for helping sleep)

4. Preparing for Landing → Landing → Taxing → Arrival

a. Keep awake and refresh oneself
(go to the bathroom, skin-care, ask for drink, etc.)

- ***Relief, finally to the end***
- ***Look forward to the destination***

b. Pack up stuff

- ***Worried about leaving stuff behind***
- ***Exhausted because of bad sleep***

Transcription

[redacted]
起飞前：广播巴拉巴拉，检查我的包（pad+手机+充电宝充电线+U 形枕头）很难再去拿，所以放脚边，翻翻手机听听音乐， 跟爸妈汇报一下，看椅子后背的杂志信息；起飞中：精神的话看风景，餐车来了就要水要吃的；睡觉：一定要有枕头和毯子盖住腿，选择靠窗，这样不会靠到人，很难固定脖子和头；空间太小，取东西很难施展开，东西多的话整理起来很麻烦；叫醒别人也很可怕；在旅程后半段，无聊就会看风景；睡过去的话会是一长段，2 小时左右，很少被干扰醒来，都是自然醒来。

[redacted]
找落地时间白天，所以一般会挑选很晚起飞的飞机，所以一般很早就会送餐，带耳塞带眼罩脱鞋子把外套盖在身上，一般会选靠窗、安全出口，空间大一点，不停地试最舒服的姿势，调整椅背角度；一个小时后就送餐，灯很亮、餐车有味道有震动，知道有人但是不想醒，这时候所有人都醒着在吃饭，就很奇怪，但是吃完之后大家就开始睡，强迫自己醒过来，问空姐要饭，很怕打扰别人因为自己的作息跟大家相反；东西很多要收起来整理一下，就很烦；相当于调整时差，但是又很难调整适应。

[redacted]
先把行李放上去，找到位置，然后开始把各类物品归类（贵重物品、靠枕、毯子、电子设备、水杯等），找到自己舒服的位置，经济舱空间有限，所以动作很局促，不是很舒服很令人满意，主要是因为小！把电子设备（kindle、iphone）拿出来，再看看飞机上有什么好玩的（杂志、电影），非常期待，尤其是国际航班很令人开心！选一个满意的事情，可以一直做下去，然后餐车就来了，是我期待的一个点，提供什么餐饮。印象很深的国泰航空给的菜单，这个是增加我的期待值的点，很棒！最讨厌的是上厕所，如果旁边的人在睡觉，会憋死，会减少喝水的量。看电影看累了就睡着了，通常在电影中入睡，通常 2-3 小时的睡眠段，如果在过道， 比较会被其他乘客打扰。空乘人员不会叫醒你，贴个条子会很贴心。睡眠中最不舒服的是腿脚伸展不开。

[redacted]
登机不会带特别多的东西，会有个随身的小包，手机、耳机，也没有网不提前下载东西，飞机自带的电影就够，听空姐的安全须知太多次会忽略，之后就拿出耳机听听音乐，空乘分饮料。如果是夜班，会慢慢关灯，为了倒时差会马上睡觉，而且会用 U 形枕头，但是其实反而不舒服。中间会醒很多次，经济舱伸展不开，起来很多次，先看时间，然后去上厕所，再看定影，能看 2-3 个电影，其他活动不多，中间会吃个饭。后半程会期待，会更开心，更频繁地看时间，顺便开始收拾随身物品，折毯子。对光不敏感，对气味相对敏感，但是没有特别极端的经历。上厕所的时候不想在门口等，在座位上等，但是回头等待的过程中，也会有人比你更早站起来，就又要等。

[redacted]
放行李开始，把需要用的都拿出来，眼罩、书、耳机，坐下来之后晃一晃椅子，试试能不能往后调整，因为可能后边的人会有影响。一般都是晚班，所以会熄灯，腿的位置不够用，长途飞行都会选择过道座位，然后开始等飞机餐，会很期待！然后开始看电影，眼睛疼，闭眼，尝试入睡，椅子很难受，换姿势也很难入睡，会想喝水，因为特别干。还有噪音，但是戴各种耳机都会疼，可能是因为气压原因，一般会闭眼一个小时，然后看书，一个小时左右，也是为了入睡。如果依然没入睡，就起来走一走，去等着上个厕所，是为了活动，而不是真正需求。然后跟空姐要水，形成循环，看个航线图，一般会循环个三次。如果能睡着或者眼睛实在太累了，就会睡 1 一个小时左右，下飞机之前会醒着，去洗个脸 refresh 自己，其实也不是很舒服，空间太小，扬得哪儿都是，其实也占别人的时间，会很尴尬。以为自己睡了很久，醒来发现才过了 20 分钟，就很崩溃。

整体侧重护肤，因为很无聊，没有别的事情干，太干燥了需要精致一点，所以自己搭配一个带上去的套装，之前会想象那个场景，不只有脸上，还有脚上用的，比较期待开心要开始新的旅程。上飞机后就放到座位下面，为了上卫生间会调整自己的位置，以便实时查看是否 available，会脱掉鞋子换拖鞋。但是卫生间空间很小很简陋，也没有地方放化妆包，不适合梳妆，比较沮丧，一般会待小于 5 分钟，如果化妆就会久一点，视心情、干燥而定。如果坐过道，就会增加频率，如果靠窗，就会减小频率或者直接拿个镜子或者不化妆。睡前护肤流程结束，看个电影催眠，然后就进入循环，吃饭-看电影-看困了就睡-醒了起来，飞机上非常非常干，想叫空姐，无聊了又觉得皮肤干，又想护肤，睡眠不深容易感受到旁人走动。会查看时间，如果半小时之后就到了，就开始收拾物品。

[redacted]
找座位，半夜飞机，经历了香港的暴动，已经很累了，而且只有中间的位置，为了安慰乘客，就给了洗漱套装，候机的时候把所有厚重的衣物都卸下来，换了舒适的衣服。到上飞机的时候已经非常累，无力洗漱。芬兰航空播了一个视频，到处都是冰，模拟一个冰窖的环境，灯暗下来，有蓝悠悠的光，开始喷冷气烟雾，渲染了让人睡觉的氛围。左右两个英国老头，开始聊天，影响入睡，快要睡的时候，有空乘来上机餐，要了两瓶红酒，咕噜咕噜喝完就想睡觉。结果英国老头开始打呼噜，自己想上厕所，结果心情很差。继续播睡前视频，大家进入深度睡眠之后，头碰来碰去，然后就有早餐，再也没有睡意。平常也不太看电影，如果要睡觉的话。因为会让思维变得活跃，反而会清醒。

[redacted]:
会准备很多资源，所以上飞机会很期待，晚上 23 点的飞机，等待很累，登机会很开心，一上飞机就会想睡觉，听音乐入睡。1. 被旁边的人叫醒，会很抱歉，顺便出去溜达一圈活动一下；2. 有机餐吃，会很开心；3. 顺利睡着，睡 3 个小时之后会自己醒来，因为腰疼，然后就很难受最糟糕的阶段，然后会等旁边的人醒来出去上厕所，顺便做些小锻炼，足够好了就回来，检测腰还疼不疼，尾椎骨会疼，趴着会舒服点，然后就继续睡，如此反复。最后两个小时会很兴奋，不断查看航线图。对环境不是特别敏感，比较能睡。

[redacted]
只有一次长途飞行，第一次所以会兴奋，把枕头毯子拿出来就对芬航挺满意的。很难找到合适的姿势躺着，很快就送餐，没有料想到 12 点多了还有机餐，因为为了放机餐，要把东西都收一收就很麻烦。然后就在找合适的姿势和准备入睡循环，之后睡着了就挺开心挺舒服了，醒来后会观察周围的人在干嘛，旁边的人看到自己醒了，就会去上厕所，然后又觉得还挺麻烦因为要收东西，然后自己也去上个厕所，回来之后就不是很困，没有睡觉需求。再稍微清醒一点就玩一玩屏幕，还挺开心，就等着降落。

[redacted]
先找位置，没情绪的行为，然后为了 curiosity，探寻周围的人，等待分配，没有什么偏好。然后好奇地探索音乐和电影。有时候会一直睡觉，或者一直不睡觉，亢奋导致不想睡觉，就想看电影。带着期待的心情等着机餐，吃完会去上厕所，经历过等待、把人拍醒，干自己想干的事情，没有特殊心情。回来继续看电影，情绪逐渐波动，情绪化，不是因为情节，主要是坐太久了，之后又是期待和厌恶等第二顿机餐，但是一般都是失望的。之后就收拾收拾，等待降落。

[redacted]
很累，会倾向选择靠窗的位置，对光相对敏感，所以想控制。随即登机而不是按位置登机，所以等待时间很烦人。坐下之后戴耳机，因为不想跟别人交流，之后

会等小推车，如果想睡觉，就很烦，因为会被叫醒。一般会要酒，因为想要快速入睡。灯光设计，顶板很低，很压抑，让人不舒服，缺少个人空间，灯的明暗度低于5，如果想出去没啥指引灯不方便，旁边的阅读灯会影响到个人。声音，发动机声音很烦，需要降噪耳机，想把聒噪的小孩踢死，戴耳机也没有改善，踢自己的椅子。想在洗手间化妆洗脸收拾自己，会有羞愧的感觉，因为占用了别人的时间，很不好意思。下飞机的时候，方案不合理，灯全亮了，但是其实还是要等很久。如果能知道何时能下去，就很方便安心。如果想睡的话，就能从头睡到尾，所以想要在靠窗的位置，如果坐靠近走廊真的很不开心很不舒服。

[redacted]

根据 element 来写，1. 脖子很不满意，尽管有 U 形枕头还是会歪；2. 腿根本伸不开；3. 胳膊很尴尬，如果用 armrest 更占用空间；4. 靠窗太亮了；5. 小桌板太低了，吃饭不爽也不能架腿；6. 腰疼，枕头其实没太大用，还是需要走动走动；7. 耳鸣现象很明显，跟空姐对话都很难，咽唾沫来缓解；8. 有个随身的包，放下面挡脚；9. 飞机餐的气味让人晕机，要用橘子皮，做的热的食物散发的味道让人恶心，沙拉、三明治就还好。最讨厌中间，喜欢靠过道多余靠窗，腿的空间大一点，垂直空间小。窗户不干净，影响看风景的体验。

[redacted]

登机分段，分区域，挺好的。烦的是需要把行李放上面，比较负面，上去晚了点话就放不到自己附近。会带个随身的手提包，个人物品（拖鞋、毯子会发、颈枕、眼罩）set up 之后会看电影，一个小时后就会有飞机餐，所以不会先睡觉，看会儿 ipad，放个眼睛、放个 pad、放小吃，眼镜没有合适的地方放。终于坐上飞机了，比较激动开心，电影也挺好的，吃免费餐也挺开心的。比较好的航空公司，会给菜单，还能勾选，但是纸质菜单不环保，为何不用屏幕呢？可以更环保可持续。吃完之后，看电影，如果困了就睡觉。首选靠窗，然后过道。窗边比较有安全感，有东西靠，可以看到景色，飞机翼旁边巨响。KLM 靠过道会被空姐撞到，特别讨厌。如果坐里面，就会减少活动，虽然对睡眠挺好的，但是姿势不舒服，需要经常调整。中间上厕所，体验很差，需要叫别人让座，过意不去不好意思，等厕所无所谓，可以顺便活动。如果正睡着，空姐来了叫醒你，那个瞬间心情复杂，想吃但是又困，想等会儿再送吧，但是等会儿又没了，annoying 低落。如果旁边有合适的人，唠嗑也挺开心，德国小姐姐，不睡觉会困。降落的时候还挺开心。

[redacted]

开始登机，exhausted，希望有个清净的空间，电影、游戏，有点失望，因为触屏不是很好用，反应时间比较长。后面的人会影响，来搭讪就很 annoying，有点社恐，想尽快逃离，distract from 电影，声音影响，导致头疼。不太困，送餐来了，很烦，因为要暂停，摘耳机带耳机，接餐、收盘子，对食物没什么特别的期待。看完一个电影，灯就关了，情绪会受电影的影响，就很累了，然后稍微休息一下，中间会因为某个部位不舒服而醒来，调整姿势，然后灯亮了，第二顿饭就来了，被迫醒来。不太清醒也不太高兴，希望不用等太久，马上能拿到饭。之后再睡就很难，因为已经休息了，就想再看个电影，想用手机又没有网，所以开始看相册，整理一下相册，还挺放松的。旁边的人想上厕所，很有礼貌，也没有被打扰。降落前的一个多小时保持清醒，紧张担心降落这个过程，心情有点复杂，早上到的，有温差，担心火车等后续的事情，而且快到了，想跟家人联系一下报个平安。

Group2

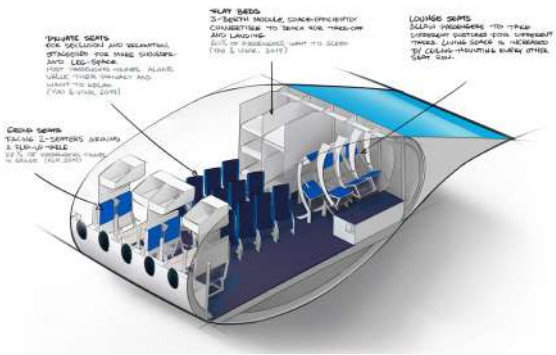
1. 长时间封闭的空间，打一盘文明，可以玩十几个小时甚至几十个小时，上飞机前就可以选择，像在网吧里面开黑；
2. 为了保证良好睡眠，吃完机餐后，能有充足的伸展空间，能自己调整温度，不用担心水洒了又能随时补水，不会被打扰，希望有没有副作用的助眠的药；
3. 不睡的航行，现在无法开足够亮的灯，希望有专门用来看书或者其他娱乐的地方，或者是做瑜伽锻炼的地方，提前选择挑战任务模式，然后可能忘记时间；
4. 商机：飞机上提供护肤小样套装给乘客们使用，跟公司合作提供分销渠道；
5. 为了财务安全，希望有更多保险措施，小锁/隔间/密码等，如果不在视线范围内，就容易焦虑担心；
6. 需要更大更透明的储物空间，防止遗忘遗漏丢；
7. 希望有自主选择的机餐；什么时候开饭？提前选择食谱，提前告知送餐时间，自主传送带不需要统一收垃圾；自己叫服务，而不是统一的服务；
8. 芬航-提供一整个氛围，主题地铁（灯、温度、音乐、湿度）等，为了想睡觉的人划分一个区域，用帘子等隔开不同的区域；
9. 需要收纳架，上完厕所之后发现有 3 个枕头出现在自己的位置，零碎的小东西无处安放；
10. 什么时候周围的人会醒来？旋转座位，可以不打扰别人自由出入；
11. 能躺能坐能站，节约竖着的空间，改成两层的客舱；
12. 飞机餐改成标准化的东西，比如 KFC 方便面，大家都不会讨厌的东西；
13. 要有 wifi；
14. 让婴儿消声；
15. 比较 private 的隔绝空间，座椅能躺能睡能坐的，胶囊座椅；
16. Lighting design-整个顶板变成了灯板，冷暖颜色/主题模拟蓝天星空极光/助眠灯+指示灯提供信息；
17. 把三个座位隔开，有个直角挡板；
18. 想要个 smoking room；
19. 想要个头盔，不被打扰也不会打扰别人；
20. 头等舱配置；
21. 生化危机-座位可站可坐可躺，半站不坐，不倒翁似的，想隔绝就隔绝，有个轨道，大家能按照作息表来自由选择移动；
22. 私密+自动调节温度+干净卫生+安全感+自助服务+新鲜空气+健康舒适（防止晕机）+功能娱乐分区；

B. Online Survey

Questionnaire

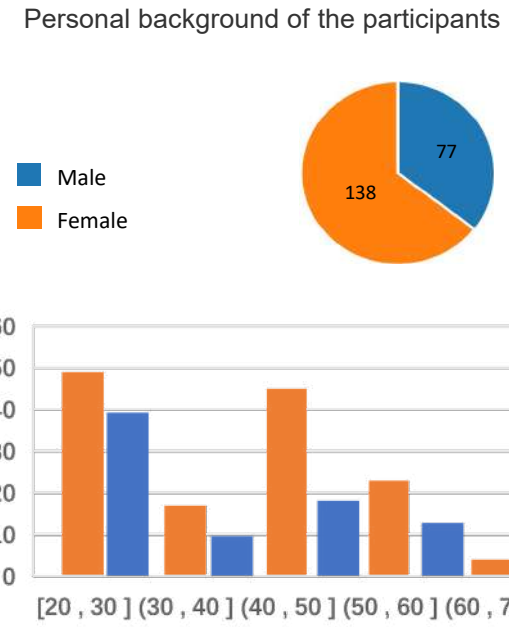
The questionnaire with more specific questions and options are designed for a wider-range participant, no matter they have long-haul flight experience or not. The quantitative data is collected and analysed to verify if there is relationship, and the reason behind the qualitative results from the generative session. Additionally, one of the main purposes is to test if there is difference between experienced passengers and inexperienced people. 12 related questions are designed for quantitative answers to the research questions. The questionnaire was powered by Microsoft Form and published online.

1. Personal information (gender, age, occupation)
2. Do you have a long-haul flight (≥8 hours) experience?
   A. Yes, only a few times (≤4) **B. Yes, many times (> 4)** C. Never
3. What was the purpose for (if have more than one type, please choose the latest one for the following questions)?
   A. Holiday travel B. Study or work (move to another place for a long time)
   C. Business travel D. Group activity E. Other _____
4. How many people were accompanied with you?
   A. No one else, single travel B. 2-3 C. ≥4
5. While booking, what factors are more important to you (sort by priority)?
   A. Specific plane type B. Specific location of seat C. specific taking-off/landing time D. Specific airline(service)
   E. Price F. Transit G. Other _____
6. What kind of items did you pack up in your carry-on luggage (multi-option)?
   A. Entertainment equipment (iPad, earphone, kindle, etc.)
   B. Sleeping suit (pajama, slippers, eyepatch, earplugs, U-pillow, etc.)
   C. Wash supplies (toothbrush, toothpaste, mouthwash, makeup, skin-care product, etc.)
   D. Food/water
   E. Other _____
7. What kind of in-flight routine did you perform?
   A. Sleep as much as possible
   B. Keep awake because of _____
   C. Loop of awake and sleep
   D. Depends on situation, such as _____
8. How many times were you awakened?
   A. ≤2 B. 3-6 C. > 6
9. What were the reasons of being awakened?
   A. Disturbed by neighbors (noise, ask for going out, etc.)
   B. Disturbed by crews (catering service, broadcast, etc.)
   C. Unsatisfied environment (temperature, humidity, light, etc.)
   D. Physical condition (pain, etc.)
   E. Other _____
10. What kind of seats do you prefer?
    A. Private seat
    B. Group seat
    C. Sleeping seat
    D. Lounge seat

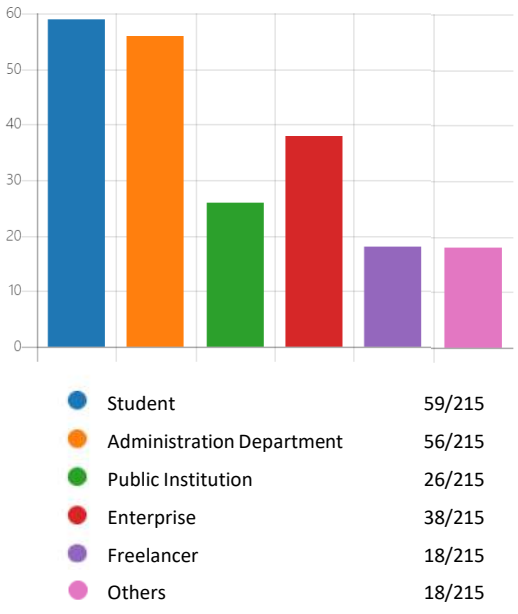


12. What experience of that flight did you have (0-7)?
    Comfort
    Safety
    Hygiene
13. What should be improved most (sort by priority)?
    A. Privacy B. Seat C. Hygiene D. In-flight service E. Environment (temperature, humidity, light, etc.)
    F. Others

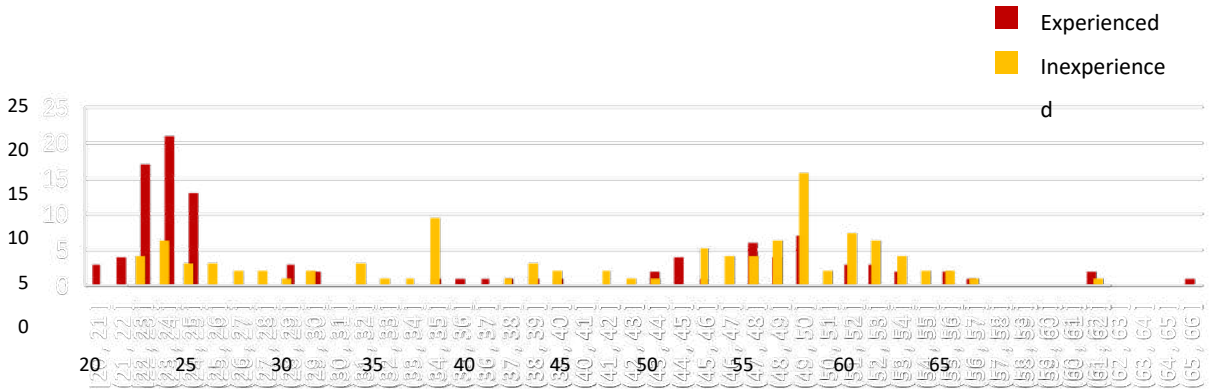
Result



Gender and age distribution

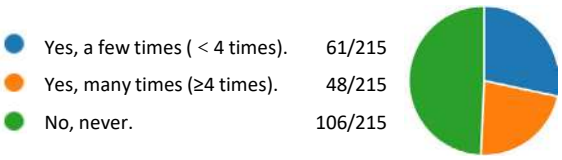


Occupation distribution

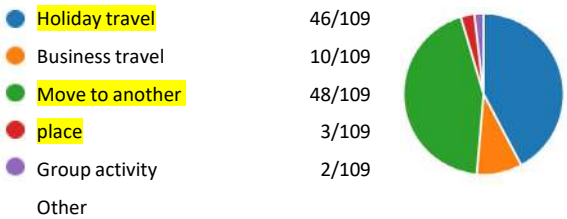


Age distribution

Do you have any experience of ***long-haul flight*** (≥8 hours)?



*What was the ***purpose*** of your latest long-haul flight?

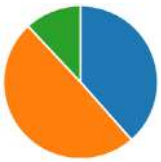


*What was your ***common in-flight sleeping experience***?

Keep asleep	8/109	
Keep awake	16/109	
In between of asleep and awake	71/109	
It depends	14/109	

*How many times did you ***awaken*** during the flight?

≤3 times	42/109	
4-6 times	54/109	
≥7 times	13/109	

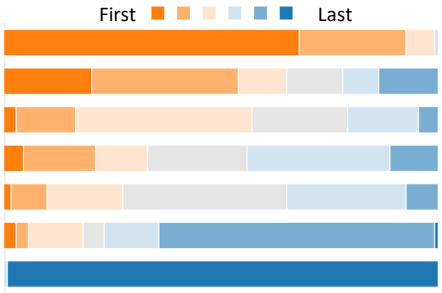


*What was the most frequent ***reason for being awaken*** ?

Neighbor (noise, make way for others)	11/109	10.09%
Crew (food, drink, broadcast)	38/109	34.86%
Environment (temperature, light)	28/109	25.69%
Self condition (physical pain, mood)	22/109	20.18%
Others (can't lay down, engine noise, naturally awake)	10/109	9.17%

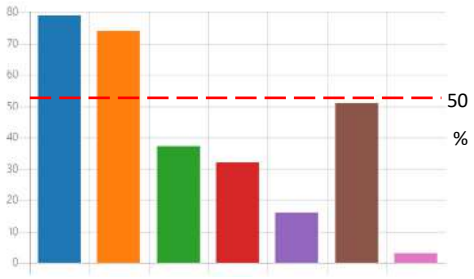
*Which aspect ***needs to be improved*** most in the long-haul flight (please rank them by importance)?

1. Comfort of seats
2. Privacy
3. Hygiene
4. Environment
5. In-flight service
6. Entertainment
7. Other



*What ***items*** did you bring to the long-haul flight? (multiple choices)

Entertainment equipment (iPad, earphone, kindle)	79/109	72.48%
Sleeping kit (pajama, slippers, sleeping mask, earplugs, U-pillow)	74/109	67.89%
Wash supplies (toothbrush, toothpaste, mouthwash)	37/109	33.94%
Makeup product	32/109	29.36%
Skin-care product	16/109	14.68%
Food/water	51/109	46.79%
Others	3/109	2.75%

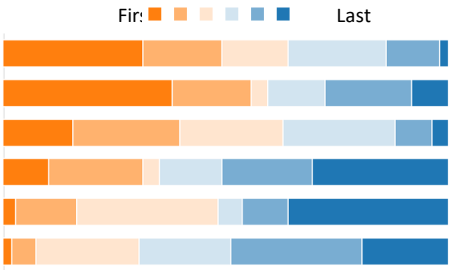


*** Questions only for Experienced passengers**

What are the most ***important considerations*** when booking a flight (please rank them by importance)?

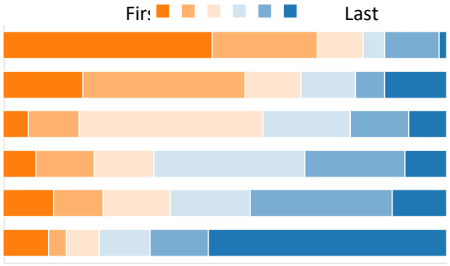
Experienced passengers

1. Airline (service)
2. Price
3. Taking-off/landing time
4. Airplane type
5. Transit
6. Location of seat



Inexperienced people

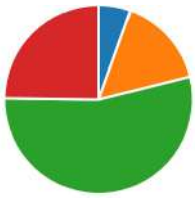
1. Airline (service)
2. Airplane type
3. Location of seat
4. Taking-off/landing time
5. Price
6. Transit



What kind of ***seat do you prefer*** during the long-haul flight?

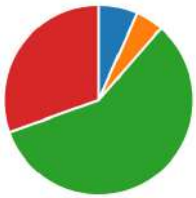
Experienced passengers

Group seat	6/109	5.50%
Single seat	17/109	15.60%
Lounge seat	59/109	54.13%
Sleeping seat	27/109	24.77%

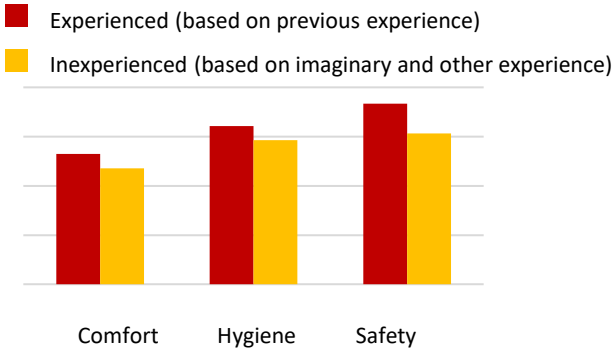


Inexperienced people

Group seat	7/106	6.60%
Single seat	6/106	5.66%
Lounge seat	61/106	57.55%
Sleeping seat	32/106	30.19%



Please rate the ***comfort/hygiene/safety*** of the long-haul flight experience.



C. Creative Facilitation - Ideation Session

Introduction

The problem owner of this session is Zimeng He, who was in the ideation phase of her graduation project.
The main purpose of this session was to generate new ideas/ solutions and to expand the opportunity space for her graduation project. Before the session first we had an intake meeting as preparation. As one of the results, we decided our original problem statement as "What elements/ aspects of the whole long-flight experience can be improved to make the customer feel in control". This statement would be presented to our research group (RG) as "Problem as Give" (PaG) and they were supposed to explore and reframe it during the session.
Our research group consists of 6 students from the IDE faculty, including our PO. All of them have relevant experience about long-time flight.

Oveview of the Procedure

Session Introduction - 30min

- Welcome & Self-Introduction (5 min)
- Problem introduction from PO* (5+5 min)
- Introduction of the agenda (5min)

Problem Finding - 65min

Diverging - 40min

- 5W1H (10 min)
- Ladder of Abstraction (20 min)
- H2 (5 min)

Reverging - 15min

- Spontaneous Clustering (10 min)
- Review and Discuss (5 min)

Converging - 10min

- Hit & Dot & PO's preferrence (5+2 min)
- Problem statement (3 min)

Idea Finding - 95min

Diverging - 50min

- Purge (5 min)
- Absurd Questions (45 min)

Reverging - 30min

- Clustering (10 min)
- C-Box (10 min)
- Review and Discuss (10 min)

Converging - 15min

- Hit & Dot - Restatement (15 min)

Session Introduction

Self- Introduction

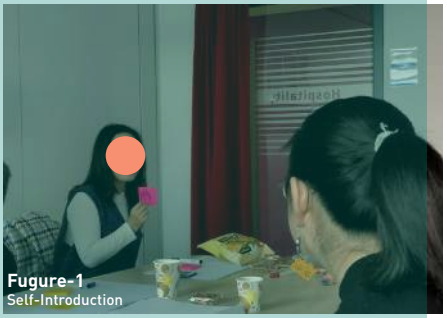
Purpose
The purpose of this phase was to set the right atmosphere to promote openness and collaboration.
Content
To make the RG feel at ease and speak up for the first time, here the participants were invited to play a game named Pair Portrait Sketching, in which each participant needed to close their eyes and sketch the person sitting opposite to her and then introduce themselves one after another.

Problem introduction

Purpose
This phase served as a starting point to build a shared understanding of the actual problem.
Content
Problem owner were invited to give a 5-min presentation about necessary information about the problems, including the context, important insights from the existing research work and most importantly, the original problem statement (PaG).

Problem introduction

Purpose:
St the expectations for the session.
Content:
Facilitator briefly introduce the simplified agenda and the purpose of this session to the participants so that participants can get an idea of what they are going to achieve and how

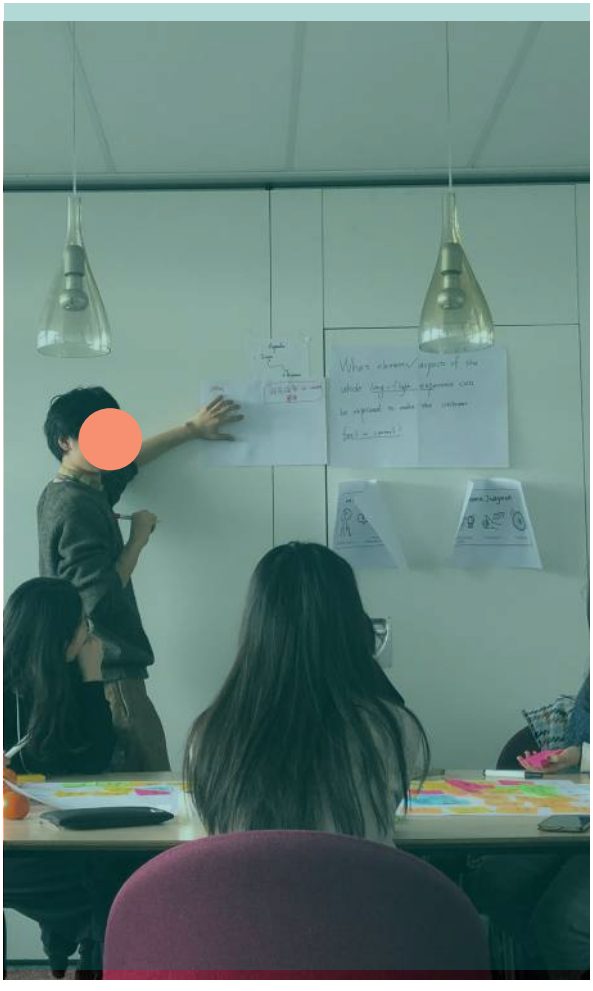


Fugure-1
Self-Introduction

Fugure-2
Problem Introduction

Problem Finding

Based on the PaG, participants would be guided to explore the context of the problem, propose their own understanding, try reframing the problem and finally come up with a new problem statement. During this phase, our participants were supposed to dive deeply into the problem and thus get ready for the next idea finding phase. In addition, the process of the exploration and reframing can be also beneficial and inspiring for PO.

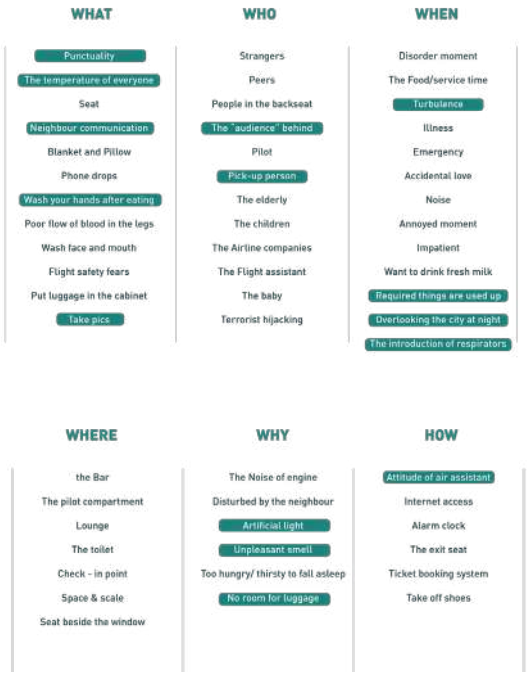


Problem Finding - Diverging

5W1H

#Purpose
A checklist technique for analyzing the Problem as given. Gathered facts and data to achieve a rich description of the problem statement
#Content
The participants are required to ask problems with Who, What, Where, When, Why and How, which are relevant to the long-time flight experience. These questions will be written down and be gathered together on a flip-over. PO will be invited to the questions if necessary.
#OutCome
The research group achieve a complete understanding of the context about long-time flight experience. In addition, some novel elements are proposed as well, as is show in the fugure.

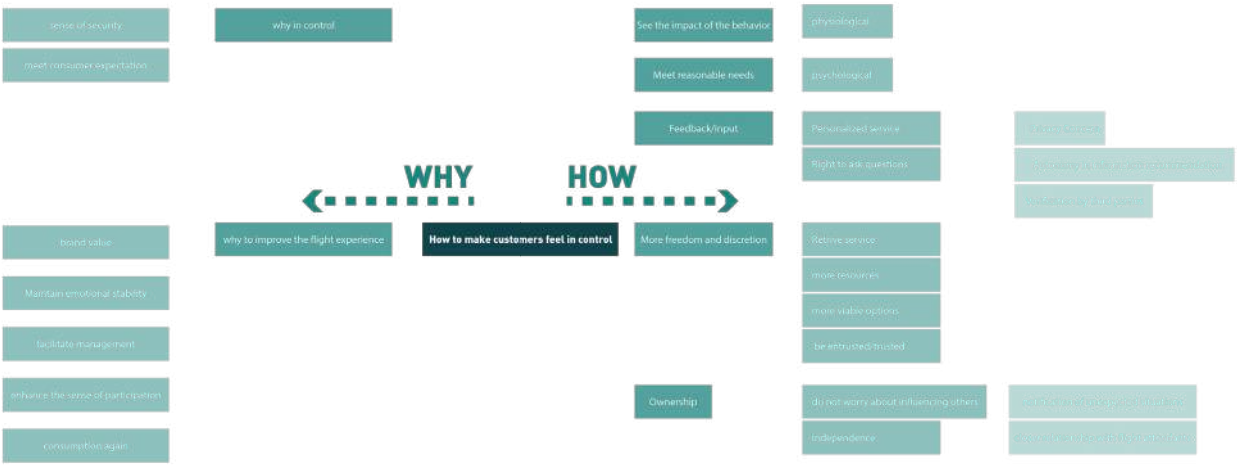
Fugure-3
5W1H



Ladder of Abstraction

Purpose
Help explore the problem and the solution space on different levels of abstraction
Content
The participants are first guided to propose "why" questions for the current PaG, such as "why do customers need to feel in control", "Why do companies need to improve the flight experience". Then the abstraction level moves up and participants will be required to generate new "why" questions for the ones just generated. Another round with "How" questions are done in the same procedure.

Outcome
Through the process of the ladder of abstraction, the participant keep reformulating and exploring the reason and the possible solutions relevant to the flight experience improvement. Therefore the problem space is greatly expanded both in the specific and the highly abstract direction, as is shown in the figure.



Problem as given

What elements/ aspects of the whole long-flight experience can be improved to make the customer feel in control

→

Problem as perceived

How might we raise the customers' awareness of the pleasures in the cruise experience?

Problem Finding - Reverging & Converging

H2

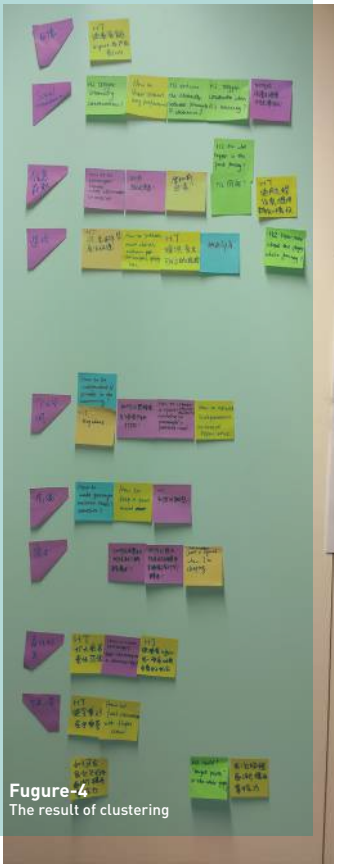
Based on the knowledge achieved in the previous phases, participants are asked to propose new problem statement in the form of "How to". The new questions should combine participants own understanding & the PaG(What elements/ aspects of the whole long-flight experience can be improved to make the customer feel in control.). These questions are collected as the options for the new problem statement.
#Outcome
After 5 mins' brainstorming, 46 new problem statements are generated

Spontaneous Clustering

#Purpose
Provide the overview of the generated options and bring order into the large quantity of options.
#Content
The participants are asked to overview all the options generated, especially the ones generated by others, so that they can form a clear idea of problem spaces. Participants are free to discuss on the options if necessary.
#Outcome
The 46 statements are finally divided into 8 clusters.

Hit & Dot

Every participants are provided with 2 stickers, with which they can vote for the favorite 3 clusters. After the voting, clusters with more than 1 stickers are picked. The participants are guided to discuss on the selected clusters again and finally, a new problem statement is proposed.
#Outcome
Finally there are 3 clusters selected (emotion, choice and ownership). After some further discussion, the key elements in these clusters were reframed and new problem statement was generated as problem as perceived (PaP).



Fugure-4
The result of clustering

Idea Finding - Diverging

Purge

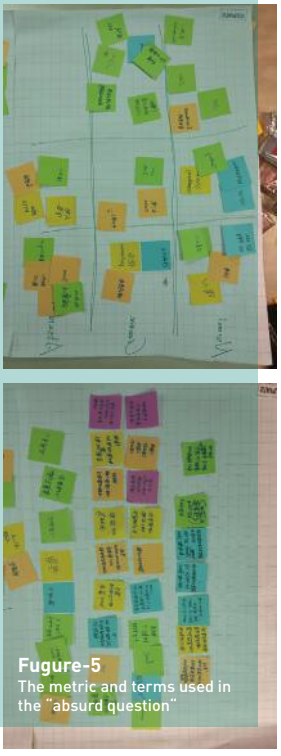
#Purpose
Clear mind and write down all options they already have so that they can generate other novel ideas other than common/silly ideas.
#Content
Since participants have successfully propose a new problem statement, at this moment probably they already have some ideas about the solution. In this phase, they are required to first writing these already existing ideas down in order to clear their mind and set the basis for the further creative confrontation phase. The ideas generated in this phase will be kept and be included in the future Reverging phase.

Creative Confrontation – Absurd Question

#Purpose
"All newness comes from chaos". In this part, the participants were guided to move away from the problem statement through a so-called "excursion". The aim of this phase is to create "safe" chaos by gradually leading the RG to domains outside the obvious.
#Content
Participants are required to choose 3 terms in the PaP. These terms became the columns in a matrix. And then participants were asked to fill up the matrix by generating substitutes for the terms in 3 stages:
1. Nearby
2. More creative
3. Absurd

After the matrix were filled up, the participants were asked to start force-fitting - generate new solution options based on the terms in the matrix.

#Outcome
4 sheet of solution Ideas



Fugure-5
The metric and terms used in the "absurd question"

Idea Finding - Reverging

Clustering

Due to the time limitation, clustering is the final part of this session. In this part, we carefully reviewed the solution ideas generated in the diverging phase and had discussions on the potential ones. In the end, we divided these options into 12 clusters. Although there was not enough time left in this session to develop them into sufficiently detailed solutions, the existing cluster has been able to provide some helpful and inspiring future design directions.

Feedback

H2 to enable passengers to input and have an impact

Social conversation

H2 trigger conversations;
H2 show othes my preferrence;
H2 to enhance the interaction between passenger & assistant;
H2 trigger conversation when it is necessary;
H2 find something to do for the idle passengers

Information acquisition

H2 get passenger choose what information to receive;
H2 to verify information;How to playback;
H2 know what happens in the past journey;
H2 provide more information about the journey

Choice

H2 select the seat environment through VR;
H2 provide more choices without passenger getting lost;
H2 provide multiple choices;
H2 choose a neighbour;
H2 know more about the whole journey

Personal Space

H2 stay alone;
H2 keep passengers who want to sleep undisturbed;
H2 be independent & private in the community;
H2 create a space according to passenger's personal needs;
H2 ensure independent on-board experience

Emotion

H2 make passenger maintain stable emotion;
H2 keep a good mood;
H2 create superiority

Ownership

H2 expand the scope of passengers' responsibilities;
H2 make passengers feel like they are a community;
How can a passenger offer another passenger a free opportunity

Flight attendant

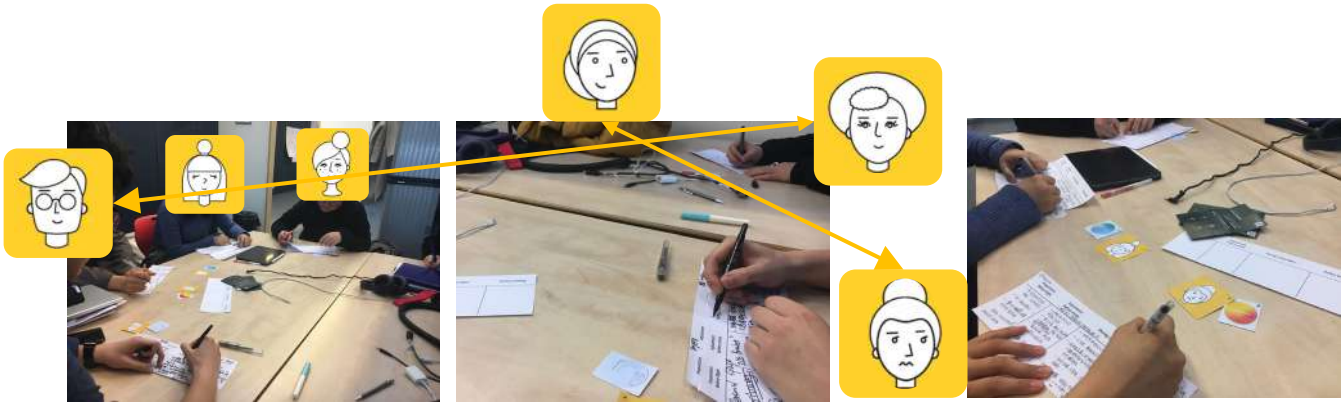
H2 make flight attendants care about passengers;
H2 do flight attendants connect

How might we raise the customers' awareness of the pleasures in the cruise experience?

D. Prototype of Concept 2- Role Play

Steps

- 6 students, randomly pick one of the roles and one of the moods, trying to role play the real person;
- Then imagine the journey with the current system, interact with each other without any introduction or intervention;
- Let participants write down their feeling;
- Introduce a Match System to re-arrange the seat location, repeat last step, compared with the previous one.



9 years old
"It is the first time for me to go abroad in summer holiday with parents."

28 years old
"I'm going on vacation with my boyfriend. We'll stay there for half a month."

34 years old
"I'm going on vacation with my girlfriend. We'll stay there for half a month."

62 years old
"I'm going back my home from my daughter's home. She now live abroad."

26 years old
"I'm an international student, now going back to attend my cousin's wedding."

32 years old
"I'm going on a business trip for the fashion week as an editor of a fashion magazine."

Dynamic user profile	Tendency
 26 years old *"I'm an international student, now going back to attend my cousin's wedding."* **Cheerful** • Engage in pleasurable activities; • Be optimistic, open for communication; • Embrace your situation; • Be enthusiastic and open-minded;	- Open for communication; - Tolerant to unstable situation; - Be willing to offer help for others.
 28 years old *"I'm going on vacation with my boyfriend. We'll stay there for half a month."* **Relaxed** • Embrace the situation • Open-minded and take time • Move calmly • Care-free and kind • See the good	- Take time to enjoy the journey; - Open-minded and tolerant; - Embrace the situation, move calmly.
 9 years old *"It is the first time for me to go abroad in summer holiday with parents."* **Sentimental** • Avoid the centre of attention • Meandering thoughts • Seek familiar experiences and routines • Contemplate • Be quiet	Children: - Will attract more attention, but not necessarily need; - Have some special help or guidance; - Tend to follow their daily routines, need familiarity; - Are more emotionally volatile; - Need more reassurance and distraction.
 34 years old *"I'm going on vacation with my girlfriend. We'll stay there for half a month."* **Lethargic** • Close off for communication; • Respond with delay; • Be indifferent, quiet and reluctant; • Save energy.	- Avoid social communication - Tend to be quiet, indifferent about the environment; - Self-immersed, tend to ignore others.
 62 years old *"I'm going back my home from my daughter's home. She now live abroad."* **Rebellious** • Act impulsively; • Expand energy, tend to lead; • Engage in energetic activities; • Are impatient and intolerant; • Take risks.	- Want more social communication; - Be self-centered, tend to break the rules; - Tend to disregard others; - Want to get others' acknowledgement and attention.
 32 years old *"I'm going on a business trip for the fashion week as an editor of a fashion magazine."* **Grumpy** • Be close-minded, impolite; • Be pessimistic; • Be intolerant and impatient; • See the bad; • Tense up.	- Avoid social communication; - Be self-centered, tend to disregard others; - Dissatisfied with everything; - Impatient for the unexpected event; - Want to get others' acknowledgement and attention.

Prototype insights

- ✓ It is useful to increase the **awareness of the individual mood** state;
- ✓ It is helpful to **avoid possible big conflict**;
- ✓ Make it easier for **flight assistant**, releasing their pressure;

- Define what should be collected, what should be shared, what should be analyzed;
- Find the useful information, build the relationship, difficult to see the nuances;
- The data collection is challenging, like mood measurement, travel history;
- Reduce the negative influence, like the feeling of being used of, or the feeling of deserved privilege;

E. Evaluation Test

Script

Welcome

Explain to the participant:

- *Thank you for coming to my test of the graduation project.*
- *We are here today to test the digital platform for better in-flight experience.*
- *The goal of the research is to gain insights in how potential users interact with and experience the concept to improve it.*

Observation

- *It would really help if you would think out loud so we get a better grasp of your experience to improve the concept. Thinking out loud means that you say everything you are thinking, what you're doing and what you like and don't like (so for example, if you click the button, you would say 'Now I'm gonna click the button for the next step, I want to try this function')*
- *I will give you the instructions for the test and ask you questions later.*
- *The test and interview will be recorded on video that will only be used for learning purposes within this project (just me, no one else).*
- *If you agree, could you please sign this **consent form** before we proceed.*
    - *Can you please write your name, age and your job here?*

Test procedure

- *The test will take approximately one hour existing of two different parts. I will explain them to you in a bit.*
- *It is very important that you know we are testing the prototype, not **you**! All feedback is valuable, no matter your reaction is positive or negative!*
- *Please think out loud so we can understand your thinking and follow your reasoning!*

Do you have any questions so far? If not then I will start recording.

START RECORDING

Pre-test interview

Goal: get acquainted with the participant and use his experience level etc as input for adapting the scenarios. Make the participant feel at ease.

- *Could you tell me a little bit about yourself?*
    - *Where do you live?*
- *What are your experiences with the flight?*
    - *How often do you take a flight?*
    - *For what purposes do you take a flight?*
- *What are your experiences with a long-haul flight experience?*
    - *Have you ever taken a long-haul flight before?*
    - *What did you like about it?*
    - *What did you not like about it?*
- *Can you describe how is your in-flight sleep experience?*
    - *How was your experience like?*

- *Dislike or liked a specific part?*

The prototype is not of very high fidelity but every element is functional, so you can use everything. Take your time, you can just try and explore every function you'd like to use. Before we go through the concept, I would like to ask you to take a look at the system.

- *What do you see?*
  - *Please describe all the elements and their function*
- *What stands out in a positive or negative way?*
- *Here I will give some basic information, your flight number is NH212, your booking number is 18490387.*

Interview during the use cases

First part – mobile phone application

This app aims to help you experience an easy travel of long-haul flight experience. You can use it before boarding and after landing.

Can you please imagine you are at home and now start preparing this flight?
Can you please imagine you are at the airport and wait for checking in?

Questions about the first part – mobile app
(For questions related to general aspects that don't change on all user cases, only ask questions that haven't been asked before).

- *In your experience, how did it go?*
  - *How easy or difficult did you experience completing the task?*
  - *What was difficult? Why?*
- *What was positive and what was less positive?*
  - *To what extent was the scanning easy to understand?*
  - *To what extent did you find it easy or difficult to scan your products?*
  - *What do you think about the cart placement?*
  - *What do you think about the two scanners? Any difficulties with those?*
- *How do you feel about the flow of the process?*
  - *How do you feel about the order of the on-screen interface? And according to the steps you followed?* (show paper on screen interface)
- *Do you have any questions that haven't been addressed so far?*

Second part – IFE platform

This IFE platform also aims to help you experience an easy travel of long-haul flight experience. And you can use it during the flight.
And now I will add some background noise to stimulate the real situation.
Can you please imagine you have been on boarding and sit in the cabin?

Questions about second part – IFE
(For questions related to general aspects that don't change on all user cases, only ask questions that haven't been asked before).

- *In your experience, how did it go?*
    - *How easy or difficult did you experience completing the task?*
    - *What was difficult? Why?*
- *What was positive and what was less positive?*
    - *To what extent was the scanning easy to understand?*
    - *To what extent did you find it easy or difficult to scan your products?*
    - *What do you think about the cart placement?*
    - *What do you think about the two scanners? Any difficulties with those?*
- *How do you feel about the flow of the process?*
    - *How do you feel about the order of the on-screen interface? And according to the steps you followed?* (show paper on screen interface)
- *Do you have any questions that haven't been addressed so far?*

Welcome

- 谢谢你来参加我的毕业设计测试。
- 我们今天在这里测试数字平台，以获得更好的飞行体验。
- 本研究的目的是深入了解潜在用户如何与概念进行交互和体验，从而改进概念。

测试程序

- 测试将花费大约一个小时，有两个不同的部分组成，第一部分是手机 App，第二部分是飞机上的机载娱乐系统。
- 我一会儿会一步一步引导你做一些任务。
- 重要的是你要知道我们是在测试原型，而不是你！所有的反馈都是有价值的，不管你的反应是积极的还是消极的！
- 如果你能大声说出你的想法，那将会很有帮助，这样我们就能更好地理解你的经验，从而改进这个概念。Thinking out loud 意思是你说出你所想的一切，你在做什么，你喜欢什么，不喜欢什么(例如，如果你点击按钮，你会说“现在我要点击按钮，下一步，我想尝试这个功能”)
- 测试和面试将被录制成视频，只用于本项目的学习目的(只有我，没有其他人)。
- 如果您同意，请在我们开始之前签署这份同意书。
- 到目前为止你有什么问题吗？如果没有，我就开始录音。

START RECORDING

Pre-test interview

Goal: get acquainted with the participant and use his experience level etc as input for adapting the scenarios. Make the participant feel at ease.

你能简单介绍一下你自己吗?
你住在哪里?

• 你的飞行经历是什么?

o 你多久乘一次飞机?你飞行的目的是什么?

• 你有过长途飞行的经历吗?你以前坐过长途飞机吗?

你喜欢那里的什么?你不喜欢它的什么地方?

• 你能描述一下你在飞机上的睡眠体验吗?

你的经历怎么样?不喜欢或喜欢某个特定的部分?

原型不是非常高保真，但每一个元素都是功能性的，所以你可以使用一切。慢慢来，你可以尝试和探索你想要使用的每一个功能。

• 在我们讨论这个概念之前，我想请你们先看看这个系统。你看到了什么?

• 请描述所有元素及其功能

• 什么在积极或消极的方面突出?

• 这里我将提供一些基本信息：您将在两天后从伦敦希思罗机场前往东京，主要就是去玩儿的，您的航班号是 NH212，您的预订号是 18490387。

Interview during the use cases

First part – mobile phone application

这款应用旨在帮助你体验轻松的长途飞行体验。您可以在登机前和降落后使用。

你能想象你现在在家，然后开始准备这次飞行吗?

你能想象你在机场等着办理登机手续吗?

用户任务
1. Enter the application 进入应用程序
2. Tick the box to prepare carry-on luggage 准备自己的随身行李，给需要的物品打勾
3. Check the flight information 检查自己的航班信息是否有误，安排好自己的出行时间
4. Check in 4.1 Choose the seat I prefer (32K) 4.2 Find the check-in desk in airport 网上值机，选择自己喜欢的**（32K）**靠窗的位置 在机场找到托运行李柜台
5. Waiting for boarding and pre-arranging the in-flight activities 等待登机， 闲来无事开始安排机上活动 **（先听会儿音乐，再看个电影，睡一觉，醒来学习看会儿书）**， 查看飞机上提供的餐饮服务
6. Boarding and find the way to my seat 登机后找到自己的座位**（32K）**
7. Waiting for landing and lining up to leave the plane. Check personal report and find interesting spots in Tokyo. 降落后等待下飞机，开始查看自己在旅途中的身体数据报告，寻找东京有趣的地方。

Questions about the first part – mobile app

问题:第一部分——移动应用

- 根据你的经验，事情进展如何?你完成这项任务的难易程度如何?什么是困难的?为什么?
- 什么是积极的，什么是不那么积极的?
- 你对流程的感觉如何?
- 你觉得屏幕界面的次序如何？根据你遵循的步骤? (可以回看 link 说明)
- 你有什么问题到目前为止还没有解决的吗?

好的，接下来我们来完成一个测评表

Second part – IFE platform

这个 IFE 平台也是为了帮助您体验轻松的长途飞行体验。你可以在飞行中使用它。

现在我要添加一些背景噪音来模拟真实的场景。

你能想象一下你已经登机并坐在机舱里了吗?

你能回忆一下自己一般在什么情况下，以及如何使用这些机上屏幕的吗?

用户任务
1. Enter the IFE system 进入飞机娱乐系统
2. Watch safety instruction 观看安全须知
3. Have drink and meal based on personal demand 按照自己的需求选择是否需要餐饮服务
4. Explore the entertainment system 探索整个系统有什么娱乐功能
5. Try to import personal schedule made in APP 试着把手机端预先安排的活动导入系统
6. Try to have a good rest and fall asleep 试着好好休息放松自己，准备入睡
7. Do exercises for health, following the guidance after sleep 醒来后做一些小的锻炼，改善身体状况
8. Generate and export personal report 生成并导出自己在飞机上的乘机报告
9. Prepare for landing and leaving the plane 准备降落并离开飞机

Questions about second part – IFE

- 根据你的经验，事情进展如何?什么是困难的?为什么?
- 什么是积极的，什么是不那么积极的?
- 和现有的机上娱乐屏幕相比，有什么优缺点吗?
- 你觉得屏幕界面的次序如何？根据你遵循的步骤? (可以回看 link 说明)
- 你有什么问题到目前为止还没有解决的吗?

好的，接下来我们来完成一个测评表

Consent Form

Consent form for participation in user test

Dear participant,

For the project “Enhancing In-Flight Sleep Experience”, which is a graduation project of Zimeng He, Faculty of Industrial Design Engineering, Delft University of Technology.
The aim of the project is to develop a digital platform for passengers to have a better in-flight experience from the preparation, to adjustment, cruise, and after-sleep phases.

I’d like to ask you to read this form carefully and ask me any questions you might have.

1. Your participation in this test is completely voluntary. If you do not feel comfortable during the test and do not want to continue, you are free to withdraw at any time.
2. During the test, I will ask you a few questions referring to your personal experiences. If you don’t feel comfortable to share, you have the right to skip any of these questions.
3. The test will take approximately 60 minutes. The process:
    a) Brief introduction (5min)
    b) App test (10min)
    c) Interview and evaluation form (10min)
    d) In-flight Entertainment system test (15min)
    e) Interview and evaluation form (10min)
    f) Overall feedback (5min)

During the test, I will take notes and screen recording (online test)/film (offline test). If you do not want to be recorded/filmed, you are free not to take part in the user test. Please check any boxes you give permission to:

☑ Being filmed and the voice being recorded.

❑ Photos being used in academic publications. The personal identity will be protected by blurring the face.

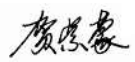
All information will be used for an internal purpose and in any sort of publication I will not include any information that will make it possible to identify you.

I have read the description of the study and of my rights as a percipient and I have received the answer to everything I asked. I hereby voluntarily agree to patriciate in this study.

Signatures

_____	_____	_____
Name of participant	Signature	Date

have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Zimeng He		2020/05/07
Researcher name	Signature	Date

参与测试用户知情书

亲爱的测试用户:

您参与的“改善飞机上睡眠体验”的设计项目是代尔夫特理工大学工业设计院学生贺紫蒙的毕业设计。该项目的目的是开发一个数字平台，让乘客在进行飞前准备、起飞后调整、巡航和睡眠后阶段有更好的飞行体验。

我想请您仔细阅读这张表格，并问我提出您可能存在的任何疑问。

1. 首先，您参加这次测试完全是自愿的。如果您在测试过程中感到不舒服，不想继续，您可以随时退出。
2. 测试期间，我会根据您的个人经历问您几个问题。如果您不愿意分享，您可以跳过任何一个问题。
3. 测试时间约为60分钟。大致流程为:
   a) 背景介绍（5分钟）
   b) 手机应用程序交互测试（10分钟）
   c) 采访、填写反馈表（10分钟）
   d) 飞机屏幕系统交互测试（15分钟）
   e) 采访、填写反馈表（10分钟）
   f) 总结反馈（5分钟）

在测试期间，我会做笔记和录屏(线上测试)/摄影(线下测试)。如果您不想被录制，您可以不参加用户测试。请选择您允许的任何选项:

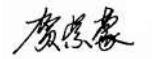
☑被拍摄和声音被记录。

❑照片用于学术出版物（为保护个人隐私，会对面部进行模糊处理）。
所有信息将用于内部用途，任何形式的出版物将不包括任何可能识别您身份的信息。

我已经阅读了该研究的描述和我作为一名参与测试者的权利，我已经得到了我所要求的一切的答案。
本人在此自愿同意参加本研究。

_____ _____ _____
参与者姓名 签字 日期

我已准确地向潜在的参与者宣读了信息表，并尽我所能确保参与者理解他们自愿同意的内容。

_____贺紫蒙_____ _____  _____ ___2020/05/07_
研究员姓名 签字 日期

Post Survey

Forms (预览) 手机系统可用性评分表（改善长途飞... - 已保存

手机系统可用性评分表（改善长途飞行体验）

System Usability Scale (Enhancing long-haul flight experience)

10	20:37	活动
答复	平均完成时间	状态

1. 性别 Gender

女 Woman	5
男 Man	5
非二元性别 Non-binary	0
不想说 Prefer not to say	0

2. 年龄 Age

10	最新回复
答复	"25"
	"56"
	"26"

3. 你认为这个系统能在飞行前增强你的安全感吗？(1表示强烈反对，7表示强烈赞同） Do you think the system makes you feel more secure before a flight? （7 means strongly agree)

10	5.5
答复	平均数

4. 你认为这个系统让你觉得更能发挥主观能动性吗？(1表示强烈反对，7表示强烈赞同） Do you think the system makes you feel more autonomous (opposites dependent)? (7 means strongly agree)

10	4.8
答复	平均数

5. 你认为这个系统比其他类似工具更灵活吗？(1表示强烈反对，7表示强烈赞同） Do you think the system is flexible (opposites fixed)? (7 means strongly agree)

10	5.3
答复	平均数

6. 你认为使用这个系统让你觉得更从容吗？(1表示强烈反对，7表示强烈赞同） Do you think using the system makes you feel serene (opposites pressured)? (7 means strongly agree)

10	5.2
答复	平均数

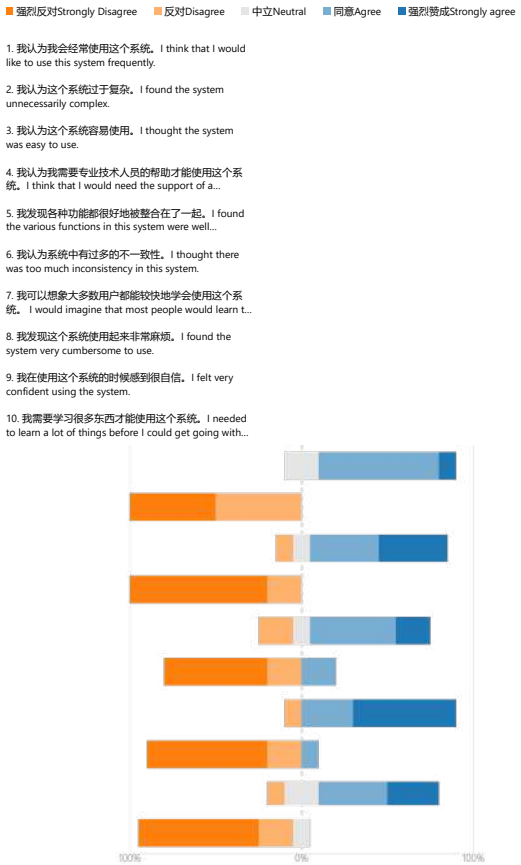
7. 你认为这个系统有利于你为飞行做准备吗？(1表示强烈反对，7表示强烈赞同） Do you think the system is helpful for better preparation before a flight? (7 means strongly agree)

10	6
答复	平均数

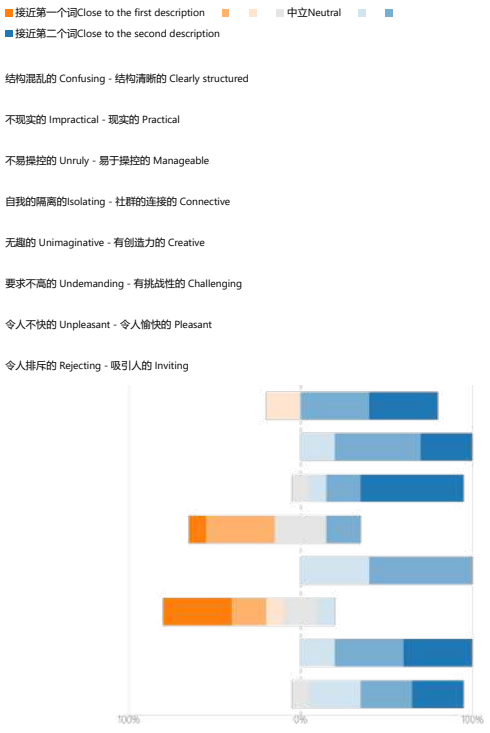
8. 你认为这个系统有利于你对刚经历的飞行进行回顾总结吗？(1表示强烈反对，7表示强烈赞同） Do you think the system is helpful for better reflection after a flight? (7 means strongly agree)

10	5.4
答复	平均数

9. 评分表由10个小问题组成，请选择最接近你想法的一项。 The System Usability Scale consists of ten questions, please choose one option for each question.



10. 评分表由多组相对的形容词组成，请选择最接近你想法的一项。 The AttrakDiff Evaluation consists of descriptive word pairs, please choose one option for each question.



Forms (预览) 飞机娱乐系统可用性评分表（改善长... - 已保存

飞机娱乐系统可用性评分表（改善长途飞行体验）

System Usability Scale (Enhancing long-haul flight experience)

10	96:59	活动
答复	平均完成时间	状态

1. 你认为这个系统能在飞行时增强你的安全感吗？(1表示强烈反对，7表示强烈赞同） Do you think the system makes you feel more secure during the flight? （7 means strongly agree)

10	4.1
答复	平均数

2. 你认为这个系统让你觉得更能发挥主观能动性吗？(1表示强烈反对，7表示强烈赞同） Do you think the system makes you feel more autonomous (opposites dependent)?（7 means strongly agree)

10	5.5
答复	平均数

3. 你认为这个系统比现有系统更灵活吗？(1表示强烈反对，7表示强烈赞同） Do you think the system is flexible (opposites fixed)?（7 means strongly agree)

10	5.1
答复	平均数

4. 你认为使用这个系统让你觉得更从容更放松吗？(1表示强烈反对，7表示强烈赞同） Do you think using the system makes you feel serene and relaxed (opposites pressured, anxious)?（7 means strongly agree)

10	5.4
答复	平均数

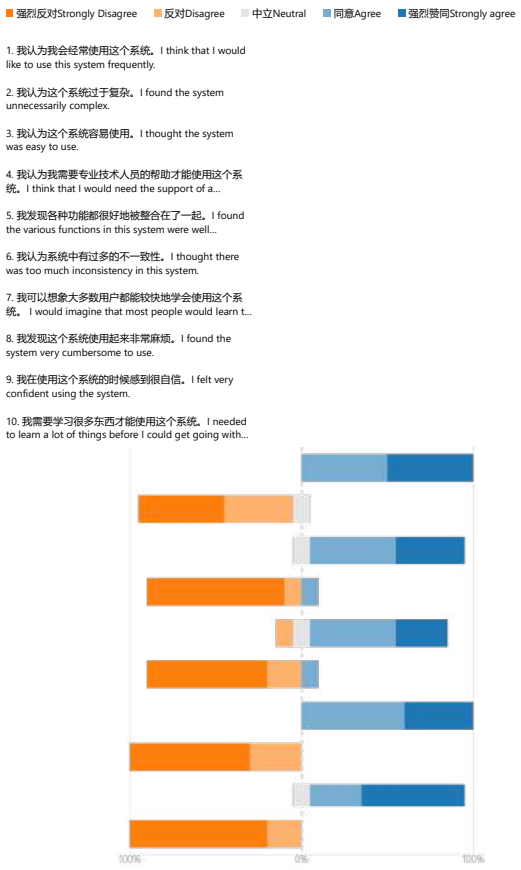
5. 你认为这个系统有利于你安排自己的机上活动吗？(1表示强烈反对，7表示强烈赞同） Do you think the system is helpful for better arrange in-flight activities?（7 means strongly agree)

10	6
答复	平均数

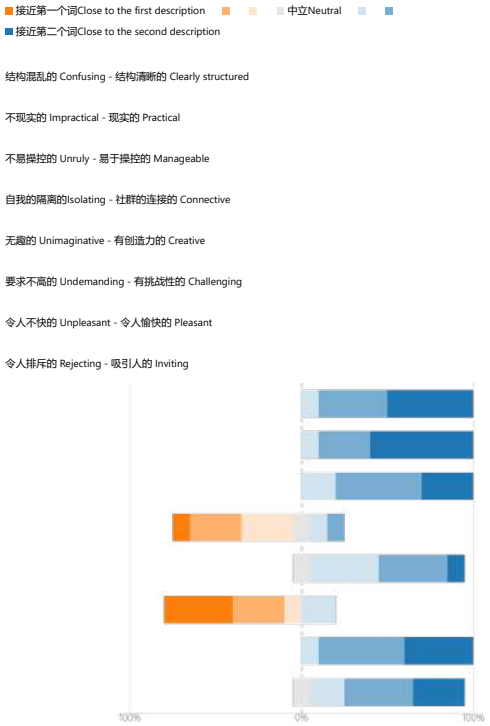
6. 你认为这个系统有利于你对刚经历的飞行进行回顾总结吗？(1表示强烈反对，7表示强烈赞同） Do you think the system is helpful for better reflection after a flight?（7 means strongly agree)

10	5.7
答复	平均数

7. 评分表由10个小问题组成，请选择最接近你想法的一项。 The System Usability Scale consists of ten questions, please choose one option for each question.



8. 评分表由多组相对的形容词组成，请选择最接近你想法的一项。 The AttrakDiff Evaluation consists of descriptive word pairs, please choose one option for each question.



Transcription

A1-25-Male

1-2 times/year

Phone APP:

1. Something that I don't need, so I want to delete instead of leaving it blank;
2. There is already a routine that I can follow, and I feel good because the arrangement is clear;
3. The seat map is not clear enough to see which seat has been chosen;
4. I want to have a screen shot and save the image of the information;
5. Prefer to see the timeline in the local time zone, or at least in "Take off" and "Landing";
6. Dragging the schedule module is not convenient for me, not used to it;
7. Add more text information next to the icon, so I can understand the meaning of each;
8. Combine the pre-schedule and in-flight service, to avoid overlapping information;
9. IFE needs more explanation (personal report);
10. New destination seems useless for me, because it's only a redirect page;
11. Airport information is more important after landing, e.g. how to check, how to collect baggage, clear immigration (before baggage claim) and customs (after baggage claim);
12. Only when I have a long waiting time, I'd like to see more information of new destination;

13. The timeline logic is not consistent, the tasks are ok, but the information is not;
14. The order is a bit confusing, Before Boarding-Boarding-In Flight;
15. The structure needs to be strengthened, card mode;
16. The symbol is confusing, tick box/hollow circle/solid circle.

IFE:

1. Timeline is helpful for me to be aware of time, and what will happen;
2. Prefer to enter the sleeping mode from the very beginning;
3. The relaxation part is good and might be really helpful for me;
4. Easy for me to interact with, some improvement of the current one.

A2-24-Male

10 times/year, short-haul flight frequent;
biggest problem in long-haul flight is SLEEP, small leg room, jetlag, always have a transition

Phone APP:

1. The design is clear at a glance;
2. The check list is not pertinent enough, maybe based on the travel purpose and travel length is more suitable;
3. Add food and water in the check list;
4. Estimate the weight of the carry-on luggage, because I'm worried about it would be prohibited;
5. I'd like to see a map of the airport, telling me how to go to the check counter;
6. + is not visible enough, can't get attention;
7. Pre-schedule is useless for laid-back passenger, who want to have a more flexible schedule, they don't care much about it;
8. Choose meal in advance is nice, but there might be a time limitation, like at least 3 days before;
9. Before landing ← in-flight
10. Boarding time - count down, don't miss the deadline;
11. After landing, want to score the airline;
12. Needs more information of the destination airport, exchange rate, how to call a taxi, etc.;
13. The page of pre-schedule can provide more info of the IFE, what movies/music/game will be provided in flight;
14. Provide the transportation information and tips, like how to avoid traffic jam;
15. Check list is good for more security;
16. Autonomous is not as good as Ctrip(Xiecheng), which provides pick up service from airport to the hotel;
17. The social media can be connected as well. The personal diary is good for sharing in social platform, like Xiaohongshu, Mafengwo, including the evaluation to the airlines;

IFE:

1. Mode setting is good, but the emoji is not clear enough;
2. Generally, it's very normal, even less function than the current system. For example, no flying map;
3. Can choose the meal time is good, more flexible, and can adjust the sleep time, relax time, game time;
4. Seat exercises are useful, would be better to get more scientific suggestion on how to arrange time to avoid jetlag;
5. Not a fan of arranging time in advance, no need for that;
6. Easy to use, user-friendly, target is clear and strong;
7. The system is more like a communication tool between passengers and airlines, is more efficient than verbal communication, less misunderstanding;
8. Airline could gather more information and make improvement based on that.

A3-Zhenyu-25-Male

2-3 times long-haul/year
The priority of sleep is the first, other like watch series, listen to music;
Space is too limited, legs are easily get dropsy, skin is easily get dry; Entertainment in economy class is limited, movies are old, no subtitles;
Meals are terrible, but don't want to take a heavy luggage on board, so no food nor water.

Phone APP:

1. The interface is user-friendly, looks comfortable and clean;
2. The preparation-needs a map guiding me from where I am to the airport, how is the current traffic condition;
3. Carry-on luggage-the list is too close to the left side, easily to be unintendedly activated;
4. Sliding tabs are convenient, information is comprehensive;
5. Pre-schedule-needs some instruction, no idea where to put these activity modules;
6. Could have some dash line hint, "adsorption interaction", add "from 2:00 to 3:30";
7. Meal be selected in advance;
8. Landing-less useful because the tight schedule, too many things need to be take care, like the procedure of taking baggage, customs;
9. Could add more airport indoor map, guiding passengers go to these point, and the material they might need (Visa, passport);
10. The function is not enough, especially the airport updated information and the traffic information;
11. Security-airplane type (like how many years have been used), personal history;

IFE: the noise is the biggest problem

1. Pop-up reminder might be annoying, would be regarded as advertisement. If can appear from the side, might be easily acknowledged;
2. Personal part is confusing, needs more instruction;
3. Schedule is not useful for me, I prefer flexible schedule;
4. Relaxation is essential and useful to take a rest;
5. The connection between phone and IFE is good;
6. Similar with the current system, the side bar is not easily understandable;
7. Timeline is helpful, remind me of the service time;
8. Not necessary to touch the physical light button on the top, it's convenient to control the environment;
9. Want to have more social quality, so passengers can share their experience in one platform with different languages, or with people who used to sit here, etc.

A4-Yue-25-Female

1-2 times long-haul/year
the space is too limited and want to go outside freely, so prefer the seat next to the hallway;
can hardly fall asleep because of the jetlag and small leg room; will bring own electronic devices, read novels, listen to music;

Phone APP:

1. The UI is clean and understandable;
2. The structure is not visible enough, sub-function looks similar with the main function, the circle and color needs more obvious difference;
3. More choices of electronics and skin care, pen, toothbrush;
4. Flight info-the size and weight of luggage;
5. Check the timeline in advance is really important, because I used to sleeping right after boarding, I often miss the first round of meal;
6. Schedule in advance is not useful for me, it's difficult to predict what I want to do during the cruise;
7. It's impossible for me to work or read, suffering from motion sickness;
8. I am interested in the health report, and would like to share it with my friends or family, just in social media, and see others' reports as well;
9. After landing-how to change a SIM card, connecting the wifi, signal is more important;
10. Then is calling a taxi, because too many exits, and difficult to find the right one;
11. Integration in one platform is nice, avoiding switching among various applications to find what I really need, especially for people like me, who are easily get nervous before a flight;
12. It helps me to easy anxiety, and easy, user-friendly, every separate part is clear, and I'd like to share it with others;

IFE:

1. I'd like to see the map, how much is the flying height while landing, etc.;
2. Choose the dinner time is very nice, but worried about increasing the work load of flight attendants;
3. I am willing to try to use the function of Relaxation, looks very helpful, never see this in a flight, could help me to focus on myself;
4. Guidance of doing small exercises is nice, tried once in Tianjin Airline, passengers are willing to follow with the broadcast;
5. Mode options are nice, active mode/sleep mode/don't disturb mode;
6. If can control the temperature and the wind circulation system;
7. Still worry about the objective constraint, and the development of technology, and if they are affordable.

B1-Gubing-26-Female

3 times long-haul/year back home is relaxing, but leaving to a new place (alone) is pressured, because needs to arrange after-landing by myself;
Like to communicate with neighbour, walk around between snaps;
Would be disturbed during the sleep, and it takes more time to fall asleep;
Would forget something important, but notice too late, like the delay of the flight, seat selection;

Phone APP:

1. How much food or snacks do I need?
2. Sliding tabs are confusing;
3. Availability of seats are not clear enough;
4. Like to have reminder, because always forget to choose seat in advance;
5. Boarding information needs to be double checked;
6. Timeline of inflight activity needs to be highlighted;
7. Want to adjust the meal time as well;
8. Like the health report, because I am interested in this field, think it would be useful if there are more scientific suggestion, like how much sleep do I need to overcome the jetlag;
9. If the data is far from the average, then would be nervous about the health condition, and be more aware of that in the next time;
10. Really want to have some personal time after boarding, because staying in the public environment for a long time;
11. Want to communicate with boyfriend after landing in a private space to avoid embarrassment;
12. Overall, I like the feeling that I can know comprehensive information in advance, but the real situation must be more flexible;
13. Compared with KLM app, it integrates more functions, but I am worried about the connection with airline. Do flight attendants know about that?

IFE:

1. Like the feedback of when the drink and meal will be served, so I can prepared;
2. The schedule could be imported into the system, which is cool, but want to see if could be zoomed in;
3. The report could be exported into phone, also nice;
4. The touchable screen is not sensitive enough, so not sure if there are more options of activities.

B2-Max-33-Male

2 times/year
From Beijing to US, 16-17 hours, have a transition in between
Activities: watch movie, although not often watch in daily life; Would like to walk around, sometimes there is a snack bar in the tail of the cabin;
If have more budget, then I would choose seat with more space, like in the first line;
If go for a conference or other meeting, feel more pressured, then would like to have more resting time, to be prepared for the following activities after landing.

Phone APP:

1. Color of UI is fresh, but without strong correlation with the flight;
2. Check list can be a reference, want to bring snacks as well;
3. Charger/laptop/files/documents, more options for working purpose;
4. Better to choose the purpose for the check list;
5. If Wifi is free, then highlight it;
6. Use solid circle to represent the current tab;
7. E17 check counter could be shown in an airport map;
8. Before boarding, would make sure everything needed in the accessible pocket or the most outside layer;
9. See the timeline in pre-schedule, would try to click the circle and see what is in each step, connect with the service provided, entertainment provided;
10. Not many people using the pre-schedule function, still use instinct to do what they want to do;
11. This function is not necessary for individual, redundant for me;
12. It's necessary for vegan or people who have a special diet to order food in advance;
13. If have a habit to wear a smart band, then it would be useful and can compare with the history;
14. It's too complex, though might be helpful, focus on the current happening thing would be more suitable for me;
15. New destination is good for me to see different platforms in one time (weather, traffic, service desk, wifi, signal);
16. Like the use of flat icons, clear and friendly;

IFE:

1. Controlling and adjusting the lightness is good;
2. Easy for me to operate and understand;
3. Nice UI;
4. It's intuitive to arrange in-flight activities according to the timeline in the bottom;
5. Nice to connect with phone;
6. Not useful to give feedbacks to airlines, also concern about the privacy, personal data be used for other purposes;
7. Use the same style and basic structure with the current system;
8. Needs more rewarding mechanism as promotion.

B3-Peixin-23-Female

Tried to work in-flight, not really handy, because of the uncomfortable posture and limited space;
Afraid of "big" neighbours, noisy and chatty neighbours;

Phone APP:

1. Like the check list, but if could be edited, would be better;
2. Needs some tips for safety check, like less than 100ml, battery, the liquid;
3. Confused about the circle and the check box;
4. The availability of seat is not clear;
5. Like the preschedule function, which could help me organize the time, want to see end time, (form 2:00 to 3:00, work for one hour);
6. Have a sleep habit of sleeping for the times of 1.5 hours, so I would calculate how long is good for me to adjust the sleep cycle in the local time;
7. If I just take a leisure flight to travel on holiday, I wouldn't use it;
8. If I have to work in the cabin, I would use it because I don't want to waste time. But the biggest issue is the work itself, not the environment or self-condition;
9. Menu for meals is good for overcome the language barriers, also nice to think in advance, so won't waste other passengers' time;
10. After landing-need to know how long the custom procedure takes, updated information of the que;
11. Feeling of "everything in control" is strong, but no highlights, each part seems equal and functional, no emotional feedback;
12. Overall, it's better than the other similar applications developed by airlines, have more guidance;

IFE:

1. The timeline is very nice, so I can prepare a little bit to choose what I want;
2. The security is more from the airplane itself, like the turbulence;
3. Add personal arrangement in the timeline is helpful, and also creative;
4. After landing, I'd like to give score to the airline. It doesn't matter if they are will to take the feedbacks, I just want to blow off steam;

C1-Tianyu-26-Male

Never take a long-haul flight, but have many experiences of over-night train;
Don't have much expectation on the public transportation;
The only few experiences of flights were all satisfactory, and all short-haul flight. The impression was faster, more comfortable than train;
During the overnight train trip, would listen to music, watch videos, have snacks and check if the train is on time or not (use phone applications);

Phone APP:

1. Not quite familiar with these steps, so might search the basic procedure first;
2. The carry-on luggage check list is for checking? Or remind me to bring things?
3. The seat map is not easy to understand, color coding not obvious;
4. The dragging function is not functional, not easy to use. Might need some hint to understand;
5. Leisure activities and sleep are flexible, not necessarily need pre-arrangement;
6. Not sure how flight activities would be practical, might be influenced by the changing situation;
7. The meal selection is good, saving the communication costs, and effective;
8. The icon of (day-night) for sleep is difficult to understand;
9. I am interested in the sleep/health monitoring report, but only take a look to kill time, won't import it into phone;
10. Also I would doubt the accuracy of the report, whether it is trustful, and seems useless because I am not able to change it (not take a flight so often;
11. The ordinary document would more helpful (for frequent passengers);
12. Generally, the process is smooth and logic, reminder could help a lot. I'd follow each step to arrange my schedule and won't forget thing, won't miss the time.
13. Might be interesting to add social characters, the frequent traveler might share their experiences;
14. Seat selection-add the social interaction, passengers could choose to show part of their information, like age, gender, hobby, etc.

IFE:

1. If I sleep right after on boarding, then still need some reminder from broadcast;
2. The connection with application is nice, because phone is more often used in daily life;
3. The main concern is how to fall asleep faster and avoid disturbance.

C2-Belle-56-Female

Never take a long-haul flight, the only few experiences of flights were all satisfactory, and all short-haul flight;
The impression was fast and comfortable, especially the in-flight service;

Phone APP:

1. Quite satisfied with all functions, clear and organized, feel sure about the essential information;
2. The communication steps are simplified, could imagine less misunderstanding, less waiting time;
3. The + icon could be add on the timeline, so draw more attention;
4. Care much about own health, because of the previous experience of heart attack. So a clear report would ease my nervous condition.

IFE:

1. The service time range is thoughtful, in case I don't feel hungry at that time;
2. Meditation is good, because I've tried it before go to the bed. But never tried the guided one, definitely want to use this function;
3. The seat exercises function is also good;
4. The only missing part is the social interaction with neighbors, if I feel lonely or boring, still want to have some real interaction instead of staring at the screen;
5. The destination information could be richer, like the climate, hot news, history, etc.

C3-Ray-35-Female

Never take a long-haul flight, the only few experiences of flights were holiday travel;
2 hours midnight flight, the budget airline is not so satisfied, like the seats are unadjustable;
Don't feel comfortable to waken neighbour, worried about to go toilet;
Prefer to use own portable electronics instead of the in-flight entertainment system, though would easily get motion sickness or sore eyes.

Phone APP:

1. The UI is very clear and logic, color coding is comfortable;
2. The intuition information on the overview page, don't need click or enter into a new page;
3. Probably take more personal care items;
4. The online checking is so convenient, saving much time;
5. But the seat map is not clear, seem confusing to me;
6. Feel curious about the health report, and have the habit to check the wearable band in life;
7. The taxi information would be handy if provided after landing;

IFE:

1. The timetable could be imported into the system, which makes it more convenient to check and arrange;
2. The seat exercises seem limited due to the small leg room and neighbors;
3. The meal service chosen in advance and postpone the time function is user-friendly to people who are afraid of the communication, without language barrier;
4. Would like to try all relaxation function, because it was tiring to take a long-haul flight;
5. The mode chosen function is also convenient, without any efforts;
6. The mode for children, like "eye protection" or "teenager mode";
7. For little children, if any activities more specific? Like drawing on the screen or other physical interaction.